Wairarapa Water Resilience Strategy

Prepared for:
Wairarapa Councils

Presented by:
Geoff Henley

12 May 2021

Joint Statement by Ngati Kahungunu PSGE ki Wairarapa and Rangitāne Tū Mai Rā Trust (Wairarapa Tamaki Nui Ā Rua) PSGE

Water is the blood of the earth mother Papatūānuku and the rivers are her veins. It is her who has given us life from time immemorial and it is with her that solutions to climate change lie. All things animate and inanimate have mauri. Mauri is an innate life force that requires balance.

We have disrupted the balance of the natural world. We have altered the natural way of things such as the rivers and the streams and as a result the earth mother is less able to nurture us in the face of climate change. Climate change will affect our whole region, the land and rivers, lakes and coastal areas. We need to restore the natural processes that sustain them.

We recognise that we live in a changed world. Restoring natural processes involves repairing, freeing up and empowering natural processes by cleaning rivers, supporting river flows, encouraging the flow of natural springs and retaining water in the natural ecosystem. We can do that with the benefit of both modern and traditional knowledge and practices.

Our role in resource management is now set down in Acts of Parliament and that is a good first step, but we as iwi of Wairarapa see that real progress is possible when we are in equal partnership with the Councils and the Crown, respecting our contributions and for the benefit of all. We want to be equal partners not only in law but in the quest to restore water resilience including, but not limited to, the co-management and co monitoring of water and active in the environmental restoration together.

Restoration of the mauri of the water will lead to restoration of the mana of our people. Our mission is to restore the healing power of Papatāūnuku through the restoration of as many natural processes of water resilience as possible. We welcome modern methods and technologies especially where they strengthen the catchment-wide reach of the earth mother and her natural processes that will be the difference between success and failure.

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Our Vision

A spring of water from the heart of Papatūānuku

An eternal spring of water, unfailing

An eternal spring supports life

An eternal spring supports longevity

An eternal spring supports eternal well-being

Background

- NIWA Wellington region climate change report (June 2017)
- Publication of the Ruamāhanga Whaitua Implementation Programme (Aug 2018)
- Identified in the Wairarapa Economic Development Strategy (Oct 2018)
- Initiated by the Wairarapa Water Users Group (November 2018)
- Application to the Provincial Growth Fund approved (late 2019)
- Wairarapa Water Resilience Group formed (late 2019/early 2020)
- Work commenced (beginning of 2020)
- First full draft completed (December 2020)
- Final draft completed (February 2021); draft finalised 3 May 2021

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Climate change threatens that eternal spring of water

The “shock” of climate change:

- **Water deficit** – 15% less by mid-century (evaporation)
- **Low flows** – more water required
- **Economic and population growth** – more water required
- **Loss of mauri** – more water required to protect the environment
- **Infrastructure challenges** – councils already have major water-related financial commitments e.g. plugging leaks

Could require up to **40-50%** more water (or less water used) than at present, by mid-century in the water deficit period.

The Shock: the climate change impact will be progressive, cumulative, long term and destructive (and irreversible)

The Response: progressive, cumulative, rational, constructive, unrelenting and collaborative

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Our goals

To protect Papatūanuku

Because without her we have nothing

To protect ourselves, our communities and our livelihoods

Because without them we are nothing

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Iwi Position – Rangitāne Tū Mai Rā Trust Wairarapa (Tamaki Nui Ā Rua) PSGE and Ngati Kahungunu PSGE ki Wairarapa in co-governance.

Direction of current discussions:

- **Solution-focused** – taking a solution focused approach to issues
- **All solutions are in play** – may be multiple solutions in play at once
- **Focused on the mauri of water** – a shared value system in regards to water(Te mana o te wai)
- **Nature-based (green) solutions** - favour nature based green solutions across the whole-of-catchment
- **Transformational** – stronger emphasis on the transformational end of the spectrum
- **Experimental and collaborative** - keen to be active and try new ways together to find transformative solutions
- **Influence** - part of decision-making and governance, not just advisory

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Preparing our mindset

The scale:	**The impact is large,** but it is slow-release
Long term:	**The impacts may be over 100 years,** though they will be significant over 50 and consequential over the next 20 years. We have never really thought in those number before.
The unknown:	**There is likely much more we don't know** than we do know about the impact and consequences. This is the start of a journey of ongoing absorption/adaption/transformation.
Invisible:	**The doubters will have a plausible case,** at least on the surface, because many effects will be imperceptible until small effects have cumulated into a major effect.
Priority:	**Other things will appear more important in the moment.** The longer we delay action the more we risk foreclosure of options.
Complexity:	**The complexity is high** because there will be issues of fairness and responsibility.
Iwi/Māori:	**Working with iwi** as partners in the management of water.

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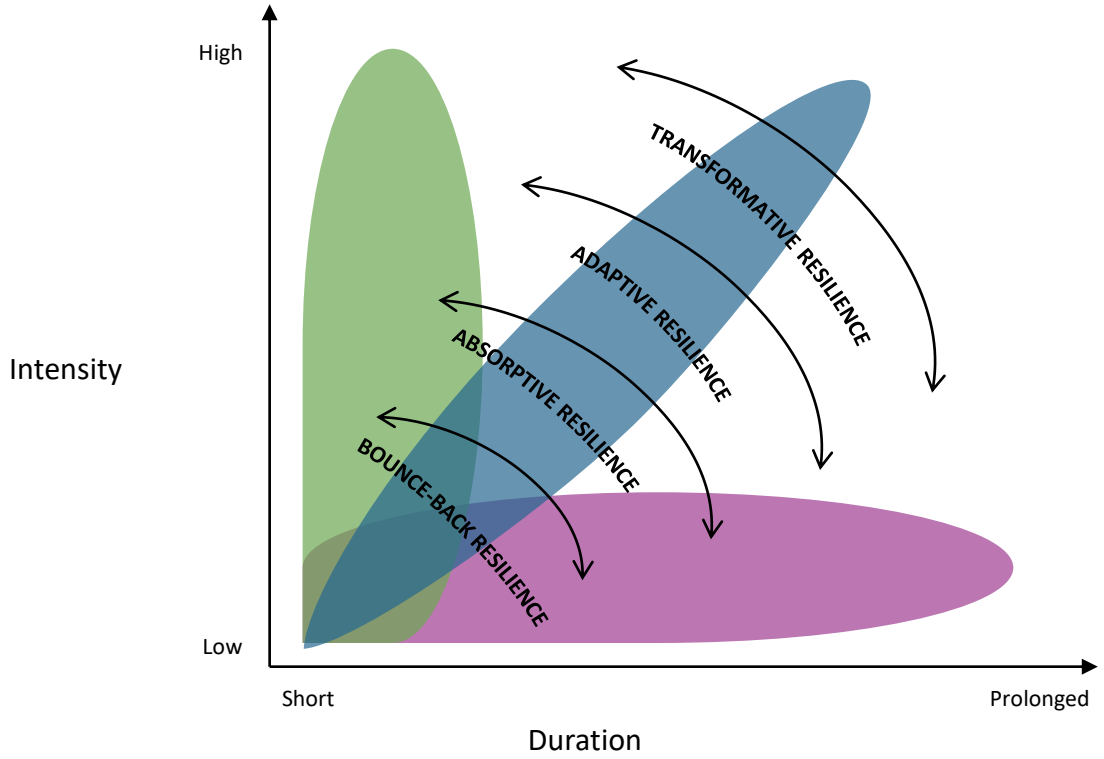
What is Resilience?

Response to a ‘shock’:

- **Bounce back** – to status quo
- **Absorption** – with moderate but not fundamental change
- **Adaption** – pre and post shock
- **Transformation** – making significant change to new normal.

All these levels of resilience are in play in this Strategy.



Source: Adapted from the handbook of regional economic resilience

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Essence of the Strategy

- **Temper demand**

  Doing more with less generally, but particularly through land use changes
  Encouraging less water-intensive land uses
  Pushing amenable land uses to the shoulders
  Encouraging greater efficiencies including allocation
  Encouraging greater GMP
  Better public education about volume use in dry periods

- **Enhance supply**

  Sequestering water by directing it to, and retaining it in, the whole ecosystem
  Augmenting groundwater, surface water, lakes, wetlands
  Holding water in streams, soil and vegetation
  Retaining water through constructed storage (rural and urban)

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Strategy v Tactics

Our overarching strategic focus:

Tempering demand and enhancing supply generally

Our step-by-step tactical focus:

Targeting demand in the water deficit period

- Land use change
- GMP/public education
- Efficiency/allocation

Targeting supply in the water deficit period

- Capturing water from rainfall-induced "freshes" in spring and summer
- Directing that water into groundwater (using primarily green/grey solutions with green bias)
- Using the holding/delaying capacity of the groundwater system to build/retain groundwater volumes (rural and urban use)
- Operating at a whole-of-catchment level to achieve the volumes and ease access
- Compressing the water deficit period into January to March (and holding it there)

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Green and Grey

All solutions are in play across the grey/green spectrum – each designed for a particular purpose

Almost all solutions are a combination of green and grey:

riparian planting

wetlands

adaptive land use/GMP

stock water races

public education

urban & rural use efficiency

managed retention – bunds

groundwater augmentation - MAR

bulk storage

rainwater harvesting

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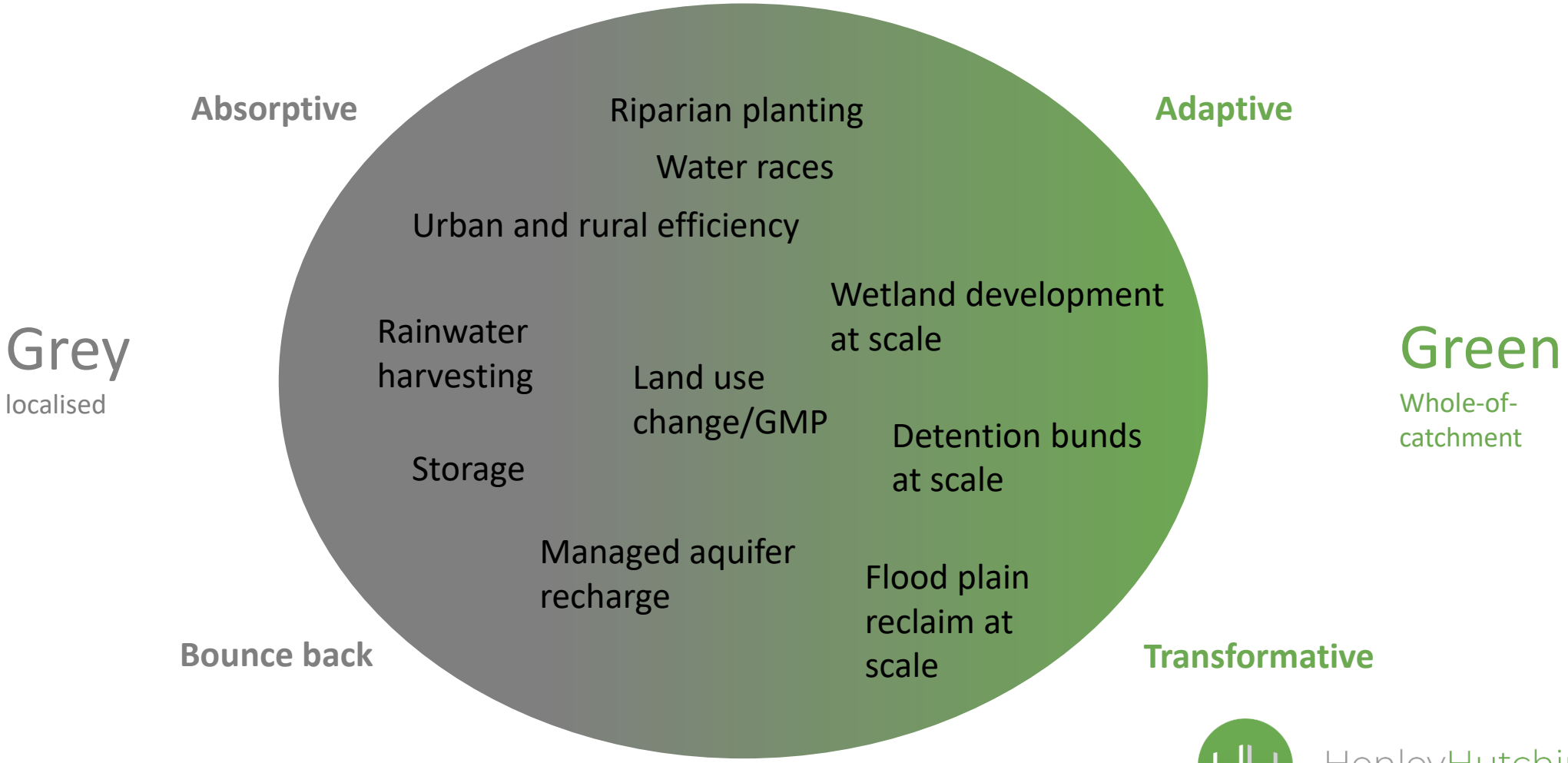
Roles of solutions



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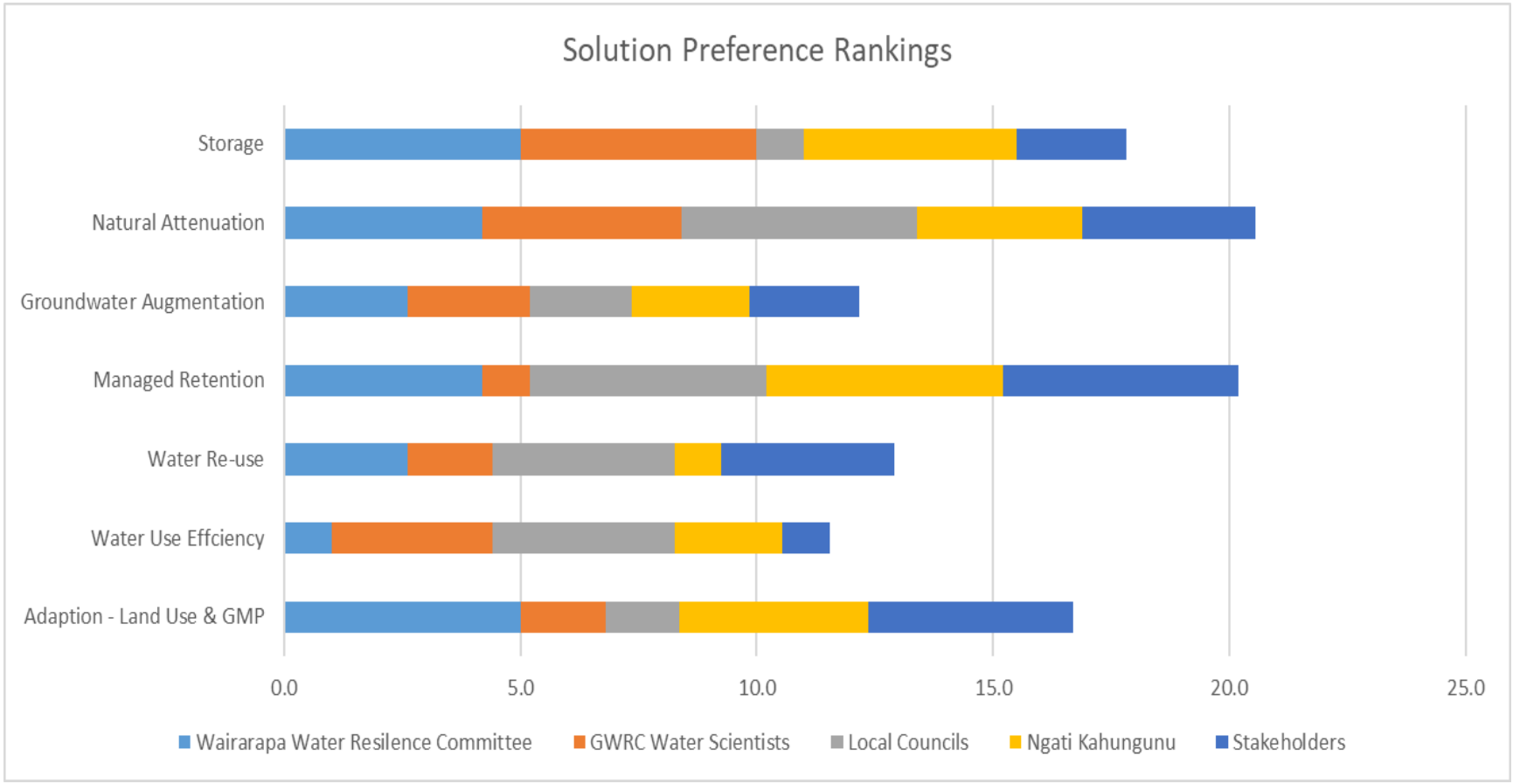
All options are in play



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The Greatest Challenge

The greatest challenge is not science or our
ability to make and build our defences:

WE ARE SMART AND INNOVATIVE

The greatest challenge is the people challenge,
dealing with doubt, denial, fear, rigidity, uncertainty and complexity:

LEADERSHIP

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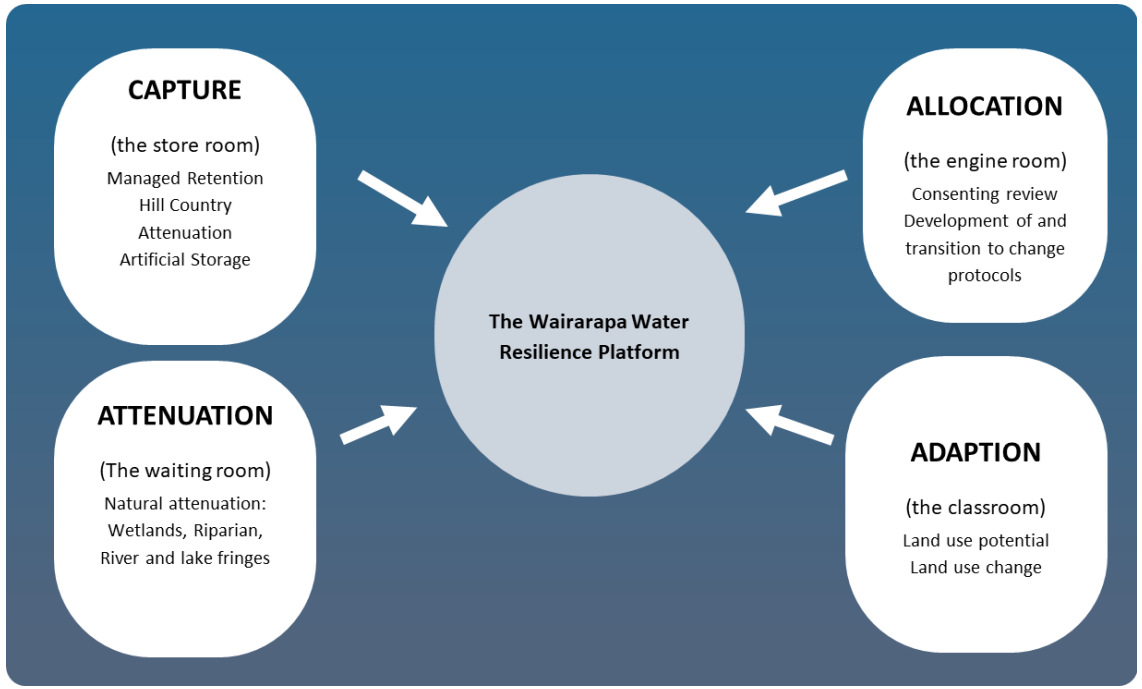
Creating a Leadership Platform

- **Resilience Platform** – the focal point, the leadership base
- **Capture** (the store room) – solutions that augment water supply
- **Attenuation** (the waiting room) – solutions that hold moisture/water in the ecosystem
- **Adaption** (the class room) – land use practice-change that tempers demand
- **Allocation** (the engine room) – regimes that regulate and distribute an increasingly scarce and valuable resource



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Whose involved?

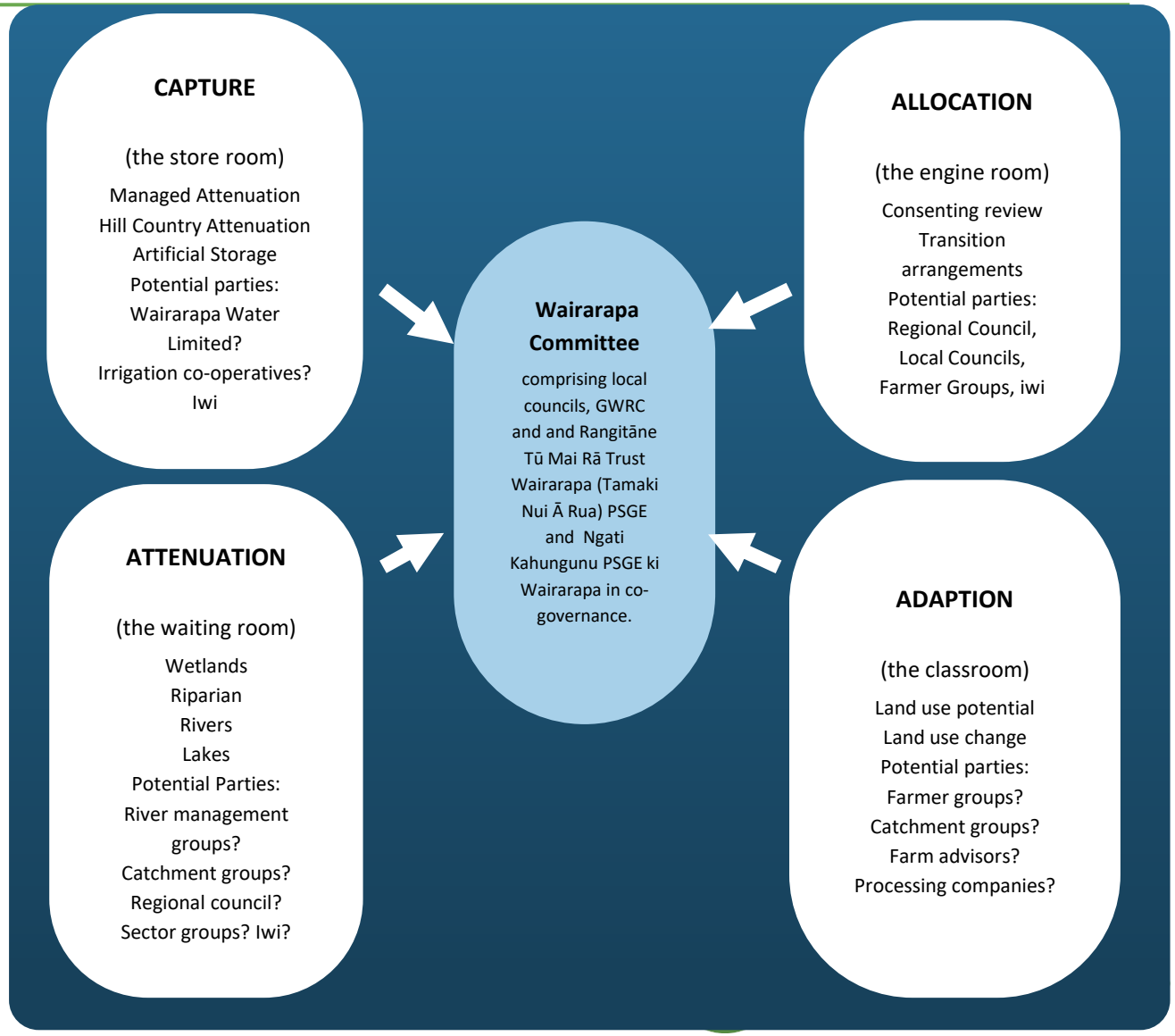
Total community and stakeholder effort

- Local councils
- Regional Council
- Iwi
- Irrigation interests
- Farmers groups
- Catchment and River Management Groups
- Environmental Groups

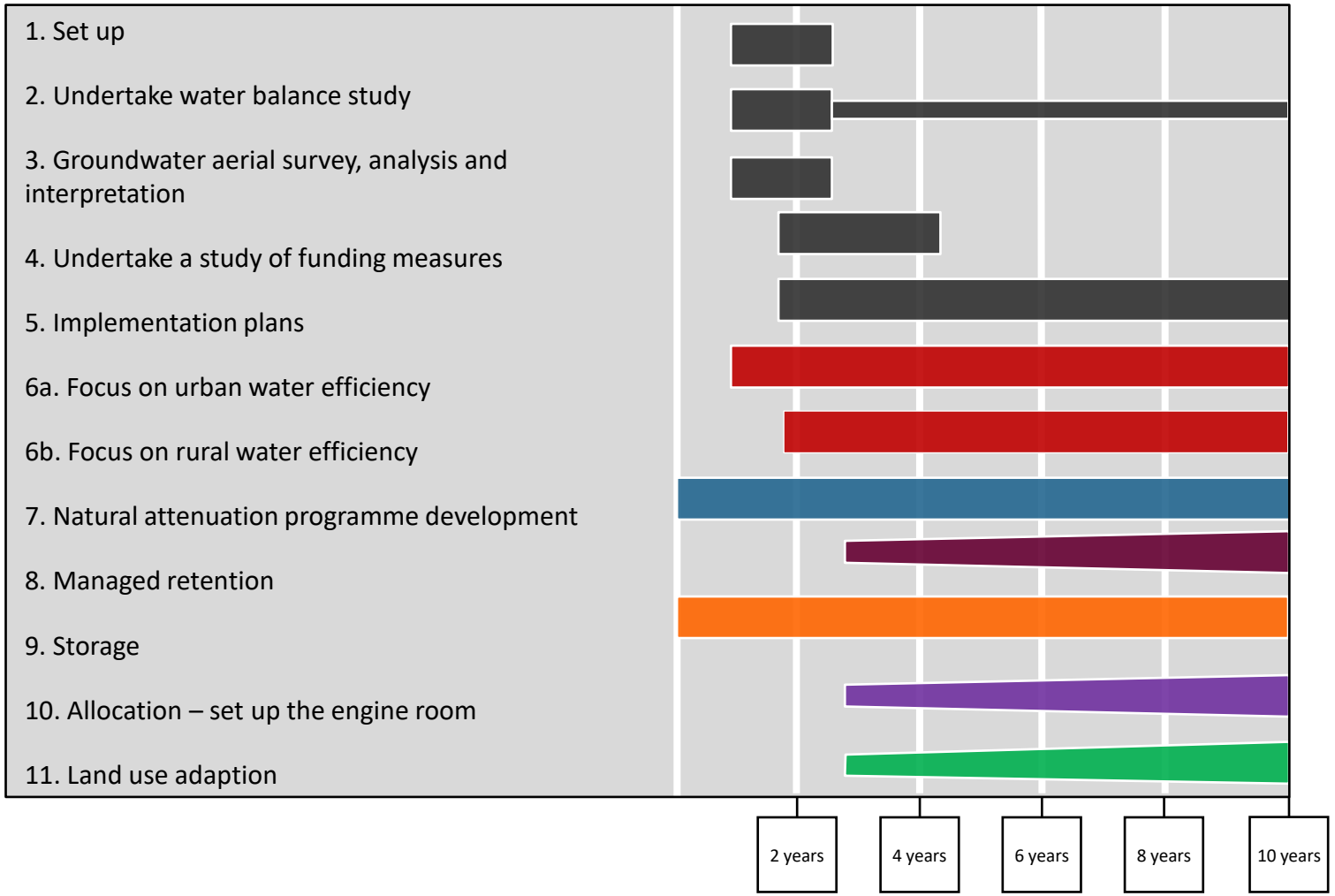
All operating to the same plan

Each in their own swim lane

Connected through the Wairarapa Committee



Scheduling



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Next Steps

- **Commitment in principle** – gain the commitment of key organisations
- **Create the leadership entity** – the platform that drives the programme
- **Schedule the work programme**
  - prioritise the four rooms, some are more immediate than others
  - Build into the programme the key relationships with partners
  - Delegate responsibilities
- **Mount support projects:**
  - Launch the Strategy
  - Stocktake of existing relevant projects to get an overview
  - Undertake water balance study and establish KPIs
  - Undertake SkyTEM study and incorporate findings

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WAIRARAPA WATER RESILIENCE STRATEGY 2021

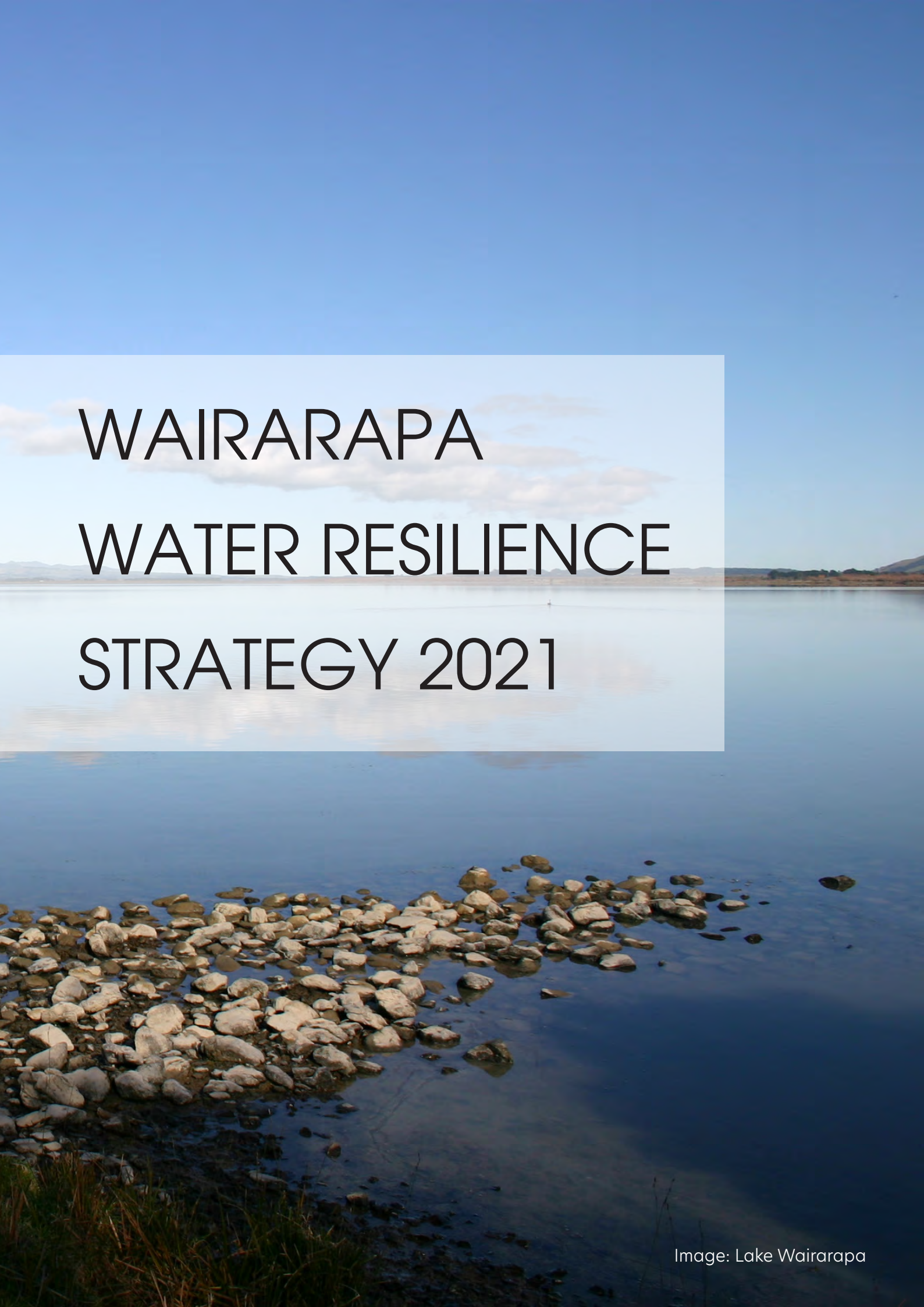

Image: Lake Wairarapa

He puna manawa, he manawa whenua!

He manawa whenua, he manawa ora!

He manawa whenua, he manawa tū!

He manawa whenua, he manawa tangata!

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Joint Statement by Ngati Kahungunu PSGE ki Wairarapa and Rangitāne Tū Mai Rā Trust (Wairarapa Tamaki Nui Ā Rua) PSGE

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All things animate and inanimate have mauri. Mauri is an innate life force that requires balance. We have disrupted the balance of the natural world. We have altered the natural way of things such as the rivers and the streams and as a result the earth mother is less able to nurture us in the face of climate change.

Climate change will affect our whole region, the land and rivers, lakes and coastal areas. We need to restore the natural processes that sustain them. We recognise that we live in a changed world. Restoring natural processes involves repairing, freeing up and empowering natural processes by cleaning rivers, supporting river flows, encouraging the flow of natural springs and retaining water in the natural ecosystem. We can do that with the benefit of both modern and traditional knowledge and practices.

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Foreword

The October 2018 Wairarapa Economic Development Strategy and Action Plan said that "an optimum and integrated view of water is required" when referring to water use in Wairarapa. It said: "The opportunity is to address these issues in an integrated manner now while there is time, to avoid being forced into urgent action when time is compressed".

Climate change is arguably the major threat of our age. It also presents significant opportunities, but we will only grasp those if we address the climate change challenges head-on.

It was with this thinking in mind that the idea of this Wairarapa Water Resilience Strategy (WWRS) was initiated by a local water user group who convened a meeting of farmers, industry users and local council representatives at a meeting in November 2018 and another in January 2019. The group was joined by the local council mayors, the Chair and Wairarapa members of Greater Wellington Regional Council and Iwi leaders of the Rangatāne and Kahungunu Settlement Trusts. Later, members with an environmental interest and the Chair of the Whaitua joined.

Concurrently funding was made available to Wairarapa Water Ltd by the Provincial Growth Fund for a feasibility of a storage scheme at Wakamoekau. It was believed by those involved that a broader catchment-level resilience strategy was required to address the broader climate change issues. The WWRS Group was formed - a large group representing many interests including councils, iwi, land users, commercial interests, sector and advocacy groups. WellingtonNZ acted as the overseeing agency and I was pleased to be asked to chair the WWRS Group, extending from my role as chair of the Wairarapa Economic Development Strategy.

It was clear to me that successful water resilience would only happen if all interests in the community worked together. As a result, we took an inclusive approach and while it resulted in much intense debate, the result is a broad consensus about what needs to be done. The direction and approach pointed to in the Strategy provides an effective vehicle which will evolve over time. The important thing is to get started.

I would like to thank all those involved in the Strategy Group for their contribution and patience, their openness and willingness to discuss and debate. The patronage of the mayors/chair and councils has been vital and all have stayed the course. The iwi contribution has been significant and have actively assisted us reflect their views and priorities. I hope a co-governance management model will ensure their full participation over the years to come. This could not have been completed without the funding and in-kind support from the PGF and the councils, including the Greater Wellington Regional Council.

It's a big read, but a worthwhile one. The Executive Summary overviews the thread of the Strategy and the Addenda contain a lot of background information that helped build the arguments. The result is a piece of thinking of the scale required to address an issue as complex as climate change. The journey now begins.

Dame Margaret Bazley ONZ, DMNZ
Chairperson of the Wairarapa Water Resilience Strategy Group
May 2021

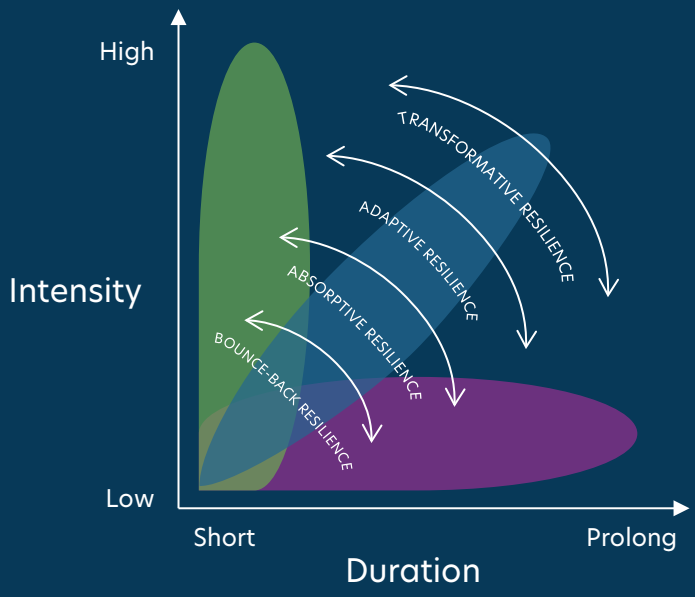
Executive summary

The October 2018 Wairarapa Economic Development Strategy and Action Plan said that "an optimum and integrated view of water is required" when referring to water use in Wairarapa. It said, "The opportunity is to address these issues in an integrated manner now while there is time, to avoid being forced into urgent action when time is compressed".

There is no resource more fundamental than freshwater and yet we often don't appreciate its importance until the supply is threatened. Climate change is the primary threat, aided and abetted by our 'traditional' approach towards water: that there are supposedly infinite volumes available and that where there is scarcity, infrastructure solutions will save the day. That will simply not be the case. Climate change effects will be experienced most along the New Zealand's eastern margins, including Wairarapa, and overtime they will be severe.

What is resilience?

Resilience is often regarded as the ability to "bounce back" after a shock, or alternatively the ability to absorb shock without changing the structure, identity or function of the structure or system. A third conception of resilience is 'positive adaptability' capacity in anticipation of, and after a shock. This definition is more akin to robustness and is often termed adaptive resilience. There is transformative resilience. This is where significant change is required to adjust to the shock and prosper. All three definitions are relevant to our task.



Source: Adapted from the Handbook of regional Economic Resilience

Climate change is not a sudden event. It will be a **progressive, cumulative, long term, destructive and perhaps irreversible**, process that will define the next 100 years of human existence. In this context, resilience is less about bouncing back and more about springing forward to a new and more sustainable reality. The quicker we spring to a new reality, the better, and how we define that new reality and what actions we take to achieve it are the subject of this report. It is also about building a new robustness to resist the negative impacts of climate change.

That more sustainable reality will only be realised by a **progressive, cumulative, constructive, unrelenting and collaborative** response where a whole community works together at a whole-of-catchment level for a common goal. The

robustness of the response must match the scale and complexity of the challenge. Success- whatever that ends up being, and that will only become apparent as we move forward- will only be achieved by all parties staying together and staying the distance.

The iwi idea of mauri regards everything as being in balance and where it is out of balance, that that balance is returned. Reversing many of the impacts of climate change will be impossible. Instead, iwi will need to be involved in the decision-making around what the "bounce forward" balance might be. Climate change challenges all of our mindsets.

There are other resilience challenges such as ageing infrastructure, earthquake and other natural events, but the climate change challenge is the single dominant and integrating consideration in resilience for the next 20-30 years.

What is the climate change "shock"?

Less water in an economy that is highly dependent on water (especially for agriculture and tourism) will likely lead to fewer jobs and static or falling prosperity[1]. The economy could adapt by moving away from water-based industries and there is evidence of this, but it is not the focus of this Strategy. It could do more with less water and this is the primary focus of this Strategy.

There are five aspects of the "shock" that add up to a significant impact on our community and economy:

- **Water deficit** - by mid-century, it will take 15% more water just to continue with our present day activities, due to less rainfall and increased evaporation.
- **Restrictions at low flows** - increasing some minimum flows and some restrictions on groundwater users recommended by the Ruamāhanga Whaitua will significantly reduce water that is available for abstraction in the hot, dry summer water deficit period.
- **Accommodating growth** - there is already demand pressure on freshwater and Wairarapa is growing. Even at 1% a year (current estimates) this involves significant extra demand for water over 20 years.
- **Loss of mauri** - mauri is likely to be further degraded and restoration and protection of the mauri of the water is likely to require more water directed to the environment (the amount is unable to be specified at this time).
- **Infrastructure challenges** - the local councils are already facing a hefty bill for the upgrade of ageing water infrastructure meaning that limited public capital funds may be available for investing in other resilience priorities.

This problem statement is a crude estimate to illustrate the scale of the "shock", which is potentially substantial. Work will be required to more accurately detail the impact.

[1] This is assumption and has not been modelled.

How do we find our way through this conundrum? There are some short-term relievers. For example, there are potential efficiency gains as towns reduce their losses due to current high levels of leakage from piping systems. This could result in a 5-10-year demand plateau in the towns as a result of improved efficiency. There is also a positive gap between what water is consented and what is used, meaning there is still some capacity available, but this may only help in the shoulder seasons and similar to the urban situation, is probably temporary.

The real problem is that the water deficit period on average experienced from January to March, will intensify and even expand with climate change and that will be the pressure point. Already water consumption increases significantly in this period in both town and country. Why? Because it is hot and will become hotter. As minimum flow regulations progressively tighten throughout January to March (the peak growing, tourism and visitor season) then availability will become severely constrained. Nonetheless, if we act over the next 10 years, and resilience needs to be viewed over a 50-year horizon, then we have some hope of managing the impact of the shock and bouncing forward to a new equilibrium. In fact, it may precipitate 'systemic' changes that have been needed for a long time.

The value and the "values" associated with water

Not only do we need to come together on changed approaches to the management and use of water, but we need to come together with a common mindset about how we view and value water. If we look after the water, the water will look after us. If we manipulate and modify the water without careful thought and shared values, we could create unintended consequences we will come to regret. Accordingly, this Strategy recognises the Treaty of Waitangi, and the importance of co-governance[2] with iwi entities and seeks to understand how these apply to water resilience (**Error! Reference source not found.** - Te Mana o te Wai). It also seeks to incorporate the Māori world view contained in the opening statement of this Strategy document and to introduce co-governance with Maori for the management of water resilience. It recognises that water has mauri and that needs to be maintained. It also seeks to understand the world view of all interests and find points of common agreement from which we can launch our response to protecting this fundamental asset in an era of progressive climate change.

The essence of the Strategy?

The key threat is the loss of water through evaporation as a result of higher temperatures and a longer dry period. The counter is essentially two-fold:

i. To manage or temper demand by doing more with less (efficiency) such as urban use and land use changes.

[2] Examples of co-goverance around water are emerging around the country, most notable examples are Te Waihora in Canterbury where there is a true 50/50 partnership approach and a Hawke's Bay Regional Council Water management Committee.

ii. To enhance supply by retaining water in the total Wairarapa ecosystem from the surplus periods (primarily winter) to the deficit period (high summer) through as many means as possible.

The supply problem is more nuanced. Climate change predictions postulate that there will continue to be rainfall events through the October to April period, though they may be more frequent but of less volume. Known as "freshes", they have the potential to enhance the Wairarapa water ecosystem if that water can be slowed and retained in that system for longer and provide both societal and environmental benefits.

How could we manage or temper demand?

- Broadening water use throughout the year, particularly in shoulder seasons (November/December).
- Facilitating its availability to encourage innovative resilience-conscious uses.
- Changing land uses towards lower water using 'crops', deeper rooting and more resilient plants.
- Educating residents about wise water use to reduce the currently very high per capita consumption.

How could we enhance supply?

- Slowing flows in rivers, lakes and streams – holding/retaining water in the catchment for longer.
- Sequestering water into groundwater and/or surface storage such as reservoirs and tanks for later use.
- Holding moisture in soils and vegetation and by providing shading to reduce evaporation.

The Strategy seeks to harness all these activities into a comprehensive, integrated and well-orchestrated programme of action.

Equal to the physical challenges involved is the change of mind-set required to manage the water resource much more effectively than we have previously. Much progress has been made, but there is much to do. It requires a transition to new ways of managing our water resource. Amongst the options, each has strengths and weaknesses. The Strategy seeks to take advantage of the strengths and offset the weaknesses of multiple solutions operating together.

Green and grey

Historically our go-to solutions have tended to focus on built or "grey" infrastructure: various types of storage solutions and irrigation systems. They have been favoured because generally they can deal with large volumes of water and can be controlled to achieve reliability of supply. But the challenges of climate change require a much more comprehensive response.

At the very least, stand-alone grey solutions are simply not sufficient to deal with the scope of the problem. They tend to be focused on specific geographic

areas - such as irrigation command areas[3] or specific municipal supply locations. They are generally focused on a single or small number of uses and those which have a direct economic return. They are often expensive making them less suitable for medium or lower value activities or extensive application. They also can sometimes have significant environmental impacts which can be mitigated in many cases, but at a cost. Their greatest limitation is the narrowness of their focus. They do not address water scarcity at a catchment level which has become necessary given the diverse and severe effects of climate change which impact on the whole catchment.

Nature-based solutions involve working with nature rather than against it, yet they also have their limitations. Many are relatively untried (such as retrofitting them to existing solutions), especially at a whole-of-catchment scale, but this does not meant they won't work. Their development time can be longer simply because of the natural growth cycle. They themselves can be vulnerable to climate change impacts. Their intrinsic benefits are significant. They are often simple to introduce and operate. They often cost less. They are often within the scope of a single farmer or small group of farmers or a small town. They address a complex of needs from economic to social and environmental. Most importantly, they are strongly supported by iwi because they take advantage of the huge resource of the natural resilience of nature. Nature-based solutions provide huge benefits in providing ecosystem services such as increased biodiversity and improved water quality.

Optimisation

No one solution will do the job. A bundle of solutions will be required. Most solutions are, in fact, combinations of grey and green where each enhances the other, and where a cluster of solutions generates sufficient scale and effect to address the substantial impacts of climate change. In simple terms green solutions would be ideal for holding water in soils and vegetation, providing shade, directing water into groundwater for later use, broadening production to the shoulder seasons and squeezing the climate change effects out of the shoulder seasons. Grey solutions may be required to offset the intense water loss during the water deficit period by augmenting supplies, providing reliable water for high value activities. Green solutions are vital in retaining and restoring the mauri of the water. They are not simply an optional ingredient of the final mix of solutions.

Systemic solutions are also required. Significant inefficiencies in water allocation are identified and the vulnerability of urban storage capacity is similarly identified. The "shock" of climate change will have the effect of de-locking some of the practices and pathways of

[3] Irrigation command area is the gross area that could be supplied with water from an irrigation scheme. It therefore includes the areas applied with water, plus the broader area such as roads, tracks, buildings, rivers, hedge rows and so forth.

water management that are simply no longer fit-for-purpose.

The task of this Strategy is to optimise the combination of grey/green solutions using a wide range of criteria. For example, simple structures like water retention bunds (grey) could be used to direct surface water into groundwater (green). Water from storage can be used to augment rivers and streams to offset low flows. Constructed and restored wetlands can be used to retain water and moisten the surrounding soil (besides their capacity to process nitrogen). Where do we best direct our scarce investment resources?

The challenges

There are challenges at every turn. If we direct water into groundwater for storage, in many situations there is no guarantee that the water will be recoverable for use, although it will still enhance water ecosystems. If we contemplate land use change will there be a market for different types of products and farmers willing to grow them? Will residents be prepared to be more water-conscious and reduce their per capita use? Is the Wairarapa community up for these challenges, or is it all too hard? All these matters are worked through in the Strategy and solutions sought.

From another angle, we may need to be innovative - trial and potentially use technologies or concepts that have yet to be proven at catchment scale. Likewise, the Strategy has identified the need to increase our knowledge of the water resource from a resilience perspective.

Setting a course

The WWRS established a range of outcomes, principles and priority uses to guide them in the optimisation challenge.

These underpin and validate the Strategy. Priority uses are particularly important. They recognise that there are some uses that take precedence or that some are low-hanging fruit with respect to water resilience.

THE OUTCOME SOUGHT

"Secure, efficient and resilient supplies of freshwater for all people of Wairarapa, in a way acceptable to tangata whenua and within acceptable environmental standards".

GUIDING PRINCIPLES

- **Equity** - sharing the costs and benefits.
- **Natural resilience** - blending grey and green.
- **Mauri** - gradually restoring the mauri of water.
- **Prosperity** - sustaining community prosperity.
- **Value** - best use of water.
- **Knowledge** - building knowledge and understanding of the challenges and solutions.
- **Reliability/consistency** - maximising reliability.
- **Multiple solutions** - not putting our eggs in one basket.
- **Rural and urban** - both have their responsibilities.

PRIORITY USES

- **Environmental bottom lines** - the Whaitua guidelines are taken as fundamental.
- **Drinking water** - quality and access.
- **Stock drinking water** - availability and animal welfare are paramount.
- **Cultural uses** - uses that are fundamental to cultural values and expression.
- **Non-consumptive uses** - because they don't use up the water - e.g. water sports.
- **Capital uses** - to protect capital stock such as root stock, resilience planting and so on.

Resilience solutions

The list of possible resilience solutions – grey and green – is very long. The current state of knowledge, their value and how inter-operable they are in a total package of responses to climate change was assessed. A set of criteria was established and a multi-criteria analysis was undertaken using five different stakeholder groups comprising a mixture of technical and informed people and others with an active interest but not necessarily a high technical understanding – a combination of expert and common sense opinion.

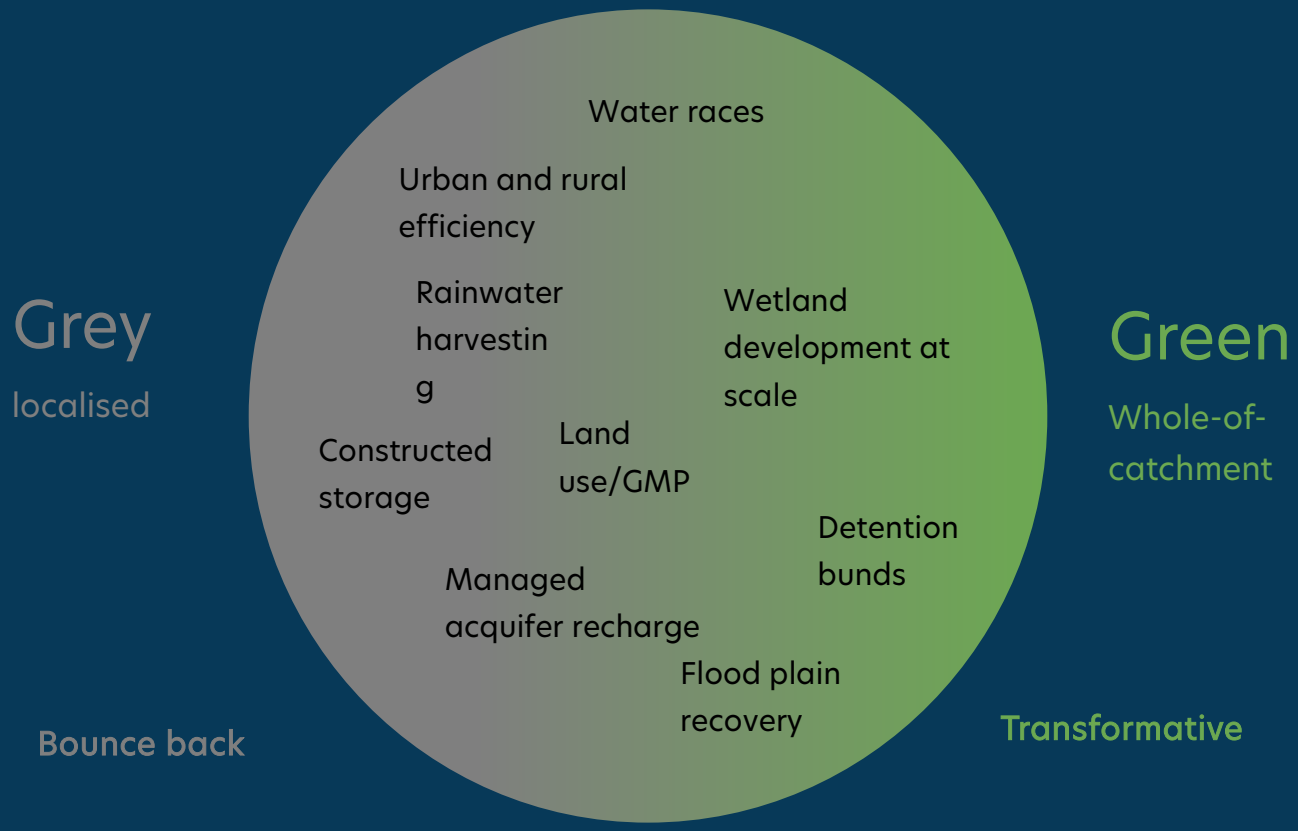
The range of resilience solutions used fell into two broad categories – adaptive solutions (which are on the demand side) and "More Available Water" (MAW) solutions (which are on the supply side). Adaptive solutions include those that reduce, diversify or spread demand for water. MAW solutions include those that create more usable water through techniques such as capture, retention, storage and efficient use.

- **Adaptive solutions**
  - Diversified land use
  - Seasonal adjustment
  - Land use management to enhance water reliability
  - Improved water use allocation procedures
  - Good management practice
  - Tactical seasonal use
  - Reducing soil compaction

- **More available water (MAW) solutions**
  - Water use efficiency
    - Public education
    - Rural water use efficiency
    - Urban water use efficiency
    - Seasonal water rationing
    - Seasonal public education
  - Water re-use or multiple use
    - Domestic wastewater
    - Industrial wastewater
    - Grey water
    - Farm drains
  - Managed retention
    - Detention bunds
    - Accessing natural flood plains
    - Nano dams, leaky dams and straw dams
    - Repurposing water races
  - Natural attenuation
    - Land cover and afforestation
    - Wetlands regeneration
    - Riparian planting
    - Lake enhancement
    - Water sensitive towns
  - Groundwater augmentation
    - Managed Aquifer Recharge
    - Deep groundwater identification
  - Storage
    - Bulk storage
    - On-farm storage
    - Rural stormwater collection
    - Rainwater harvesting.

Placing the solutions into the Framework

An integrated view of the context of the resilience and grey/green framework with the solutions placed within it is presented in the diagram below.



The way ahead

Setting firm priorities was hampered by the variable technical knowledge across the solutions. Another complicating factor was the need for an integrated approach where solutions are mixed and blended to achieve an overall effect. Success will come from the cumulative effect of a range of interventions, not just one or two.

Accordingly, the WWRS agreed that parallel initiatives on four key 'fronts' were required. These are termed "focus areas" and the four that should form the nucleus of a strategy and action plan are identified and described below.

Of these four key focus areas, two fall into the each of the categories of adaptive (demand-side) and MAW (supply-side) solutions:

MORE AVAILABLE WATER (MAW) SOLUTIONS

1. **Water capture focus area**

   Within this focus area we identified three solutions worthy of priority attention:

   - **Managed retention**

     Though largely experimental in nature to date, this was viewed as having potential because of its whole-of-catchment reach and relatively modest cost versus benefits. However, the concept and the economics need to be proven.

     It is considered that a programme of experimental sites is required to trial these solutions and once approved, devise how best to roll them out more generally across the region.

   - **Constructed storage**

     Multiple storage sites have been investigated over the last few years and in-depth feasibility is being done on the Wakamoekau site. While suffering many of the limitations of stand-alone grey developments, it is seen as a provider of reliable water when reliability is critical. There is consideration to mitigate adverse effects.

     The Strategy recommends that storage at a range of scales is continued to be explored and that constructed storage projects are considered on their merits as part of the spectrum of solutions. No recommendation is made on the Wakamoekau project because it is a separate project undergoing its own feasibility, with its own management and resourcing. A set of principles is developed in this report to evaluate storage proposals.

   - **Hill country attenuation**

     The eastern hills in particular, are going to be hard hit by climate change. The economics

of water capture in the hills may be challenging, but there is a range of solutions that can be considered, together with adaptive solutions.

The Strategy recommends that a programme of experimental sites is developed associated with those for managed retention and with the same objectives.

2. **Natural attenuation focus area**

Of all the nature-based solutions, those in this category are the most developed. There are already many examples of restored wetlands, riparian planting, woodlots and afforestation. We know these solutions retain moisture in the ecosystem and while they are very localised, when developed at scale they have catchment-wide implications such as water quality and sediment control. They also have multiple benefits including social, cultural and aesthetic benefits. However, they will likely take time to become fully effective at scale so early action is required.

An important goal of natural attenuation is to contribute to the restoration and protection of the mauri of water, by improving both quality and quantity. Natural attenuation also provides ecosystem services such as biodiversity. The Strategy recommends that a co-ordinated package of natural attenuation initiatives is encouraged and that shared cost initiatives are sought to support them.

ADAPTIVE SOLUTIONS

3. **Allocation focus area**

Reduced availability of water with climate change and the cost of MAW initiatives will mean that the whole question of who gets the water and how much, needs to be revisited. The current allocation regime does not adequately recognise the increased "competition" for water and the equity and access issues that come with it. There are periods where there is limited use but high need, but the water is tied up in existing allocations.

The initiatives that have been considered in the strategy process are:

- **Moving water allocations and maximising beneficial use**
  This involves establishing policies that encourage transfer of allocations or a more complex allocation system rather than a simple "annual allocation" system. It may include developing a set of criteria for allocating water based on benefits, resilience outcomes and availability. This would also consider allocation efficiency.

- **Using planning rather than consenting instruments**
  This is an approach that is used for allocation of water in the Waitaki where substantial amounts of water are used for irrigation.

The Strategy recommends that a review of the allocation system is undertaken by Greater Wellington, taking into account the broader statutory and regulatory context.

4. **Land use adaption focus area**
   De-intensifying demand in the water deficit period by spreading demand across the year, particularly into the shoulder periods and changing land use patterns will have the benefit of transitioning productivity (and therefore prosperity) through the climate change shock.

The initiatives that have been considered are:

- **Introduction of adapted crops**
  Introducing crops that take advantage of an expanded growing season, require less water or root more deeply.

- **Encouragement of mixed farming models**
  Using changing farming regimes and systems that are better adapted to changed climatic conditions and water availability.

The Strategy recommends that a land use adaption programme is developed in the region to draw on science and practice knowledge to support and advocate land use adaption.

Making it work

This is a complex programme of work which would require well-developed leadership and management systems and skills. It will inevitably fall on existing entities such as Greater Wellington and the local councils to provide funding and support. Yet this must be a total community and stakeholder effort with contributions from central government and active involvement of local people in rural and urban settings. In particular, engagement with river management groups, catchment management structures and sector groups will be vital.

With regard to governance and oversight, a "four rooms" configuration is recommended, connected through a central coordinating entity. The central coordinating entity would comprise the regional and local councils, iwi and central government (in association).

The four "rooms" would comprise the following interests:

i. **Water capture** (the store room – creating a hedge against periods of scarcity) – Wairarapa Water Ltd, irrigators and irrigator collectives (where they exist), GWRC and river management groups.

ii. **Attenuation** (the waiting room – holding water in the environment) – River management and catchment groups, town advancement groups, GWRC, local councils and sector groups, DOC.

iii. **Allocation** (the engine room – optimising the distribution of water) – GWRC, local councils, sector advocacy groups.

iv. **Adaption** (the classroom – applying science to achieve more with less water) – Farm sector groups, farm advisors, processing companies, river management and catchment groups.

Iwi may be involved in any or all of these focus areas.

Planning and scheduling

The priorities would be scheduled over an extended period with a base of a 10 year programme (to coordinate with council Long Term Plans) but also with a 50-year horizon.

There would be an emphasis on "getting ready" for when the shock of climate change impacts more strongly, so experimentation and development work on managed retention, land use adaption and allocation would be encouraged to create a framework for the future. In parallel, ongoing implementation in water capture and natural attenuation would continue.

The WWRS Group believes that a progressive, cumulative, constructive, unrelenting and collaborative response of this scale is required to address the progressive, cumulative and destructive impact of climate change. Anything less will result in fragmentation, vulnerability, blaming and worst of all, adverse impacts on the prosperity, wellbeing and attractiveness of the Wairarapa region. By taking early action there will be more options; late action could mean that some options could be compromised.

Recommendations

The following recommendations are submitted for consideration. They represent a long journey and the sooner that journey is commenced the stronger we will be as climate change intensifies.

Adoption

1. That the direction set by this Strategy forms the basis of water resilience planning in Wairarapa over the next 10 years.
2. That a goal is set to have all the fundamentals of a resilience strategy in place within 10 years so that development is keeping pace with the impacts of climate change.

3. That the local councils of Wairarapa and the Greater Wellington Regional Council adopt in principle the intent and general direction outlined in this Resilience Strategy.

4. That the iwi of Wairarapa are invited to adopt in principle the intent and general direction outlined in this Resilience Strategy.

5. That the various advocacy and interest groups are invited to adopt in principle the intent and general direction outlined in this Resilience Strategy.

Leadership

6. That all parties who subscribe to the intent and general direction of the Resilience Strategy consider the

leadership model proposed, which involves the formation of a Wairarapa Water Resilience Committee (or similar entity) drawing on specialist capability in each of the four focus areas.

7. That subsequently, business and project planning is undertaken including governance, partnerships, priorities, funding and resourcing.

Councils and alignment

8. That councils consider how current activities, and their timing and associated budgets in the current draft council LTPs could align with a catchment-wide water resilience work programme e.g. water storage, metering, water re-use, the future of water races.

9. That there is a commitment in principle in the current LTPs currently being consulted to water resilience.

10. That councils ensure LTP planning for the management of three waters, and operations is integrated with water resilience, not stand alone, with improved catchment-wide water resilience.

Iwi

11. That any outstanding issues raised by iwi are considered for inclusion or amendment in the strategy.

12. That the synergy of mātauranga Māori and 'western science' are used to identify and refine future strategies and actions.

Evaluation of resilience solutions

13. That a multi-solution approach is taken including both supply and demand side solutions.

14. That a scientific and systematic approach is taken to the evaluation of resilience solutions using the criteria highlighted in this Strategy and with strong reference to Te mana o te wai and Māori values.

Alignment with the WIP

15. That in all activities associated with the Resilience Strategy that the WIP recommendations and any underlying information remain a basis for determining the principles regarding water management, especially in regard to future resilience, in the Ruamāhanga catchment.

Success Statements

This strategy document does not itemise KPIs for the implementation of the Strategy. This is a function of the governance of the project once it is underway. We have created some success statements that reflect the key milestones that are required to successfully execute the Strategy.

High level outcome success statements

There is a series of high-level long term strategic outcomes or impacts that the Strategy is trying to achieve. These include:

- Making water resilience a community wide concern and priority
- Confining the worst impacts of climate change to the January to March period and protecting the shoulder seasons.
- Harnessing and holding in the environment/ecosystem, significant

quantities of water from periodic "freshes" and rainfall events.
- Slowing water down throughout the catchment and improved moisture retention in soils
- Retaining adequate river flows in the shoulder seasons and satisfying the requirements of Te Mana o Te Wai.
- Strategic protection of nature-based assets (such as planting) from the adverse climate effects.

Operational level success statements

Water monitoring and availability

1. That facilities and systems are created to obtain, on an ongoing basis, further information about the nature of Wairarapa's water resource through monitoring, analysis and interpretation of data, surveys and investigations.

2. That in effect, the region is continually tracking its water balance (demand v supply) as foundation information for refining the implementation of the Strategy.

3. That this information becomes a vital evidential base to inform progress towards water resilience KPIs and is transparent to all users and organisations.

Land use adaption

4. That a land use adaption programme is developed in the region drawing on science and practice knowledge and to support and advocate land use adaption.

5. That a sector and community-based entity is established broadly as outlined in the Resilience Strategy to give direction and leadership to consideration and implementation of land use adaption practices – referred to in the Strategy as the "Classroom".

6. That this entity has a watching brief on similar developments locally and internationally and progress regarding the Sustainable Food and Fibre land use diversification proposal especially in respect of how this would fit into the rest of the water resilience package.

Piloting and experimentation with managed retention

7. That a programme of trials for managed retention is developed to potentially ground truth the various proposals. The viability of managed retention techniques, such as detention bunds, is established to test and build knowledge on the efficacy of these.

8. That a schedule of 'innovative' solutions especially for managed retention is created, that is, solutions that need to undergo proof of concept in principle or in the Wairarapa setting and prioritise these in terms of effort required to develop them further.

Natural attenuation

9. That a coordinated package of natural attenuation initiatives is established with a shared cost approach across public and private sector stakeholders.

Rainwater harvesting

10. That the current process of consideration by councils in their combined district plan of rainwater capture tanks for new houses is

taken to completion for consideration as a long term resilience measure.

11. The voluntary installation of rainwater tanks for non-potable uses such as water gardens should be encouraged with a view to formalising compliance in the long term.

Storage

12. That storage at a range of scales continues to be integrated into a catchment-wide water resilience package for various urban and rural water activities.

13. That a 'watching brief' is kept on any large and medium scale constructed water storage project proposals, especially in respect of how they would fit into the catchment's water resilience package.

14. That the set of principles developed in this report to evaluate storage proposals are applied in all cases and refined as a result of practice and experience.

Allocation

15. That a review of the current allocation system is undertaken by Greater Wellington Regional Council, taking into account the broader statutory and regulatory context.

16. That analytical work is put in place to further ascertain the differences between actual water and consented water use in terms of how this information would inform allocation processes and decision making.

Water races

17. That targeted investigations are completed on each of the water races and the potential role for them in the future including previous GNS modelling for the Whaitua considerations, landowner issues, how and who will manage them. That this be done with a view to settling the future of these assets so that this can be taken into account in other considerations.

Introduction

The importance of water

It goes without saying, and yet has to be said, that water is fundamental to life on our planet. Planets without water are without life. The water cycle whereby water evaporates from the oceans, falls on the land and nourishes animal and plant life is also the life cycle. A healthy water cycle is the ultimate form of resilience and the one we have relied upon for millennia. Human induced climate change is disrupting that cycle.

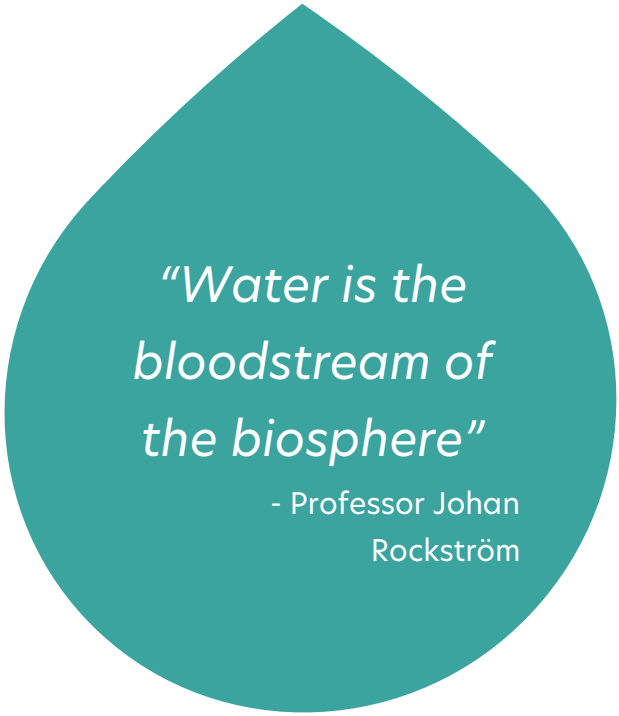
The Te Moari Project, a Rangitāne o Wairarapa initiative, makes the point "We all come from water". *"When we are pure potential within our mothers and fathers, we are water. When they come together to create us water is present. When we are growing in our mother's womb water is present. When we are born water is present. Water is essential in our whole lives and will be used when we die. Our descendants will be the same. They are called mokopuna because they spring (puna) from a blueprint (moko) modelled by you and created by your ancestors thousands of years ago."*[4]

We are entering a period of severe global-scale resource depletion and freshwater is the earth's greatest resource. Seventy percent of the earth is covered in water. Two thirds of our body is comprised of water. Our origin as a species is from water. We are water and water is us. This "truth" is recognised in the Māori whakatauki- "Ko au te awa, ko te awa ko au" meaning "I am the river and the river is me". This implied personal relationship with the natural world is in contrast with the more functional views we have allowed to evolve in the last few hundred years and which, with resource depletion, we are having to review and rethink.

The resilience challenge

"The climate's number one victim is always water," says Professor Johan Rockström of the Stockholm Resilience Centre. *"Water is the bloodstream of the biosphere and the determinant of our future. As it dries out, water can induce tipping points."*[5]

The simplest definition of resilience is resistance capacity to shock. This is the ability of a system, in this case a freshwater system, to rebound after an abnormal, generally external, event, or absorb the impacts of a shock, yet retain its fundamental integrity. A shock could be



[4] Pontangaroa, J Te Moari Project 2018-2019 "Rangitane o Wairarapa Cultural Health Monitoring Report" pp9

[5] Quoted in Workman, j, "Why Understanding Resilience is key to water management" Source IWA April 2017

a one-off event such as an earthquake that could damage aquifers and block rivers with land slips, or it could be a "slow-reveal" shock like climate change whose effects are progressive and possibly non-reversible.

Rebound or recovery is one way of looking at resilience, but in the case of environment-related shocks where tipping points have been passed, then no amount of restoration is going to reverse that situation. In such situations resilience is more about building a new balance. This is well summarised in the following quote from a Boston Consulting Group article: *"Much has been said about resilience in recent times, but people often overlook its duality. It isn't just about springing back from a crisis, as commonly understood; it is also about springing forward into a new reality".* [6]

This adaptive resilience is predicated on the idea that while a system may change as a result of a shock, it should still maintain its core functions which in this case is the ability to allocate a resource efficiently – that is, water. This pre-supposes that the current system is efficient, which many would contend it is not, particularly with regard to externalities such as protection of the environment. This suggests that this Strategy is not just about protecting from the climate change shock but reviewing a system that already has some significant flaws. We are involved in a programme of evolutionary resilience[7]. It may require revised systems and processes as well as individual solutions. This Strategy addresses both individual solutions and the system as a whole.

The rebound may require natural or artificial solutions or combinations of both. We shouldn't forget that it is nature-based processes that have protected us in the past and our growing demand for water is competing with the environment for water. We cannot allow this competition to happen because there is no winner. We need these natural processes to protect us in the face of the current climate emergency.

Water resilience is also human resilience. Māori see restoration of the mauri of water contributing to the restoration of their mana as people. To address water resilience we must all 'own' the challenge and continuing the Māori world view we must be the environment and the environment must be us. If we compromise the environment, we compromise ourselves. We must be resilient, and resilience must be us. If we don't adopt this mind-set, we will face an uncertain future. Solutions that fundamentally respect the environment are vital in retaining and restoring the mauri of the water which makes them a vital not optional ingredient of the final mix of solutions.

[6] 'The Path to Business Resilience' by Karalee Close, Michael Grebe, Phillip Andersen, Varun Khurana, Marc Roman Franke, and Roelant Kalthof (6 July 2020) https://www.bcg.com/en-au/publications/2020/digital-path-to-business-resilience

[7] Martin R, Sunley p: "On the Notion of Regional Economic Resilience: Conceptualisation and Explanation" pp6

Finally, this Strategy is a water resilience strategy, not a climate change resilience strategy. It has a more specific focus than the broader adaption focus of, say, the Ministry for the Environment. It does not focus on reforestation for carbon sequestration or coastal impacts of rising sea levels. It does not look at climate change prevention through reduced carbon release (although it is mindful of this in recommending solutions). Nor is it a broader community or economic resilience strategy. The focus is directly onto freshwater resilience, but we will need to be mindful of these other connections.

A water resilience strategy is urgent in Wairarapa because the area is very susceptible. The characterisation of Wairarapa and the NIWA research contained in the appendices illustrates this point. With an early response to climate change more options will be open, leading to better outcomes, than a late one. This Strategy is a call to action now, not when it is a choice between poor options, which may be the case in 10-20 years when the better options may have been closed out.

Three key pieces of work together provided a background and direction to the development of this strategy, namely: Climate change and variability - Wellington Region by NIWA, August 2017; Ruamāhanga Whaitua Implementation programme, August 2018; Wairarapa Economic Development Strategy and Action Plan, October 2018. In addition, many other documents and stakeholder discussions were used. The Strategy has relied on existing investigations and data; it did not involve any new work. In short, it is a Strategy, not a Study.

The go forward

The Strategy is the product of multiple contributions. The WWRS Group has involved a large number of people from iwi, councils, rural sector and interest groups, industrial enterprises, advocacy interests such as the environment, former participants in the Whaitua work and others. (Appendix 6: The Wairarapa Water Resilience Strategy Group) This Strategy sets a foundation for future action.

The widely disparate resilience group agreed on the importance of establishing a resilience strategy and the direction set by this Strategy. The Strategy points a general approach and identifies a governance structure to go forward. There is much research and policy development work to be done, but the document has created a framework within which it can take place.

The WWRS Group noted that the obvious agency to provide leadership is the Greater Wellington Regional Council, but it was also acknowledged that they could not carry out that role without the full support and active involvement of all the other agencies and interests. This has to be a whole-of-community effort, partly because the impacts of climate change affect the whole community, but also because if ever there was a need to be joined up, this is it.

Section I: The water resilience challenge

Chapter1: Understanding water resilience

As an idea, water resilience is deceptively simple. As a set of policies and actions, it is very complex. Getting from the idea to action is the challenge for this Strategy and eventually for the community to implement.

What is the problem we are trying to solve?

There are five main factors at the heart of the resilience challenge and they illustrate its complexity:

1. **Water deficit**
   By mid-century it will take an estimated 15% more water to maintain current supplies and an estimated 30% by 2090 as a result of reduced rainfall and evaporation loss[8] assuming we continue with our present day activities.

2. **Restrictions to low flows**
   Low flows to protect the environment will reduce available water for other uses. The Whaitua Committee recommended minimum flow requirements for the upper Ruamāhanga and Waipoua Rivers be raised (and a small increase for the Kopuaranga). Further constraints on groundwater takes that are linked to surface water are also recommended. These changes, if they are successfully implemented via a plan change, will significantly reduce water volume and reliability for a number of water users. It is quite possible that they will be refined by the time they have gone through the full planning and cost/benefit analysis, but they will have a significant impact nonetheless.

3. **Accommodating growth**
   Climate change is likely to boost population and economic growth over the coming years. More people will consume more water. Population increases of 1% a year, a conservative estimate, quickly cumulate, as does water usage. The Wellington Regional Growth Framework anticipates significant population growth.[9]

4. **The mauri of water**
   There is a cultural shock (for Māori and Pākehā alike) involved in climate change that means that life and values will be changed, and in some cases non-recoverable. The more climate change progresses, the more acute this will be. The iwi view is that the first priority of water management should not be

[8] Effects of Climate Change and Water Resource Limits on Valley Floor Water Resources – Aqualinc/Andrew Dark 22/05/2018, pages 2 and 47

[9] Draft Wellington Regional Growth Framework 2021 pp29. Also refer Addendum 9 pp176 of this document.

the use of water, but the health of the waterway itself. The volume and flow should be sufficient to sustain the biodiversity and health qualities of the waterway. This is a further step beyond the low flow protections of the Whaitua Implementation Programme (WIP) and what this might mean in terms of the requirement for water is not known.

5. **Infrastructure challenges**
   Local councils already face hefty bills for the upgrade of ageing water infrastructure meaning that only limited funds may be available for investing in other resilience priorities. There will be an affordability problem.[10]

The combined effect of these factors can only be speculated on and will need to be regularly tracked over the coming years, but it could mean that talking in rough order of magnitude, by 2040/50 Wairarapa could have as much as 40-50% less available water in the water deficit period. The concern here is not solely the amount of water for use but the protection and integrity of waterways and water, whilst enabling use. There is not a free hand here to manipulate the water and the water system at will.

This, of course, is in a "do nothing" scenario, and there will be adaption, but the scale of these impacts is consequential, and act like a pincer, because they will have their impact at a key focal point - the January to March peak water deficit period, which is also the peak growing, visiting and events period in the Wairarapa calendar.

By 2040, in the peak water deficit season, the current one-year-in-ten drought will likely become the average summer and the revised one-year-in-ten drought event will be much more severe. A scenario of two one-in-ten-year droughts in succession is not far-fetched and could produce tipping points. It is these extreme periods that are the greatest early threat. In the worst case, trees might die. Whole forested areas like the Tararua ranges, which are already being damaged by animal and plant pests, might suffer unrecoverable damage, perhaps even those we may have planted to enhance resilience. Streams might dry with consequent loss of biodiversity. Once we are into this type of tipping point scenario, we begin to lose control of the outcomes. This is to be avoided if at all possible.

Creating a resilience framework

We need a simple framework to think about resilience and to apply to our situation. From the literature we have brought together the adjacent diagram. In this Strategy we work our way through the stages with a problem definition, context, adaption options, prioritisation, optimisation and implementation (including governance), followed by success measures (KPIs) and monitoring.

[10] Refer Addendum 8 pp 166 of this document

The framework as presented appears rather linear. In fact, it can be characterised as a series of feedback loops that gradually build the capability and capacity of the system to address that portion of climate change resilience that

concerns us.

The common theme across these frameworks is that they address three main actors: agents (those who will take the action – residents, farmers, council officers), institutions (the arms of governance – decision-makers) and systems (the system of hydrological study, water management, distribution and allocation). To change attitudes and practice all three have to be addressed. This Strategy does that.

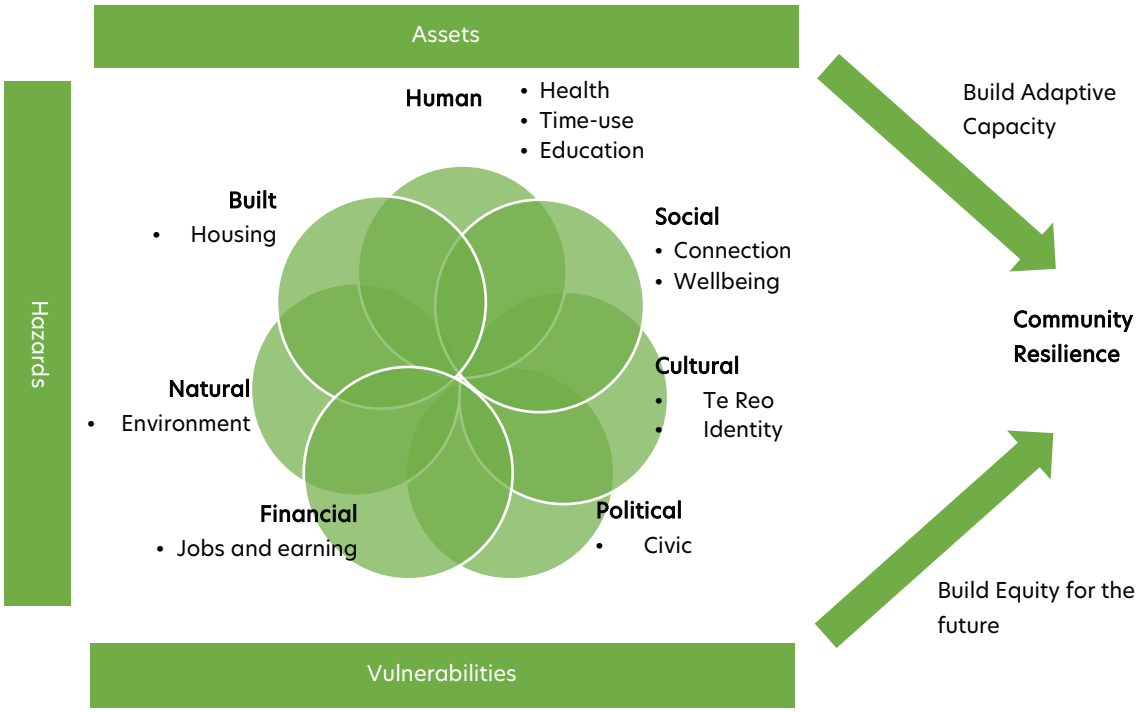
Building community resilience

Water has to be seen in a context of community resilience, which involves human and attitudinal challenges, not just infrastructure challenges. Hearts and minds are as important as built assets. "Soft infrastructure" - building adaptive capacity in people involves building equity in public attitudes, governance and management structures. Water resilience can only be seen in the context of overall community resilience.

The diagram over the page illustrates the web of complex considerations that are required. It draws on the Treasury Living Standards Framework, but is somewhat simplified for the application to water. It emphasises building adaptive capacity to shocks and equity for future prosperity and wellbeing. All these "capitals" - human, social, cultural, political, financial, natural and built - are relevant to water, though not all to the same extent. Water resilience is one part of the broader community resilience equation.

We know that water demand, left to its own devices, will continue to increase, in fact, accelerate, especially in the absence of a community resilience mind-set. Water users, whether they be rural or urban, have an expectation of enough good quality water when they need it. Similarly, there is a built-in reluctance to invest in any mitigation unless the need is clearly established. In short, resilience consciousness is probably low. Yet, attitudes have been changing. The Ruamāhanga Whaitua process has challenged a solely functional resource-use approach to water. Iwi have forcefully restated their commitment to the integrity of the water itself as evidenced in the opening statement to this Strategy document. There has also been a trend towards placing a much higher value on mana whenua meanings and significance as we move into a different era in our relationship with the natural world.

It now has to impact on our behaviour. For example, Wairarapa residents are big water consumers compared to New Zealand's urban areas.11 There are high levels of wastage through single use (use and discard) practices, excessive use and leakage. International best practice aims for below 15% loss of water12. The norm is about 18 to 23%. Losses of urban water in Wairarapa are much higher. So there is a long way to go. This is discussed in the chapter on urban water usage.



Water policy

A resilience mind-set has been promoted through regulation. The idea of protecting the environment was first captured in Section 2 of the RMA. The environment was defined as including:

> "(a)
> ecosystems and their constituent pa rts, including people and communities; and
> (b) all natural and physical resources; and
> (c) amenity values; and
> (d) the social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) or which are affected by those matters"[13].

In other words, it was far-reaching in its definition.

The protection of water found its expression with the National Policy Statement on Freshwater (NPS-FM), introduced in 2011 (and which was

[11] Wairarapa Township Water Supply Demand Forecasting by Tonkin & Taylor Ltd for GWRC, December 2017
[12] Radio New Zealand link https://www.rnz.co.nz/news/ldr/420937/greytown-losing-39-percent-of-water-through-infrastructure-leaks-wellington-water
[13] Resource Management Act 1991, Part 1 – Interpretation and application, Clause 2 (1)

updated in 2014, 2017, and again in 2020)[14]. The Ruamāhanga Whaitua Implementation Programme (WIP) commenced in 2012 and concluded in 2018 as a response to the NPS-FM[15]. As required by the RMA the regulatory aspects of the WIP are implemented through a regional plan.

To be effective, consciousness in policy and law need to become behaviour practices in our daily lives. The WIP has drawn a line for water's use and integrity, ensuring enough water is available for protection of the environment. Hence its work on minimum flows and groundwater levels can be seen as resilience measures. It has also established bottom lines regarding water quality with its recommendations around water contaminants and land use. The Whaitua is supported by the package of freshwater regulations currently emerging from Central Government under the title of "Essential Freshwater"[16].

The requirements in the WIP are therefore non-negotiable bottom lines for this Water Resilience Strategy. There is no need to revisit these matters because the work has been done. The post WIP challenge has been to implement its findings and if creating the WIP was tough, implementing it is proving a lot tougher and progress has been very slow. If the Whaitua process was stage one of water management in Wairarapa, this Strategy is initiating thinking and planning around a second implementation-focused stage.

Essential versus discretionary

In the minds of many users almost all water uses (especially their own) are essential, so fundamental is water to contemporary life. If pressed there would be recognition that there are some uses such as drinking and hygiene which are absolutely fundamental, whereas recreational uses might be seen as somewhat more discretionary. However, what was once discretionary is now seen as essential. For example, wellbeing values have risen in significance. The provision of water to sustain the natural environment has become fundamental as formalised in the WIP. Agricultural uses to boost productivity and output, not just protect against drought, are being seen as essential to regional and household prosperity, particularly in the age of COVID-19 where agriculture has been classed as an "essential industry" by Government.

Managing finite water resources

The total amount of freshwater from the hills and rainfall is often quoted as an illustration of the almost infinite supply of the resource, but this is misleading. Available water is the net amount available after all contingencies are

[14] https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/national-policy-statement-freshwater-management/history and https://www.mfe.govt.nz/fresh-water/national-policy-statement/about-nps

[15] https://www.gw.govt.nz/assets/Whaitua-Te-Whanganui-a-Tara/REPORT-Whaitua-Te-Whanganui-a-Tara-River-and-stream-water-quality-and-ecology.pdf and http://www.gw.govt.nz/assets/Ruamāhanga-Whaitua/Final-Ruamhanga-WIP-August-2018-Pdf-version.pdf

[16] https://www.mfe.govt.nz/essential-freshwater-new-rules-and-regulations

considered such as environmental requirements, landscape and environmental impacts, community and cultural values and cost. Water is certainly not infinite in the water deficit period of summer.

The international literature has extensive discussion on water scarcity.[17] Lorenzo et al refer to the "hydraulic mission" of the 20th century as unable to deal with the fast-changing socio-hydrological conditions we are now experiencing which are a mixture of reducing natural water availability and issues such as the political ecology of water and water justice which highlight the relationship between access, restriction, possession and dispossession of water resources.

Scarcity brings competition. Water resilience is no longer simply about boosting supply. It is about access, priority and multiple uses. There are indications that these "externalities" to hydrological solutions are having, and will have, a progressively greater effect on water availability.

Thinking whole-of-catchment

Whole-of-catchment thinking is returning as a central idea in water management and is fundamental to this Strategy. Not only is the catchment a natural entity, an ecosystem, with its own natural processes, but it is an integrating idea. As we consider blending natural and built responses to climate change and enlist the support of surrounding communities, then the catchment is the ideal unit of management. Whole-of-catchment also expresses Te mana o te wai and integrates Maori ideas of mauri and kaitiakitanga. Part of understanding a catchment is understanding its hydrological cycle.

Statutory versus non-statutory

This Strategy does not recommend specific statutory interventions though it acknowledges that regulation is likely to be part of the mix such as with water allocation. Regulation has the advantage of minimising the free-loader problem and regulation can be an effective method of public education and behaviour change. It is also necessary to protect the inherent nature of water. It also has the potential disadvantage of shifting responsibility for resilience from the water user to the regulator. Effectiveness demands that all stakeholders own the problem and seek solutions each in their own domain coordinated through over-arching leadership and governance. It is anticipated that the mix of actions required will emerge as work within the Strategy progresses.

[17] "Global Agricultural Economic Water Scarcity" Lorenzo Rosa et al, Science Advances 29 April 2020.

Chapter 2: Climate change effects in Wairarapa

Wairarapa is projected to experience some of the more extreme effects from climate change in New Zealand in respect of water – at times severe and highly variable. In Appendix I there is a detailed assessment of the effects drawn from a range of data, especially that supplied by NIWA. Those effects include:

- Higher temperatures
- Decreasing rainfall
- Increased number of consecutive dry days
- Greater evapotranspiration
- Decreasing mean river flows

Much is still speculative, which makes planning difficult. Apparent contradictions abound such as record cold temperatures as a result of polar vortexes. Contradictions will be evident in Wairarapa too and the effects may be quite variable, benefitting some and disadvantaging others, varying from year to year.

The contradictions of climate change

We know that the already hot summer will get hotter and drier. High temperatures will drive people into air conditioning as a necessity, dry out crops and grasslands and cause distress for stock. What is now "nice and warm" will become "unbearable" with consistent plus 30C and even plus 40C days. Unwelcome 'visitors' will appear such as more animal and crop diseases and changes of land use (towards de-intensification) are likely. An increased fire risk is inevitable. Some crops like grapes and olives may thrive in hot dry conditions. Higher water temperatures may seem a boon for swimming but they may produce cyanobacteria making waterways unswimmable.

The shoulder seasons will be warm and dry, potentially punctuated with storm conditions and rain, but likely providing pleasant living. Rain events may be more common but of lesser quantity. Heavy rain will be more common in the upper catchment. Lifestyle residents and visitors could be attracted to this Mediterranean-style climate and bring with them greater demand for water (and land).

The impacts on rural people and enterprises will tend to be more adverse. The balance of the economy will continue to move towards urban rather than rural activity, which will significantly change the character of Wairarapa

(Addendum 10: Characterising the future of Wairarapa). Competition for water supplies between rural and urban uses could intensify, and the rural community is likely to lose out due to its small proportion of the voting population.

Anticipated changes could also include:

- Crops that require water during the hot dry period such as most types of vegetables and horticultural products will not prosper unless they receive significant added water or their growing period is successfully shifted (which may not be possible for market and other reasons) or they are grown indoors (under glass).
- Stock will need to be supplied with stored/imported food as grass growth will be zero in the water deficit period. Stock water supplies may have to be extended or stock removed during the summer dry.
- Many types of vegetation including indigenous biodiversity could suffer with prolonged drought periods because they are not naturally adapted to it, resulting in loss of natural resilience.
- Winters will be warmer and drier opening up the opportunity for crops requiring longer growing seasons and low risk of frost. This could include orchard crops which already have a small foothold in Wairarapa. In fact, an increase in acreage of fruit trees is highly conceivable with lower frost risk.
- While growing conditions may improve in the valley (although water will be a critical factor), conditions in the eastern hills will be exceptionally dry which might incentivise alternative land uses including forestry.
- A stronger move to exotic and indigenous forestry for carbon sequestration in the eastern hills is likely unless nature-based solutions including regenerative farming are implemented. We could see diminishing rural communities in the hills and more concentrated settlement them onto the valley floor.
- Drier conditions and sharp rainstorms are likely to trigger greater erosion in the eastern hills in particular. Unless controlled, this will take the form of sediment in the streams (similar to Hawke's Bay) flowing into the Ruamāhanga exacerbating water quality issues.
- The "shock" that COVID-19 represents has hit unevenly and there is concern amongst policy makers and community leaders that this will exacerbate inequalities. Climate change, as a "slow reveal" shock is likely to have a similar effect except more prolonged and progressive.

What does water resilience mean in these various scenarios? Is it rebounding back to the status quo and holding on to what the region has, or is it bouncing forward into a very different scenario - a new status quo?

To answer this dilemma, we have to remind ourselves that climate change is progressive. Even if we reach the targets set out in the Paris Accord, which seems increasingly unlikely, how long will the lag factor be of continued warming even after emissions are controlled. Hanging on as long as possible, especially if the Paris commitments are not attained, does not seem productive. We know that for all this uncertainty and variability, we are going to have a lot less available water, especially in the water deficit period. We are going to have to spend time and cost on mitigation and, without doubt, we are going to have to **do more with less**.

A resilience strategy will, therefore, need to act on the demand and supply side of the ledger simultaneously and is going to

have to achieve several things at the same time including:

- **Greater efficiency** - minimising wasteful use; doing more with less.
- **Water capture** – storing and slowing the progress of water through the catchment to transfer availability from times of plenty to times of scarcity.
- **Minimise evaporation** – through protection and shading of water and groundwater storage.
- **Protect natural resilience assets** – so that they can continue to work for us and maintain the mauri of the water.
- **Adapt land use** – changing seasonality; introducing new land use.
- **Plan for population growth** – increase urban water storage and capacity.

Most importantly, all options have to be open and more options have to be available than is currently the case. We need existing solutions, and we need new solutions. We need to keep all the possible tools in our toolbox available to respond to circumstances as they arise, within the context of a broad strategic direction.

Chapter 3: Water use in the catchment

Water use patterns in Wairarapa are a product of history as land and water use has evolved, often in a haphazard manner. For example:

- Consented water and actual use are very different.
- Currently, actual use is generally well below consent levels suggesting that there is an element of free-board in terms of available water.
- The catchment is significantly over-allocated, though exactly by how much is not known.
- Over-allocation is not a problem in a stable water situation because it allows for flexibility of use within an envelope. It becomes a significant when climate change drives rising demand and falling supply.

The following tables show the proportion of water consented for various uses within the Ruamāhanga Whaitua. Note, this is not water actually used, but just the volume that has been consented for use.

The first table illustrates the amount of surface water used and the second table the amount of groundwater used. Seventy percent of the water consented is sourced from surface water.

Allocation of surface water in Wairarapa.[18]

Activity	Percentage of total consented	Total volume	Number of consents
Irrigation	26.78%	50,880,461 m^3	133
Industrial	0.1%	189,766 m^3	4
Stock	37.84%	71,902,080 m^3	15
Town Supply	18.39%	34,950,936 m^3	7
Other	16.89%	32,104,271 m^3	15
Total	**100%**	**190,027,514 m^3**	**174**

[18] Source: LAWA web site lawa.org.nz

Allocation of groundwater in Wairarapa[19]

Activity	Percentage of total consented	Total volume	Number of consents
Irrigation	89.44%	67,949,089 m^3	310
Industrial	0.65%	495,945 m^3	7
Stock	0.54%	408,059 m^3	2
Town Supply	5.39%	4,092,469 m^3	9
Other	3.98%	3,026,762 m^3	8
Total	**100%**	**75,972,324 m^3**	**336**

When the two tables are considered together, the following highlights emerge:

- Agricultural purposes are by far the most dominant.
- 'Irrigation' is the largest single water use, being sourced from ground and surface water.
- 'Town supply' is predominantly sourced from surface water reflecting the scale of the Masterton take compared with the other smaller towns which largely draw from groundwater.
- 'Stock' is the largest user of surface water but is predominantly used for stock water races. Overall, 27% of all the consented water is allocated to stock water races.
- 'Town supply' comprises only 15% of the total allocated volume.
- "Industrial' use appears low and it is, but this is exaggerated by several of the large plants sourcing their water from town supplies.

The 'Other' category, which appears quite large combined includes frost protection, recreation and sports fields, such as golf courses, and Masterton's two lakes and other non-reticulated uses.

Despite the high volume allocated to agriculture, large areas of agricultural land are not irrigated and will still not be irrigated even if the Wakamoekau storage proposal goes ahead. Significant areas of the region and all those on the eastern coast and hills will continue to practice dryland farming.

[19] Source: LAWA web site lawa.org.nz

Current amounts of water used

As discussed above, there is a significant disparity between consented use and actual use. Most years, many water users – rural and urban –will not use their full allocation. It has been assumed that there are significant differences between the maximum consented allocation and actual use across seasons and consented activities. More robust indications[20] of the scale of these differences have not been evident until sufficient data from relatively recent metering has become available.[21]

Seasonal and annual variation in water demand is driven by many factors, both at the local scale - soil conditions, water use type - and the regional scale - climate. To capture this natural variability and the difference between allocation and actual use, data was used from 2013-2018[22].

Water use by activity

Excluding public water supply and water race usage:

- Daily water use consistently peaked at 50% to 60% of maximum allowance across all years i.e. around 50% in average summers and about 60% for dry summers.
- In four out of the five years, no significant abstraction occurred before December.
- Across all years, abstraction was largely concluded by mid-March or early April.

Obviously, the differences between the consented and actual water use are significant and the bulk of this usage is confined to just three months (January and March inclusive).

When public water supply and water race consents are included, the peak daily use in summer is about 20% higher than when these takes are not considered.

The graph below depicts this difference between the two 'sets' of water take uses. Of course, public water supply and water race uses occur all year, but at approximately half their summer volumes over the winter months (April to November). This obviously varies from year to year.

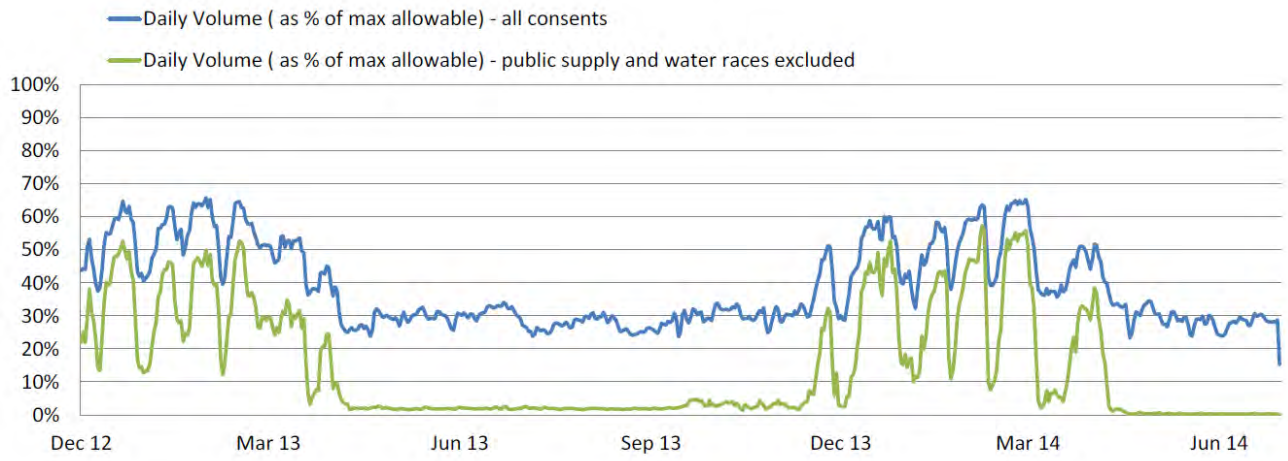
[20] Pers comm Mike Thompson, Senior Hydrologist, GWRC

[21] Estimating this difference is based on 68 (13%) of 520 ground and surface water take consents representing about 25% of the allocated total daily volume, including public water supply and water race consents but over a more limited period. They are geographically spread throughout the Ruamāhanga Valley. Nonetheless it's a relatively small sample, taken over a relatively short period.

[22] In terms of water deficit, the five years examined can be broadly described as follows:

- 2013/14 was a normal year;
- 2014/15 and 2015/16 were dry summers, resulting in substantial irrigation season deficits;
- 2016/17 was a much wetter summer than normal;
- 2017/18 was variable, but overall wetter than average.

Broadly speaking, water users responded to a relatively 'normal' range of climate conditions over the past five years.



This suggests there is a degree of elasticity in demand or in water scarcity terms: there is a level of 'flex' suggesting we are not yet hard up against supply limits. There are many factors at work here including regulation. How much flex is available in real terms is difficult to know but doesn't matter for our analysis.

Water use by source and type

Excluding public water supply and water race consents, in dry years, water use is, of course, higher so actual daily use of water is higher as a proportion of the consented allocation. In addition, the irrigation season is longer, that is, generally it starts earlier and finishes later.

Over the 'dry' 2015/16 summer for instance, Martinborough received just 30% of its normal rainfall. In terms of actual daily water use as a proportion of maximum consented allocation, the following occurred:

- Category A groundwater peak use was consistently higher (60 to 70%) than other categories of ground and surface water take (50 to 60%) during times of unrestricted take (above minimum flows).
- Category C groundwater use peaked in early February (around 60%) through until the end of March.
- Surface water and Category A takes reduced significantly during the same period, presumably as restrictions took effect.

This data suggests that in a sudden change in climate, the sort of change that we can expect in the next 20 years, demand soars and severe supply pressures come into play. Make a scenario like this a regular annual occurrence and you have the basis of a cumulative and severe water deficit.

Water use by activity in a dry year

Excluding public water supply and water race consents, in dry years, when comparing dairy, vineyard and other irrigation, plus non-irrigation water use activities, the following resulted:

- Peak use for non-dairy pasture irrigation tended to be higher (up to 80% of maximum allowable) than for dairy pasture irrigation (peaked at about 65%).
- Water use for both forms of pasture irrigation occurred over a seven-

month period (from early November until mid-May) especially in the peak summer months (December, January, February).
- Vineyard irrigators' usage peaked at around 40% of the maximum consented allocation.
- Other (non-irrigation) use increased a little during summer but was always well below maximum consented available.

This data tells us that targeting particular land uses to save water is unlikely to do so in any quantities and that the irrigation demand period would likely be extended at times of scarcity, driving further scarcity.

Phasing of peak water use

Another important aspect to consider is the extent to which irrigators using 80% or more of their maximum consented allocation, use water at the same time, that is, on the same days. About three quarters of sampled consents exceeded 80% of their daily water allocation at some time in the in the 'dry' summer of 2015/16 - the ones that didn't being mainly vineyard irrigation and 'other'.

During that year, the coincidence of irrigators using 80% or more of their allowable water take on the same day peaked at about 25%, meaning a considerable proportion of 'high volume' irrigators are not using their water on any one day. This means that pressure on the resource is less than one might think if the majority of users were taking water at the same time, again indicating that there is some flex in the system.

Implications

This flex is a cushion of unused water in a normal year in current conditions. That appears to rapidly diminish in dry years which will be the norm by 2040. We have a short term opportunity and a longer term threat.

This analysis does not provide us with a definitive water balance, only an indication. It's important to recognise that the above are 'averaged' figures for the entire Ruamāhanga valley floor. In reality, different parts of the valley will experience different water needs depending on proximity to the Tararuas, the water demands of the crop(s), soil type, constructed storage capacity, their access to water (as with water use restrictions) and the state of their respective water sources at the start of the summer period.

This data is scheduled to be updated in 2021 as background for the Ruamāhanga Plan Change; the possibility always exists therefore that the nature and scale of the mismatch between actual and consented water takes could change. The updated information will be used to inform the allocation and actual use picture.

If there is a significant mismatch between consented allocation and actual use it would significantly reduce allocative efficiency. This has potential implications for efficient and sustainable management of groundwater and surface water resource, namely:

- Where fixed volumes of groundwater or surface water are available, allocation to individual users in excess of their 'reasonable' needs can

prevent additional users accessing that water.

- The potential environmental effects of groundwater abstraction (such as potential stream depletion effects) may be significantly over-estimated when based on consented volumes.
- As water resources approach or reach full allocation, incentives may increase for existing users to transfer the unused portion of their allocation in accordance with s136 of the RMA.

These variations also make it difficult to construct a water balance for the region as the water is technically in a water take consent 'lock-up', even though it may not be used. This is a task that is well beyond the scope of this Strategy document but needs to be undertaken early in the roll out of the Strategy to strengthen the evidential base to policy. A water balance will help with the detailing of policy but is unlikely to challenge the fundamentals of what we already know. The particular focus of this work needs to be on summer availability because that is the critical season.

Section II – The value of water

Chapter 3: The meaning of water

We associate water with many positive connotations such as growth, fertility, freshness, scenery, relaxation, exercise and economic productivity. Moisture implies fertility, dryness is associated with barrenness. People in Wairarapa are never more aware of this than when struck by drought. Drought-stress is stress for people, for livestock as well as the environment, and in the case of fire, complete destruction. This is an issue for everyone because it diminishes their enjoyment of the environment and of life itself. Swimmability of rivers, recreational enjoyment of lakes and ponds have become cultural markers of enjoyment of water.

Te Mana o te Wai

To ensure that a Māori view of water was enshrined into our thinking and planning, Government developed a policy position called Te Mana o te Wai in 2014. In 2020 Government announced a set of changes to the NPS for Freshwater Management. In it, clarifications were made about what Te Mana o te Wai and how the concept applies to freshwater management. The policy of national significance requires that regional councils and their communities, including tangata whenua, should work together to understand what values are held for freshwater in their area or rohe. All decisions about freshwater management should be made putting the health and wellbeing of the water at the front of their discussions.

The Statement of national significance in the Freshwater NPS describes the concept of Te Mana o te Wai as the integrated and holistic wellbeing of the water. It is up to communities and councils to consider and recognise Te Mana o te Wai in their regions.

Te Mana o te Wai imposes a hierarchy of obligations. This hierarchy means prioritising the health and wellbeing of water first. The second priority is the health needs of people (such as drinking water) and the third is the ability of people and communities to provide for their social, economic and cultural wellbeing. The hierarchy does not mean, however, that in every case the water needs to be restored to a pristine or pre-human contact state before the other needs in the hierarchy can be addressed, nor that fundamental needs for water will be ignored to protect the environment. Picking a pathway through these priorities is what "springing forward" to a new reality means.

The six principles of Te Mana o te Wai in the NPS-FM 2020 inform its implementation and include:

1. **Mana whakahaere**: the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and wellbeing of, and their relationship with, freshwater.

2. **Kaitiakitanga**: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations.
3. **Manaakitanga**: the process by which tangata whenua show respect, generosity, and care for freshwater and for others.
4. **Governance**: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and wellbeing of freshwater now and into the future.
5. **Stewardship**: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations.
6. **Care and respect:** the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.

Ki uta ki tai

The Natural Resource Plan delivers "Ki uta ki tai". This can be translated as "mountains to sea" and refers to the holistic management of natural and physical resources. It recognises the interconnected nature of these resources and is the cornerstone of integrated catchment management. It also highlights important Māori values in the protection of land and water. It recognises the connections between:

- Surface water and ground water
- Land use and water quality
- Water quantity and water quality
- Fresh water and coastal water
- People and communities

This leads to the idea of integrated catchment management and adaptive management which are important concepts in water resilience. It brings into play iwi preferences that catchments are not broken and that public entity boundaries (and our solutions) take this into account.

Iwi want more collaborative opportunities to design a holistic system. Thoughts around this involve iwi, hapū and Māori bringing mātauranga Māori and mātauranga ā iwi into the design and practices to better care for the water and the environment. Incorporating mātauranga into the design allows for the voices of whanau, hapū, iwi and marae to be present throughout the process.

Iwi want to see protections against privatisation of water services and hope to see roles for iwi and hapū being woven into these protections. As reflected above, there were calls from iwi and hapū who want to be involved in the water quality monitoring system to weave cultural indicators and whakapapa of a water body into the process of testing the sources of water. This will require significant working through as it is unlikely that the challenges of climate change will be able to be met through public investment alone.

Cultural impact

Two cultural impact reports have been prepared in recent years by each of the iwi – Rangitane and Ngāti Kahungunu. They both detail cultural sites and cultural practices which are reflected in the above text. These provide frameworks for us to apply cultural considerations to a broader

resilience framework. It is anticipated that once the work of this Strategy is put in place then these cultural frameworks will guide it. There is a strong emphasis in these frameworks on training and engagement to build understanding. They also provide practical schedules and worksheets for use in water management activities. [23] [24]

The value of water to tangata whenua

We sought statements from people in Wairarapa to capture the value of water in their lives. The following is a statement provided by Rawene Smith of Ngāti Kahungunu:

> *"The river's place in our lives as tangata whenua defines who we are. When Māori ask, Ko wai? Or, who are you? It can literally be translated as, the water? What is the water that is you? The descriptor of our lives as tangata whenua is defined through pepeha that refers to an awa tapu or a sacred river. While tohi or baptismal rites occurred in rivers and this is sacred, rivers are sacred because moments of connecting occurred comprehensively throughout the life of tangata whenua. One marae in Wairarapa would spend four months as a community in tents on the banks of the river.*
>
> *The water for the essentials of life, drinking water, washing water and recreational water shows the importance but this does only partly define the river's influence. The endearing part of the river is because life's most beloved memories are here. It is cousins swimming every summer day. It is poupou or grandfather teaching mokopuna or grandchildren to swim, to eel, break in horses, read river flows, listen to what rivers are saying, know the dangers of the rivers, to respect our awa tapu and all of these end up defining tangata whenua. There are so many other events that means we know the smell of our river; we know the taste of the river; we know the sound of the river; we know the feel of the river; we know the sight of the river; yet the sense of the river is more than this, it is the love for our place. It is home. Wherever else we might travel to, when we remember home, we include our awa tapu because it is who I am."*

This statement was provided by Jo Hayes (GM) and Sonia Rimene (Chair) of Rangitāne-o-Tub Mai Ra Trust Wairarapa and Tamaki Nui ā Rua PSGE:

Mauri is the life force or essence of all livings things. From the people to the land (whenua) the water (he

[23] Smith, R Te Kahu cultural Health monitoring Plan for the Ruamāhanga Catchment, 2019

[24] Potangaroa, J Rangitāne o Wairarapa cultural Health Monitoring Report 2019

wai) and the air (te ha)we breathe. if the mauri of one of those things is depleted, or disturbed then it will impact on the others because they are all connected.

As Rangitāne we support the importance of sustaining and enhancing the mauri of all living things of which water, fresh or coastal figure prominently. In order to sustain the mauri of the water human actions, on our natural resources and processes requires strict management and planning because history has shown us what happens when mauri is neglected.

The relationship between Rangitāne and its resources is one of paramount significance to the very being of Rangitāne as people. It has sustained our people since time immemorial and is resultant of who we are. 'Tina te pū, Tina te aka, Tina te more i Hawaiiki' which means 'fixed are the people, like the roots of a tree, fixed at the parental source of Hawaiiki' is a part of an ancient karakia from the Kurahaupō waka. The karakia goes on to say, 'kia kotahi ki te kahui Ariki, kia kotahi ki te kahui Tauira, kia kotahi ki a koe e Io e,' meaning, 'to be one with the universe, to be one with our surroundings, to be one with you, our creator.'

To that end, our resources/environment are taonga that have equal importance to us as people and there is no hierarchy between the two as it is a constant balancing act to ensure the survivorship and preservation of both, creating a relationship underpinned by reciprocity, bearing on or binding Rangitāne and the environment equally.

Despite the current law that includes some of our concepts to manage and protect the natural environment we still do not see our values and tikanga given the necessary weight or consideration and this must change and we must be part of ensuring the change happens.

The value of water to the rural community

A statement was provided by a farmer group:

> *"There is rarely any reticence when members of the rural community meet for whatever reason. Invariably the first and immediate item of discussion is the weather. Not just the weather, but the rain – has it rained (and how much), is it raining (for how long) and is it going to rain (when)?*
> *Rural communities depend on water in a manner which could be hard to appreciate in town. We depend on it for drinking, recreation, as part of a beautiful place to live, for stock water and helping our crops and pasture to grow, to earn a living and for mental wellbeing. With reliable water rural life is made possible.*

More than that, rural inhabitants are keenly aware of the importance of ensuring the reliable availability of water. We connect to the source (bore or pipe), install the pumps and tanks and delivery systems and develop the farming systems to create an income for their families. And we worry and fix and/or adapt when supplies are under threat, pumps and delivery break down threatening family and economic health.

We turn the tap off on time in case the tank runs dry, monitor soil moisture and pumping rates to make the most of irrigation water, enjoy swimming in clean water, watch with pleasure when good crops and stock grow and most of all take pleasure in the development of our most important crop – our families.

In rural communities water raises spirits and dampens spirits. It is essential to life.
There is therefore a human resilience in the rural community in regard to water but hand in hand with the creation of this resilience is stress. For human resilience to be bearable resilient systems need also to be in place. That is our challenge."[25]

An urban perspective was not sought. This chapter illustrates just how important the "human" and cultural dimensions are to water resilience and these need to be part of the cluster of solutions that make a holistic whole.

[25] Group of farmers led by Leo Vollebregt, 2020

Section III – Building resilience

Chapter 4: Green and grey solutions

Water resilience challenges are being faced in other parts of the world that are hit a lot harder than Wairarapa and often with fewer resources to combat them. Building natural as well as artificial defences against climate change is widely supported by the Wairarapa Water Resilience Group and aligns strongly with mana whenua values. Nature-based solutions are not just a vital ingredient in building natural resilience, they are essential.

Nature-based solutions are favoured not only because they are natural, but because they work. International practice indicates that while artificial solutions have an important role to play, they can have significant limitations such as cost, narrow geographical reach and adverse environmental impacts.

Nature-based solutions are deemed an essential part of achieving sustainability goals such as the 2030 Agenda for Sustainable Development by the United Nations (UN). The comprehensive UN Report on Nature-based Solutions for Water[26] suggests that the investment in nature-based solutions is currently less than 1% of total investment in water resources management infrastructure worldwide[27], but this is rapidly changing,

The UN report talks about two types of infrastructure – green (natural) and grey (built). It makes the point that there are real opportunities for optimisation when grey and green infrastructure operate together. The UN report says: "There are a few examples where either nature-based solutions or grey infrastructure is the only option to improve water availability, but usually both should be considered, designed and operated in harmony."[28]Green versus grey is not a narrative about heroes and villains, but about building resilience with the best techniques and resources at our disposal, within a sustainability frame.

In an extensive public consultation in Canterbury in 2009, when the public was asked whether the priority for water management should be to advance environmental protection as a sole priority or advance storage infrastructure as a sole priority, they supported neither and opted decisively for the "parallel development" development of both – green and grey together.[29]

26 The United Nations world water development report 2018: nature-based solutions for water https://unesdoc.unesco.org/ark:/48223/pf0000261424

[27] Pp3

[28] Pp242

[29] "Canterbury Water Management Strategy",, Canterbury Mayoral Forum, 2009, pp35

Ecosystems, soil and water

Nature-based solutions focus around ecosystems which are the building blocks of natural resilience. Where artificial solutions are generally associated with the storage of water in lakes and ponds, nature-based solutions involve the retention of moisture throughout the environment, in soils, wetlands and vegetation. Nature-based solutions can play a vital role in maintaining the quality of those soils and their ability to sustain biodiversity which in turn retains moisture. Retention of water in soil also helps retain nutrients in soil, providing a double benefit. Indigenous biodiversity of all kinds, but particularly vegetation, plays a significant role in moisture retention within the vegetation and by providing shading and when done at scale can create micro-climates. Water bodies shaded by vegetation, especially during summer months when water would otherwise be too warm also aid natural resilience. Nature-based solutions are about retention of moisture and minimisation of water loss.

Productivity and sustainability

The UN Report makes the point that agriculture will need to meet projected increases in food demand. The BBC in a recent (February 2021) item by Lou Del Bello entitled "Why our food needs to use less water" made the point that farmers around the world are having to address water shortages with innovation. In northeast Italy, which is the largest rice growing region of Europe, drip irrigation is being introduced to rice farms that were previously flood irrigated. In India an innovation called "Bhungroo" involves pipes directing water underground during monsoons to porous soils 20 metres below, instead of it washing away into channels. In effect it is a low-cost variant on what we know as managed aquifer recharge using the resources of nature to assist nature.

> *"Tomorrow's agriculture will need to grow more with less, whether it's through high-tech solutions like drip irrigation or simple innovations such as Jain's Bhungroo. And in a water-scarce world, smarter agriculture is about more than just food – it can help build a more sustainable economy for all".*
>
> - Lou Del Bello

Water resilience is about innovation and about working with nature, not against it. The farmers of the Wairarapa, as expressed at farmer meetings, are quite clear that they too are focused on improved resource use and efficiency, in all its aspects. The piping of stock water and their focus on better productivity per animal or per hectare and per litre of water applied, not just product volume, are all illustrations of doing more with less.

This way of thinking leads us into less invasive methods of agriculture such as

minimising soil disturbance (drilling seed not ploughing), maintaining soil structure and integrity, rotating land uses to average out impacts and allow recovery. The UN report says: "Agriculture systems that rehabilitate or conserve ecosystem services can be productive and intensive, high-input systems, but with significantly reduced externalities." [30]

The report makes the point that nature-based solutions such as forestry, wetland development and well-managed grasslands can assist water quality objectives by reducing sediment loads, capturing and retaining pollutants and recycling nutrients. This effect is only possible if there is sufficient green infrastructure to support the natural water cycle and ecosystems.

What does this mean for Wairarapa?

The significance of this for Wairarapa is the need to consider a "working with nature" mindset which involves building back ecosystems rather than just compensating for their loss with more and more grey infrastructure. The role of grey infrastructure then becomes a type of partnership with nature-based solutions, rather than an end in itself, where each enhances the effectiveness of the other.

A larger proportion of our future resilience will come from green infrastructure as it has far more scale than grey infrastructure, and nature along with time, pays for much of the 'building' cost.

Whereas grey infrastructure is more prone to diminishing returns over time. The hard testing of nature-based solutions is at an early stage, whereas the benefits and costs of grey infrastructure can be more easily calculated. This Strategy argues that testing and experimentation with green and green/grey solutions needs to be undertaken promptly so that green nature-based solutions can begin to take their rightful place in the spectrum of solutions.

Wairarapa is especially well placed to do this. There is the burning platform – Wairarapa is going to be hard-hit by climate change. Doing nothing is not an option. While river and groundwater systems are complex, they are active and amenable to smaller scale non-invasive solutions. Geographically the region is relatively small so that effects can be observed more immediately and whole-of-catchment solutions are achievable. There is a tight knit and supportive community with a propensity for innovation and modernisation.

The question of how long it would take to establish green solutions at a whole-of-catchment level is open to conjecture with varying points of view. Progress over the last decade would indicate a slow pace but as the pressure of climate change mounts the pace may quicken. In addition, it may take several decades or even longer for many green solutions to show their full benefits as they rely on nature to grow a forest canopy or establish wetland species at scale. Some green solutions may be

[30] Pp44

potentially vulnerable to adverse impacts such as animal browsing, drought, weeds, disease, fire, flood damage and so on. Because of the timeframe to establish green and green/grey solutions, the effects of climate change could take hold during the intervening years. Grey solutions may have to play a role or part-role to assist with accelerating nature-based developments and compensating for them while they emerge. For example, ensuring higher river levels throughout the year can assist natural features such as wetlands to remain active and watered.

In summary, some nature-based solutions will be slow to show their full benefits, others will be much faster. Multiple solutions will be needed to optimise effectiveness over time. Water reservoirs that top up water supply can protect natural resilience from tipping points provoked by climate change. They also have limited geographical reach.

Wetlands can help retain moisture levels in surrounding land. Replacement of some of the forest cover that formerly bounded lakes and rivers could provide cooling shade and limit excessive phytoplankton growth. Trees also support birds and other animals that eat phytoplankton which are now a contaminant in our rivers. There are examples where we need nature to help do the resilience job for (and with) us.

Many farmers are covenanting native forest lots with the QEII Trust. Others are re-inventing and restoring wetlands and riparian margins and reconfiguring drainage channels to spread and slow water flow rather than simply channelling it away. The potential for encouraging nature-based solutions is considerable and a lot could be achieved with a concerted effort, and at scale.

The urban challenge

While the largest use of water by far is rural water, building water resilience applies to all uses of water – personal, cultural, urban, rural, industrial. The partnership of natural and artificial management of water has great application for domestic use in the towns just as readily as the rural hinterland.

Currently, urban supplies could be described as low resilience. Even now, during the summer months, some urban storage reaches critical levels. Action is being taken by councils and this is dealt with in this Strategy, but it is and will continue to be vulnerable to the effects of climate change.

There is no doubt that infrastructure improvements and storage and disposal technologies upgrades are required and relatively urgently, but with much of the source from surface water the potential for nature-based solutions that involve holding and delaying water at source – in the Tararua ranges – has real potential. Protection of these headwaters so that they retain and gradually release water, contributes to consistency of supply and maintenance of soil and vegetation moisture levels.

Capture of urban run-off, such as rainfall harvesting, particularly in the shoulder and

dry season can become important. Wetlands can have an urban function because they can retain and ‘clean’ water, but they can also have an amenity contribution.

In parts of the world purposeful programmes of “watering” urban areas are underway as greater moisture availability contributes to lifestyle and wellbeing during the hot dry periods. The Chinese have pioneered the idea of the “urban sponge” which collects and retains water in urban environments through deliberate greening policies, and the Australian concept of ‘Water Sensitive Cities’ (currently applied in Melbourne), are examples of the application of natural water resilience in an urban environment.

Essence of a water resilience strategy

Rounding off this section of this report we need a clear statement of the Strategy. It comprises two main streams of work:

i. **A strategic focus:**

Temper demand	Doing more with less
	Pushing amenable land uses to the shoulder seasons
	Encouraging greater efficiencies, including allocation
	Encouraging greater good management practice
	Public education about volume use in dry periods
Enhance supply	Retaining water through constructed storage (rural and urban)
	Sequestering water by directing it to, and retaining it in, the whole ecosystem
	Augmenting groundwater, surface water, lakes and wetlands
	Holding water in streams, soil and vegetation

ii. **A tactical focus:**

Targeting **demand** in the water deficit period:

- Land use change
- GMP/public education
- Efficiency/allocation

Targeting **supply** in and around the water deficit period:

- Capturing water from freshes in spring and summer
- Directing that water into groundwater (using primarily green/grey solutions with green bias)
- Using the holding/delaying capacity of the groundwater system to build/retain groundwater volumes (rural and urban use)
- Operating at a whole-of-catchment level to achieve the volumes and ease access
- Compressing the water deficit period into January to March (and holding it there)

Section IV – Our water resilience assets

Chapter 4: Surface Water

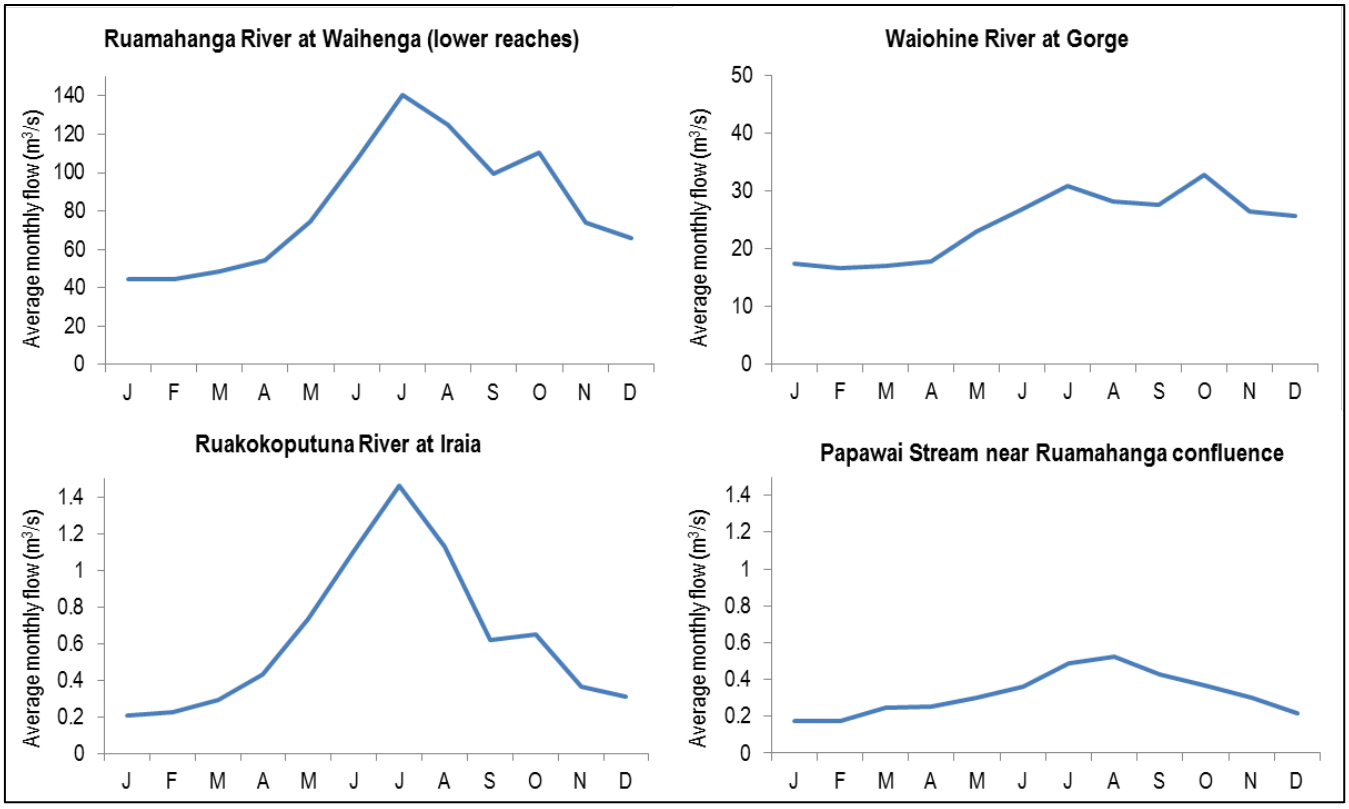
Addendum 2: Characterising the physical geography provides a detailed characterisation of the river systems of Wairarapa. Dominated by the Ruamāhanga which flows down the spine, the rivers and streams are many and complex, though of relatively small scale. In this chapter we concentrate particularly on rivers rather than lakes, because they are the key source of water for human use.

Due to the different catchment characteristics of climate, geology and elevation, the western and eastern tributaries of the Ruamāhanga tend to have quite different flow regimes. The western tributaries have higher base flows, are less prone to extreme low flows, than the eastern tributary rivers. As an indication of the relative flows of the different rivers and streams, mean annual low flow estimates for the major tributaries, and the Ruamāhanga River itself, are shown in the table below. The most significant tributaries, in terms of average flows, are the Waiohine and Waingawa rivers.

Estimated 7-day mean annual low flow (MALF) statistics for main Ruamāhanga River tributaries, at the point they enter the Ruamāhanga, and at three locations on the Ruamāhanga River.

Category	River	MALF (L/s)
Western tributaries	Waipoua River	490
	Waingawa River	1,720
	Waiohine River	3,550
	Tauherenikau River	310
Eastern tributaries	Kopuaranga River	605
	Whangaehu River	100
	Tauweru River	500
	Huangarua River	310
Lowland streams	Makoura Stream	150
	Parkvale Stream (including Booths Creek)	210
	Tilsons Creek	150
	Papawai Stream (including Tilsons Creek)	360
	Otukura Stream (including Stonestead Creek)	600
Ruamāhanga River main stream	Ruamāhanga River at Wardells (near Masterton)	3,836
	Ruamāhanga River at Waihenga (near Martinborough)	12,875
	Ruamāhanga River at Lake Ōnoke	14,800

The highest flows in the Ruamāhanga River and its major tributaries tend to occur during winter, although rivers with headwaters in the Tararua Ranges tend to have sustained high monthly average flows through spring, when frequent westerly frontal systems bring rainfall to the range. Climate change modelling indicates that these fronts will continue but their volume will decrease. The lowest flows tend to occur between January and March. The eastern tributaries tend to have a larger variation in flow between the seasons, as illustrated in the figure below:



Monthly average flows in the Ruamāhanga River and some of its tributaries. *The Waiohine River represents the western tributaries, and on average has a high baseflow during summer and sustained flows through spring. The Ruakokoputuna River represents the eastern tributaries and has large seasonal flow variation. Papawai Stream represents the lowland streams and has little seasonal variation in flow. Source: GWRC Hilltop database, flow data for 1980 to 2013.*

The flow characteristics of the lowland streams that enter the Ruamāhanga River are different to both the eastern and western tributaries. As shown in the above graphs, there is not a large seasonal variation in flow in these streams, due to their predominant source of flow being springs and seeps. However, some of the streams do experience severe low flows, due to abstraction and low groundwater levels affecting spring discharge rates during summer.

The severity of low flows in the Ruamāhanga River is strongly linked to rainfall in the Tararua Range and flows in the western tributary rivers, as these are the dominant flow contributors to Ruamāhanga River. The most severe low flows on record in the Ruamāhanga River and its western tributaries occurred in March 2013, following a period of unusually low rainfall in the Tararua Range.

The Ruamāhanga River can experience large floods due to heavy rainfall in either the Tararua Range or the eastern hills, although historically the largest floods in the Ruamāhanga River have been due to heavy rainfall in the Tararua Range. However, extensive surface flooding in the central valley (including in the small lowland streams and the lower reaches of the eastern tributaries) can occur following south easterly (often ex-tropical cyclone) rainfall events.

The frequency of 'flushing flows', that is, small flood flows that allow accumulated algae to be flushed from the river system, is an important aspect of the hydrological regime. In general, the western tributaries tend to experience flushing flows more frequently than the eastern tributaries. On average, the Ruamāhanga River experiences a flushing flow, of equal to or greater than three times the median flow, every 20 days. However, the longest period on record between flushing flow events in the lower Ruamāhanga River is four months. The frequency of these flushing flows will likely diminish, though not substantially, with climate change.

Availability and allocation

Broadly speaking, core surface water allocation in the Ruamāhanga Valley is at, or close to being fully accounted for by current consents (paper allocation). There is much more availability of supplementary allocation as it has not been historically taken up in large amounts. Volumes of water available for supplementary allocation are generally determined as a function of a 1:1 flow sharing arrangement with the river above median flows (and described in more detail in Schedule V of the Natural Resources Plan).

The two tables immediately below show the allocation limit and status for rivers and stream catchments under the Natural Resources Plan. It also shows how the status is expected to change under recommendations made by the Ruamāhanga Whaitua Committee. Allocation status for each sub-catchment is determined by both the availability of water within that sub-catchment **and** the availability within the parent catchment.

Allocation status at sub-catchment and valley scale changes on an almost weekly basis as hundreds of current consents are renewed on a rolling schedule, some conditions are changed, and numbers recalculated. As of January 2021, there is minor surface water availability in some of the larger river sub-catchments. However, the amount equates in total to less than 5% of that which has already been allocated across the valley and, more importantly, even this minor 'headroom' is expected to be removed in response to the Ruamāhanga WIP recommendations.

Surface water allocation amounts in the Ruamāhanga catchment (upstream of Lake Wairarapa outlet)

Catchment management unit	Allocation amount/limit (L/sec)	Further allocation currently available under NRP provisions	Further allocation expected to be available under WIP plan change
Ruamāhanga River and tributaries, upstream of (but not including) the confluence with the Lake Wairarapa outflow	7,430	Minor	No
Kopuaranga River and tributaries	180	Minor	No
Waipoua River and tributaries	145	Minor	No
Waingawa River and tributaries	920	No	No
Ruamāhanga River and tributaries upstream of the confluence with the Waingawa River	1,200	Minor	No
Parkvale Stream and tributaries	40	No	No
Booths Creek and tributaries	25	No	No
Mangatarere Stream and tributaries	110	No	No
Waiohine River and tributaries (excluding Mangatarere Stream and tributaries)	1,590	Minor	No
Papawai Stream and tributaries	105	No	No
Ruamāhanga River and tributaries upstream of the confluence with the Papawai Stream	1,240	Minor	No
Huangarua River and tributaries	110	Minor	No
Lower Ruamāhanga River and tributaries upstream of (but not including) the confluence with the Lake Wairarapa outflow	1,370	No	No

Surface water allocation amounts/limits in the Lake Wairarapa catchment

Catchment management unit	Allocation amount/limit (L/sec)	Further allocation currently available under NRP provisions	Further allocation expected to be available under WIP plan change
Lake Wairarapa and tributaries above the confluence of the Lake Wairarapa outflow with the Ruamāhanga River	1,800	Minor	No
Otukura Stream and tributaries above (but not including) the confluence with Dock/Stonestead Creek	40	No	No
Tauherenikau River and tributaries	410	Minor	No

Surface water represents 70% of the water used in Wairarapa but with the limited "headroom" it is not likely to be a significant future provider unless that water is stored, diverted or attenuated such as in wetlands. Surface water is prone to evaporation and as that increases, supplies will diminish, especially in the hot months. Wairarapa is significantly modified for flood control meaning that water makes its way to the sea very rapidly. This lack of attenuation also reduces the available water. Unlike Canterbury and Otago, Wairarapa does not have snow melt through to December so that this form of 'storage', which is very significant in the south, is not available in Wairarapa. In short, there is flex in surface water availability, but it is limited.

Chapter 5: Groundwater

The growing pressure on surface water means that attention turns to groundwater to make up the deficit. The difficulty is that the behaviour of water in aquifers in Wairarapa is the great unknown that lies behind this water resilience strategy. There are expectations amongst many stakeholders that it could play a significant future role in resilience against climate change impacts.

The aquifers of the Ruamāhanga are contained in the mainly gravelly deposits of the valley floor. These are quite extensive and geologically complex. The deposits comprise former river channels and flood plains and are disrupted by numerous faults and folds at depth. Thus, groundwater flows are complex and variable.

Groundwater in Wairarapa is variable and uncertain in location and not the extensive underground reservoir often associated with groundwater in Canterbury or Hawke's Bay, and other parts of the world. The total amount of groundwater available or accessible is relatively limited, although that cannot be said definitively because of uncertainty in our geological understanding, particularly of the deeper groundwater system; for example, there is some evidence of previously unidentified supplies.

Water bores that are close together can sometimes behave quite differently indicating the complexity of the substrata. On the other hand, groundwater has significant advantages in that the water is accessible and is protected from evaporation while it is in the ground, which will be a major consideration when high temperatures prevail as a result of climate change. Groundwater not linked to surface water is generally not subject to the same level of summer restrictions as surface water itself. In general, therefore, groundwater, particularly deeper groundwater, is a more reliable source than surface water.

Groundwater quality and characteristics vary. Some deeper groundwater is very old; some is up to hundreds of years old, whereas water closer to the surface can move between rivers and groundwater over a short space of time. Much groundwater is supplied from the main rivers and as it moves through the aquifers it then resurfaces in the same rivers or associated streams and waterways. This latter portion of groundwater plays an important role in the watering of the environment and therefore in supporting natural resilience.

Groundwater is important as it supplies 30% of the allocated water in the region. All three councils draw at least part of their domestic supply from aquifers. For Masterton it supplements their surface water source, while for Carterton and South Wairarapa it is their main supply.

Similarly, groundwater is an important part of the supply for rural irrigation across all three council areas with the groundwater

supply highly allocated (shallow groundwater that is connected to rivers is fully allocated). Demand for groundwater has significantly increased over the last decade. A large portion where it is close to the surface may be subject to low flow restrictions and rises and falls with flow levels in rivers and streams.

The key point is that there is considerable interaction between surface water and groundwater at depths shallower than 20-30m. In places, rivers lose water to the ground and in other places the opposite is true. These interactions are becoming better understood. Much shallow Addendum 5: Characterising the groundwater allocation regime outlines allocation of Category C water.

Some aquifers are inter-connected, but many aren't. Because the aquifers are geologically complex and their flow lines are unpredictable, it cannot be assumed that groundwater will either stay where it is or simply flow down the valley unimpeded. Often it returns to the surface back into rivers. This is a relevant point when considering the question of what the respective roles are of aquifer-sourced water and artificially- stored water. It also raises questions around water resilience solutions that rely on groundwater such as Groundwater Augmentation.

A further consideration is the availability of deep groundwater. Current research indicates that there are deeper aquifers in the Te Ore Ore, Parkvale and Lake Wairarapa and Ōnoke areas. The deeper productive pockets in the lower valley groundwater is really an extension of surface water so that bores that are highly connected to surface water are now more restricted than they have been because shallow groundwater abstraction can significantly affect river flows. These restrictions come into play when the connected surface water body reaches its minimum flow and especially once 100%, rather than 50%, cease takes take effect.

To manage the abstraction of groundwater, the valley floor is divided into 14 groundwater zones and the allocation of water uses an A, B, C system. A chart in
contain water in excess of 180 years old meaning it moves very slowly in its natural state. One very deep bore (178m) near Lake Wairarapa has a water age of 6,000 years. But this is the only bore abstracting to this depth. The 180 year example is more typical.

It is becoming evident that down in the Ōnoke area there appear to be productive aquifers in much older formations than previously realised. This is an example of how knowledge of these deep aquifers is evolving, as previous modelling assumed all useable groundwater was in younger formations. It may be possible to open up deeper aquifers elsewhere. This is a question that might be answered once the proposed aerial electromagnetic survey has been completed.

Some localised areas experience increasing drawdowns as the season progresses – relating to deeper groundwater, which may impact surface

waters - whether this is unsustainable is dependent on the magnitude of depletion effects and the vulnerability of waterways affected. Greater Wellington is currently undertaking a trends analysis to understand and identify if there are particular places where abstraction rates are unsustainable.

Greater Wellington is also in the midst of revising/reviewing the limits for the pending regional plan change which may change this. The trends analysis and limit revision will be carried out conjunctively.

There is local evidence that after a dry winter, some aquifers do not entirely replenish and can commence an irrigation season not fully recharged. In a climate change scenario where a dry winter is followed by a dry spring, supplies could be significantly stressed during the water deficit season.

Groundwater as storage

There is some serious doubt as to whether aquifers can be regarded as a method of storing water beyond the current natural processes. Mark Gyopari, a groundwater scientist with Greater Wellington has made the point that: "if we put water into the Parkvale aquifer, we may never see it again", so uncertain is it as to what happens deeper under the ground. Aquifers like Parkvale are likely very "leaky", but all aquifers can be erratic in their behaviour due to the geological complexity of deeper aquifers. They are certainly not a tank that can be filled or emptied at will. The Ruamāhanga Whaitua Committee saw potential in the aquifers and recommended that further investigations and even trials be undertaken. Other trials are being conducted in New Zealand with variable success at this stage; it's quite a costly process and there is no guarantee that the geology will facilitate this process.

There are significant spatial differences in water availability and cropping locations may have to reflect those differences. For example, in the "fan areas" which are up towards the western hills, there are generally no high-yielding aquifers (however, localised higher yields do occur) but storage in these formations is possibly not insignificant. These Category C areas would only be able to support a modest demand, in some cases lower than typical irrigation takes. A large number of low yielding wells is feasible as long as it is matched to low-demand land use.

Aquifers towards the eastern side of the valley tend to be shallow, high-yielding and directly connected to the Ruamāhanga River (Category A). There are some deeper high-yielding aquifers along the Ruamāhanga corridor and in the south around Pirinoa and Ōnoke which have a more attenuated connection to the river. These aquifers probably offer limited storage opportunities. Due to orographic warming, the eastern side of the valley experiences the highest temperatures and evaporation rates which drives demand for water.

On the eastern side there are also limestone formations that hold water. The Kourarau spring and the aquifers in the

Wainuiouru area are examples. These water sources are being used very effectively. There may be others.

Conclusion

While we would like groundwater to be a significant panacea for urban or rural water availability, with limited deep aquifers that we know of, groundwater behaves much like surface water, in fact they are an extension of each other. They are both short and plentiful at the same time. Regrettably, they are not counter-cyclical.

The potential of deeper or more productive aquifers are yet to be fully understood and it could produce some interesting outcomes. While the quantum of water may not increase, further investigations may highlight areas where well yields may be higher. This may be useful for land use change and adaption and water reliability. The SkyTEM survey[31] scheduled to be flown in 2022 could be very helpful in extending understanding of groundwater resources and patterns.

A key conclusion is that groundwater storage needs to be seen as "passing through" rather than static storage. Water could be retained in the ecosystem as it passes through the aquifers (and drawn off for irrigation), but only a limited amount could be regarded as "stored until used". This makes natural storage very dynamic and reinforces the value of being able to capture water from freshes

[31] This is an aerial survey using magnetic imaging to ascertain groundwater reserves.

Chapter 6: Water races

Water races are an enigma. They are both a constructed and now natural water features of the region. Some races were constructed pre-1900 and are therefore subject to the Historic Places Act 1993. This legislation will create an added consideration to the use of any water races that were in existence prior to 1900.

As a manmade feature they were established primarily to supply water for stock and are still used mostly for this purpose although other uses that are currently permitted include a few specified takes for irrigation and a vineyard, frost protection, domestic uses, wetlands, fire-fighting and other minor industrial purposes, including supply to a piggery. They are also have aesthetic, recreation and ecological values.

Many farmers now source stock water from their groundwater takes for reasons of convenience (river water is generally better for stock due to high levels of Fe and Mn, but cannot be used for diary due to the presence of sewage from urban discharges) and have developed piped infrastructure to do so. A few still use the races for stock water, especially higher up the catchment. Over the years, stock races have taken on a different character. Some have become biodiversity habitats in their own right. They also supply water to wetlands and springs.

The races are, by and large, on private land, and responsibility for their maintenance and upkeep rests with farmers under the guidance of local councils, making them a cost with little immediate obvious benefit. Of all the water that is allocated in the Wairarapa, 27% is consented for use in the water races and is taken from rivers.

It is thought that only a very small percentage of the total volume of water within the races is actually used. In any case, far more significant amounts are either 'lost' through evaporation and/or seepage or returned to natural surface water downstream. An estimate by Greater Wellington is that up to 50% is 'lost' to groundwater. There are also unquantified loses to evaporation. During wet conditions and at certain locations, significant quantities of water from surface runoff also enter the water races.

One estimate of loss to groundwater is for Taratahi and Carrington at 50%, but this has not been formally quantified. While this is a high percentage of water in the races going into groundwater, it represents a tiny fraction of total water going into groundwater, perhaps less than one percent on Greater Wellington estimates.

Groundwater modelling undertaken by the Ruamāhanga Whaitua Committee indicated that closing off some water races may result in significant lowering of groundwater levels. This indicates that the hydrological system associated with water races has, over an extended period, moved to a new equilibrium. Changing the

management of races should only be undertaken with full knowledge of the consequences. For example, a background report[32] for the Ruamāhanga Whaitua concluded:

> *"The extensive Taratahi water race network appears to be a long-established and important recharge source to the shallow groundwater environment. It helps to sustain the flows in natural spring-fed streams during dry periods. If the races were closed down, significant adverse effects on natural streams would be experienced."*

The races take water from the Ruamāhanga, Waingawa, Waiohine and Tauherenikau Rivers, and the Mangatarere Stream. Together they cover a significant part of the Wairarapa Valley from north of Masterton to the head of Lake Wairarapa and are a long-established and integral part of the environment.

Races in themselves are a considerable asset. They provide a channelled, carefully engineered gradient spanning hundreds of kilometres unlikely to be replicated today. If the current situation was to change, each of the races would need to be considered on their own merits as their characteristics are by no means uniform. Existing in-stream ecology of the natural streams linked to water races, and the existing hydrological system, is another consideration as some, such as the Taratahi race, are directly linked to the stream network.

Ruamāhanga WIP stock water race recommendations

As the Ruamāhanga WIP states:

> "... the water races of Wairarapa are very inefficient from the perspective of losses to groundwater and evaporation. However, their leakiness to groundwater has benefits for local groundwater users and to puna/freshwater springs. In this sense, an analysis of the efficiency of a system needs to sometimes be nuanced by allowing for recognition of the value of less efficient systems. Careful analysis is needed to determine the appropriateness of such systems in a water-constrained environment.[33]"

One of the key WIP recommendations was to reduce water race takes at minimum flows to only the water required to provide for people's domestic needs and stock drinking needs.

[32] Summary Paper: Managed Aquifer Recharge (MAR) Exploration Scenario Modelling, Earth in Mind & GNS Science July 2017

[33] PP51

Stock water races

For the last century, the Wairarapa has had an extensive network of water races. Established primarily to supply water for stock, they are still used mostly for this purpose although other uses are currently permitted: a few specified takes for dairy and vineyard irrigation, frost protection, domestic uses, wetlands, firefighting and other industrial purposes, including supply to a piggery.

Conclusions

The races divert a significant amount of water and have past their usefulness in the supply of stock water, accepting that there is a small minority of farmers who still use them for that purpose. They are also a relatively inefficient method of transferring surface water to groundwater, given the small volumes involved. Their role in terms of indigenous biodiversity needs to be considered, but like stock water, a very large amount of water is required to maintain this asset.

The WIP suggests a process to consider the future of races which should be pursued to define the future of these assets. The WIP states among other comments that;

> *"... the efficiency of water use in Wairarapa water races has not been adequately assessed. Overall there is a lack of information on the values and biophysical characteristics of water races to assess their efficiency."*

Further, it states;

> "*Overall, assessments of the efficiency of water races are needed for individual water races because of their unique influences and physical states*."

Before decisions can be made regarding their future role, governance etc., these need to be guided by the actions recommended in the WIP's on this matter:

> **Recommendation 107**
> *Greater Wellington works with territorial authorities and landowners to collect information and develop long-term management options (in conjunction with Recommendations 9 and 11) for all water races in the Ruamāhanga whaitua. The information should be collected and assessed in the order that water races come up for consent renewal.*
>
> **Recommendation 108**
> *Greater Wellington develops a policy indicating that water races requiring resource consent before appropriate long-term management options have been developed shall get short-term consent until the long-term status of the water race is decided. Appropriate information for developing long-term management options for each water race may include, but is not limited to:*
>
> *• The hydrology of the water race and the interaction with surrounding groundwater and surface water (how much water is in the water race, how much is lost, how much is discharged)*
> *• How much water is used and what it is used for*
> *• Water quality*
> *• Social values, ecological values, mana whenua values, heritage values and economic value*
> *• The efficiency of water use and options for increasing efficiency*
> *• The areas of management overlap and opportunities for better integration (regional consents and district bylaws).*

Chapter 7: Can our current assets and attitudes do the job?

Especially following European settlement, many of the modifications to rivers and waterways were undertaken to claim land for agriculture and then protect it from flood. These modifications were made at a time when planning systems were primitive and understanding of the ecology of rivers and lakes was formative. Times have changed.

The legacy is that many of the modifications have impacted the ecology of the region. There is no doubt many of the facilities of natural resistance can be restored or recovered, but not wholly so. The resilience task is one of "springing into the future" with a different mindset more characterised by natural resilience and the need to sustain our communities in a future of climate changes and other hazards.

What are some of the legacy issues that history has left us to deal with in this resilience strategy?

- **Modification of river channels**
  This has resulted in less and less water being retained in the 'system' (in the land and vegetation and water systems) as its pathway to the sea is accelerated. We now need more of that water held back in the 'system'.

- **Diversion from rivers**
  An increasing volume of water is being diverted from the rivers, the Ruamāhanga and its tributaries, for other uses adding pressure on flow volumes at critical times. This water is diverted for rural and urban purposes.

- **Pressure on groundwater**
  Expectations of supply from groundwater have increased as the availability of water in rivers has diminished at critical times, and yet the dynamic of groundwater-surface water connectivity is complex, and groundwater and surface water cannot be regarded as separate resources.

- **Inefficient use**
  Management systems often use old technology, and in some cases require upgrade as a result of low levels of efficiency and high levels of wastage. Such systems have often been tinkered with to make do, rather than being updated.

- **Historical allocation**
  The limits on water supply are being reached, but allocation is still based on historical use and the limited understanding of the water resource at that time. It has to be acknowledged that current arrangements support considerable investment in infrastructure, knowledge and processes meaning that any change has to be gradual. But apart from the fairness issues surrounding historical use which exclude new users, this approach tends to favour outdated uses or inefficient practices. It does not sufficiently encourage innovation and the principle of best value uses, especially as actual use is often substantially less than annual allocations; this raises the distinct possibility of locked up consented, but unused water.

In short, the region has experienced significant pressure on its freshwater resources from growing use, to the extent that it is bumping up against the limits of that resource and now it is faced with a new and even greater challenge, that of climate change. Climate change means we have to move to another level of sophistication in our water management.

Climate change pressures are emerging at a time when resilience in the catchment is already compromised. MAW availability issues as a result of evaporation are tumbling over the top of unresolved historical use issues, creating a challenging resilience scenario for the next 10-20 years and beyond.

The inevitable conclusion is that some significant rationalisation is required:

- Water conservation needs to be top of mind for all users and expectations need to adjust to reality.
- Land use patterns including residential location and water systems need to be modified for a changed reality.
- Mana whenua values need to be factored into water planning.
- Technology needs to play a much larger part in water management.
- Water races need to be critically evaluated so we are fully cognisant of their characteristics before any decisions are made as their future, but their high water use has to be addressed.
- Allocation of both surface and groundwater requires ongoing review and a shift towards a more sophisticated framework as greater pressure comes on the resource. This will help us do more with less.
- The storage capacity of rivers, streams, lakes, wetlands and constructed reservoirs needs to be considered as a whole picture.
- The natural resilience capability of water bodies, waterways and lakes needs to be boosted.
- Greater efficiency in water use is essential to make every drop of water go further.
- Water demand needs to be in close proximity to supply such as land uses related to groundwater supplies
- Storage and reticulation needs to be cognisant of population of the location and scale of future developments that draw on water.

It is absolutely clear from the assessment in this Strategy that single solutions, will simply not do the job. Unless water resilience enhancement is a strong focus for the community of Wairarapa over the next 10-20 years. We have the opportunity to reduce the adverse effects of climate change, but it will take a focused effort.

Section V - Demand

Chapter 8: Rural water use

Land use and water use are two sides of the same coin in the rural setting. Wairarapa Water Limited commissioned a non-profit group from Canterbury called Leftfield Innovation to work on a road map that would enable land use change from current practice to higher value and more environmentally sustainable use by initially identifying near-use for land use with access to reliable water. The Leftfield report identifies a broad range of existing temperate climate land uses:

- intensive horticulture (apples, grapes and small areas of fresh vegetables and berryfruit)
- less intensive horticulture (olives), high value seed production (e.g. sweetcorn, maize and onions)
- broadacre seed production (e.g. peas, grass seed, red clover)
- broadacre vegetables (e.g. squash)
- broadacre grains for food and feed (e.g. wheat, barley, maize and some specialist crops)
- forage crops for silage and feed (e.g. maize and brassicas)
- irrigated pasture for dairy, lamb, beef finishing, sheep milking, and hens for egg production
- dryland pasture for sheep, beef and some dairy
- apiculture (manuka and other honey)
- plantation forestry, plantation hard woods, conservation, indigenous forests[34]

The array of land uses reflects the wide variety of conditions encountered in the Wairarapa such as soils, water availability, shelter, exposure to frosts, topography etc.

Leftfield makes the point that most of the horticulture, higher value cropping, finishing and dairy properties utilise some degree of irrigation to ensure production, with sheep and beef being the predominant land use on the dryland areas. This type of farming has increasingly become dependent on irrigation to raise production levels but also to offset climate change impacts that are already with us.

It is generally conceded that significant land use change will be initiated by climate change effects. Land use change is not new to the Wairarapa but upcoming changes are likely to be significant in their impact. The introduction of the wine industry to Martinborough transformed the landscape and the prosperity of what was formerly best described as a "sleepy little town". The expansion of dairy in the 1980s and 1990s is another good example of significant change. Forestry took over much of the eastern hills in the post-war period and some parts of the region are into their third and fourth rotations. There are strong indications of a renewed resurgence of forestry for timber and carbon. In the other direction, the loss of horticulture and fruit growing has been significant and surprising, although indications from other regions are that

[34] Leftfield, "Near-term Opportunities for Value" 202 pp19

industries like this do best when there is critical mass and the fear of frost in Wairarapa was enough to discourage some production. Wairarapa's representation in these industries was probably sub-scale. The backbone of farming has been and remains, sheep and beef, with the addition of deer.

Climate change effects may change this balance noting that data shows that climate change has already commenced. These changes are already being experienced in the Wairarapa as indicated by warmer average temperatures, warmer nights, less frost etc. Not only will these changes attract horticulture and farming of other high-value crops, but also perhaps enhanced urban settlement. Non-grazing activities for instance are now forecast to increase more than seven-fold, leading to a gradual shift away from traditional pastoral farming practices. A longer growing season, fewer frosts and more benign climatic conditions through much of the year make this possible but in some cases this will require reliable access to water, whether urban or rural.

Climate change adaptation may involve tactical, strategic or transformational change. Though it is not the intention to provide an exhaustive list of these, some examples of potential changes are highlighted here as we try to characterise the future of land use in the region.

The greatest challenge to all types of water users in the region is increasing variability and extremes in weather encountered. Farmers in particular are driven by reliability. Super-wet events are no better than super dry ones. Crops don't grow as well in saturated soils where they are more prone to stock damage or suffering from disease.

Consistency is everything and if climate change brings inconsistency then farmers will be looking to smooth out the variations. The less consistent their inputs, the more conservative they have to farm. Conservative farming is less productive farming, but reduced productivity is traded off against mitigating the risk of heavy losses in adverse events.

Trends in production

The trend in agriculture production is to produce more from less, but not at the expense of the environment. There is a trend to adding value by moving up the value chain into processing, but there is also a trend towards more profitable crops or more particularly, growing crops (including stock), better.

It might include growing prime beef without checks and achieving the required grades. Consistent meat quality is determined by the ability of the farmer to feed the animal well throughout its growing life, on a rising plane as opposed to a maintenance plane. To feed it consistently requires reliability of feed quality in all seasons and therefore reliable water to grow feed in the peak-dry season as well as to water crops for winter feed. Being able to precisely fatten lambs on the irrigated valley floor that have been produced on the hills, consistent milk quality without the detrimental effects of Palm Kernel Extract

(PKE) supplementation, producing specific grades or types of apples, A2 milk, all of which require reliable and exact growing conditions.

Besides these added-value opportunities, there is the range of potential new products that are referenced elsewhere in the document and have been proposed through the work of the Leftfield team.

Chapter 9: Urban water use

Water demand in urban areas has been gradually increasing over recent years in line with population increases and greater economic activity in the region. Continuing population increases of the scale of recent years are not expected by local councils whose projections are very modest.

The challenges in urban areas are somewhat different from those in rural areas. Especially since the Havelock North event and the "Government Inquiry into Havelock North Drinking Water", quality of drinking water and quality of water infrastructure has come under the microscope nationally and it is likely the councils of Wairarapa will be subject to pending outcomes of government policy on these matters.

Urban centres are big water users especially in the sense that they supply the bulk of the area's population with water with a 24 hour water reliability; without that water they have little other choice, therefore its supply is strategically important. Councils don't have a statutory responsibility to supply water to the rural population; they generally source their own water.

Urban Wairarapa, with regard to water, suffers from its own history. All the towns of the region have a history as rural service centres in a region that has historically been relatively well supplied with water. Settlement is also widely spread being made up of a series of moderate to smaller towns (each with their own water infrastructure), rather than, for example, one very large town and small settlements. The situation for each town is somewhat different and is set out below.

Wairarapa has a population of approximately 46,917. The table below depicts Wairarapa's currently urban/ rural population split between the three districts. The urban portions are on reticulated water networks supplied by the respective councils.[35]

	Urban population	Rural population	Total population
Masterton DC	21,400	4,157	25,557
Carterton DC	5,800	4,160	9,960
South Wairarapa DC	6,700	4,700	11,400

[35] Care needs to be taken in the interpretation of these tables. The table for urban water areas includes water leaks and other industrial users in the average daily water consumed in the different towns. The NZ Urban average figure does not include leaks and other users, so the comparison is slightly misleading. Directly comparative data was not available at the time of publication.

Projected populations for each township[36]

Township	District	2013 census population	Mid-range projected 2040 population[3]	Mid-range projected 2090 Population[3]
Masterton	Masterton district	18000[1]	22692[4]	37216[4]
Greytown	South Wairarapa district	2199	2435	2494
Carterton	Carterton district	4850[2]	5504	5699
Featherston	South Wairarapa district	2253	2494	2548
Martinborough	South Wairarapa district	1470	1628	1667

[1]Masterton population connected to water supply in 2017.

[2]Carterton population connected to water supply in 2016/17.

[3]Stats NZ estimates of district-wide population for 2018, 2023, 2028, 2033, 2038 and 2043 have been used to develop predictions for 2040 and 2090 for each town.

[4]Masterton population projections based on anticipated 1% growth per annum.

The following table puts Wairarapa's urban water consumption into perspective:

Urban areas	Average daily water consumption (litres per person per day)[37]
Napier	570
Wellington average[38]	357
NZ urban average	227
Masterton urban area	655
Carterton urban area	396
South Wairarapa (average of all 3 urban areas)	569
Greytown	743
Featherston	472
Martinborough	678

Wairarapa's per capita urban usage is high, verging on excessive.

[36] Tonkin and Taylor

[37] Wairarapa Township Water Supply Demand Forecasting by Tonkin & Taylor Ltd for GWRC, December 2017 which in turn is taken from each Council asset Management plans or their equivalent.

[38] Source: Blyth, JM & Williams G 2020. Overview of the Wellington metropolitan water supply network and consideration of future pressures on infrastructure. Prepared for the Whaitua To Whanganui-a-Tara Committee on behalf of Greater Wellington Regional Council and Wellington Water Limited.

Potable water demand forecasting

Tonkin + Taylor undertook a high-level water demand forecast[39] for five Wairarapa townships: Masterton, Greytown, Carterton, Featherston and Martinborough. The forecasts took into account current and predicted populations, historic water use, and potential impacts of climate change for the five townships. They were based on per-capita consumption (PCC) values derived from bulk-metered historical data.

The principal conclusions and implications were:

- Summer months generally had mean PCC demand approximately 20% higher than the annual average in all towns other than Martinborough, with a PCC demand approximately 50% higher than the annual average.
- Carterton's projected 2090 PCC is approximately 470l/p/d, an increase of approximately 20% from that presently. As forecast population increases, the annual bulk supply is projected to increase to approximately 1,000,000m³ by 2090, an approximate 40% increase from current levels.
- Featherston's projected 2090 bulk supply requirement is 510,000m³, which is approximately a 30% increase when compared to 2016 levels.
- Greytown's projected 2090 bulk supply requirement is 760,000m3, which is approximately a 20% increase when compared to 2016 levels.
- Martinborough's projected 2090 bulk supply requirement is 540,000m3, which is approximately a 40% increase when compared to 2016 levels. Significant seasonal fluctuation is noted.
- Masterton's projected PCC reduces over the short term due to leakage improvements and then increases slightly over the longer term. However, significant population increase is projected - which results in a bulk supply increase to approximately 9,500,000m³ by 2090, an approximate 115% increase when compared to current levels.

These projections provide only a broad view of the future water demand as there's significant uncertainty in each of the inputs and assumptions concerning the population projections, future per capita consumption levels, the influence of climate factors on demand, future efforts to improve (reduce) leakage and changes in non-residential usage. We describe these estimates as conservative because they take a long-term averaged view. We know that hot temperatures drive up urban as well as rural demand as instanced in the 2013 Martinborough dry period.

These figures demonstrate that the challenges of the urban areas are similar to those of the rural areas. The combination of both is a growing demand for water during a period when supply will be significantly constrained.

[39] Wairarapa Township Water Supply Demand Forecasting by Tonkin & Taylor Ltd for GWRC, December 2017

What does this mean?

The issues that the councils are facing in their towns have a common theme and can be summarised as follows:

- **Water use efficiency**
  Metering has uncovered the extent of the leakage problem. While in the big picture, the amount of the water loss is modest, in terms of the volumes treated and the associated costs it is more significant. The loss is not just water, but also the investment capital that could be used elsewhere on other water resilience measures. It also represents early wins for water availability.

- **Storage**
  All three councils currently have very slim storage both for managing high variable water demand especially in the summer months, but also as a hedge for pressure on surface and groundwater that might arise with climate change. All three councils will have to consider the storage question immediately so they can be implemented in the medium to long term. It is noted they have schemes to help resolve these issues.

- **Supply**
  All councils essentially draw from the same ground and surface sources as rural users, and while they will have some priority because domestic use gets priority, they will not want to be seen to be competing for water with rural users who in many cases will be their own ratepayers.

- **Stormwater**
  All three councils have very limited stormwater facilities. They certainly don't see it as a source of supply in the short or long term. Capturing some of this water for non-potable uses is a possible direction of the future. Technology and unit costs will determine that.

- **Rainfall harvesting**
  All three councils are considering the application of rainfall harvest in tanks associated with dwellings. Serious questions need to be asked about this approach because while the unit cost is high, it may play an increasing role in the water deficit period and reduce (even by degrees) competition for water in this period. It could also have the effect of transferring some costs to residents allowing rates income to focus on whole-of-system challenges.

In summary, there are significant incremental gains that urban users can achieve, which cumulatively can make a tangible difference. The first priority needs to be water efficiency improvements and short term storage to minimise the shocks of extended dry spells. Capture of stormwater needs to be considered in the future especially once technology advances allow.

The urban areas also have the opportunity to set an example with natural resilience. There are extensive opportunities for water sensitive developments such as planting, wetlands and greater use of vegetation in and around the town centres. It would be fair to say that the towns of the Wairarapa are not particularly "water sensitive". There is plenty of room for improvement. The example currently being set in our region of the world is Victoria, Australia and it could be emulated. Besides natural

resilience gains, it will also enhance quality of living values, particularly in the hot dry period. The urban areas need to be setting a strong example on natural resilience and could do so at reasonably moderate cost.

The situation with urban water will be further complicated if the Wairarapa joins a larger regional entity under the Three Waters Initiative. This could make it more difficult to reconcile localised urban and rural water use with decisions on urban management to some extent taken out of the hands of the councils.

Section VI – Other resilience considerations

Chapter 10: Human resilience and leadership

While this Strategy is primarily about the ecology of water resilience, because water is a key building block of life, it is also about human resilience. Climate change will not just affect production and vegetation. It will affect lifestyles, quality of life indices, mindsets and value systems. The tempting mindset is to "stave off" its effects, but actually, it is here to stay, in fact to extend, and adaption is required.

The question is what do we mean by climate change adaption? As long as adaption really means having to make a series of reluctant concessions to the inevitability of climate change, adaption is going to be charged with tension and conflict arising from denial and competition for scarce resources. This is a very real issue because these negative attitudes will not help human resilience and it is strength of human purpose that will be required to adapt effectively.

A rich and sustaining environment is part of human resilience. The positive impacts of an attractive environment are known to be causative in human happiness and contentment. The impact of the recent (2019) drought in Wairarapa on the contentment of farmers is a very good illustration. It produced anxiety and fear as the drought caused family incomes to tumble and destroyed long-nurtured natural assets such as grassland and crops. The relatively high level of suicide amongst farmers during economic downturns is testimony to the pressure drought causes.

Doug Avery, in his book *The Resilient Farmer*,[40] describes his approach to resilience, having farmed in the drought-prone areas of southern Marlborough for a generation. He went from near failure to winning the South Island Farmer of the Year in 2010. He describes how, in highly adverse conditions, he increased his land holdings, massively increased output and profitability while being environmentally friendly.

"We are the same family", he says, "with the same farms in the same valley in the same climate. The world hasn't changed, but the story has changed. We turned our system on its head and we became a success story." He goes on to say: "Learning to farm differently – to farm with nature, rather than against it – is the heart of that success.... But even more than that I had to change my thinking processes. I became emotionally resilient."

TUITUI KAKAHU, TUTUI TANGATA
Weaving the cloak, weaving people

[40] Doug Avery, (2017), "The Resilient Farmer,", Penguin 2017

Avery's example illustrates the importance of human adaption. He makes the observation: "I thought my problem was drought, end of story. It wasn't. Until I fixed my thinking, I was never going to fix any problems.[41]" He recognised the importance of land use adaption as well as sourcing more water. He illustrates an important consideration in Wairarapa that whether or not MAW is available, many farmers are going to have to farm with less water in the future and they are going to have to adapt their farms and their minds to this changed situation. The same is true of urban dwellers. Their excessive consumption is difficult to justify.

This Strategy demonstrates that the actions and regimes required to improve water resilience will likely involve significant changes in farming and water use practice in urban areas. We are facing a period that requires high levels of innovation and change. For some this is exciting and energising, for others it is challenging, or perhaps threatening and intimidating.

The idea of water efficiency, that is, paying for water and/or reducing consumption, can cause stress for rural and urban communities who have previously been used to unfettered access. A requirement that urban residents should store water on their property for use during high summer might be challenging and cause cost stress, but it is an example of people taking responsibility for their own situation.

If we are going to succeed in building water resilience, we have to build human resilience. We do that through leadership and much of this Strategy is about leadership structures. Leadership is also people, and structures need to attract people who can give the leadership required.

Measures that demonise, marginalise and criticise farming communities, for example, will likely succeed in building anxiety and resistance in those communities. Measures that damage or diminish the relationship between Māori communities and the environment will also diminish resilience. A successful resilience strategy will require unity and cohesion, not fragmentation and blaming.

For this reason, water resilience is a team game rather than an individual sport. The best results arise from scale, especially with natural resilience solutions which involves parties collaborating together to create catchment-wide solutions. We have to consider building sound organisations and entities to support resilience so that all types of communities in the Wairarapa have the will, energy and motivation to make the changes required to enhance water resilience.

KIA MURA TONU NGA AHI KAA MO TE MATEMATEAONE
Keep the home fires burning so loved ones will always return

[41] Pp93 and 96

The example of fires illustrates the impact of water scarcity on people's confidence. The impacts of fires, particularly bush fires resulting from climate change, can be considerable. Wairarapa has yet to experience fires on the scale of other parts of New Zealand and particularly Australia, but if bush and forest areas dry out to dangerously high levels, then this is likely to become a problem. The Australian bush fire experience demonstrates the impact of climate change on human resilience and it is both dramatic and traumatic and on a smaller and local scale the way fire decimated the small town of Ohau in Otago in 2020 is illustrative. Fires fuelled by natural vegetation that has succumbed to drought illustrates just how important it is to keep our environment as well as our farms and population well-watered.

To date, relatively small-scale fires are occasionally experienced in Wairarapa and it's expected that climate change will add to the risk. The 2019 Nelson fires demonstrates this risk at a larger scale. The photo below is of the 9 February 2021 Cape Palliser area fire.

What is the resilience capacity of Wairarapa? If the community response to the COVID-19 downturn is anything to go by, then the collaborative ethic is alive and well in Wairarapa. The COVID response is a practice run for climate change.

Communities of interest

Leadership is a product of cohesion within and between the various communities of interest in Wairarapa. Here we make a cursory assessment of those communities and their leadership potential:

- **Farmers**

  To the external observer the farming sector might appear integrated and cohesive and in many respects it is. Sector groups are active and strong with notable leadership, but some context is required:

  - The rural community represents about 16% of the Wairarapa's population, and 10% of its output[42]. Wairarapa is predominantly urban.
  - Rural communities are diminishing and losing critical mass. Communities like Tinui and Gladstone work hard against the trends.
  - Rural industries are far from stable. Besides climate change they subject to fluctuating market conditions and labour shortages.
  - The exodus of young people from rural communities is simply a way of life.
  - Water quality measures contained in the WIP and upcoming regulation from central government will have significant impacts and farmers have been given time to adapt and change.

  Sector leadership such as Federated Farmers, Dairy NZ, Beef+Lamb and the water users groups will be a vital ingredient of a resilience strategy.

- **Regional and Territorial Local Authorities**

  All three TLAs are amongst the smallest local authorities in the country with very small ratepayer bases on which to develop their district. There is a growing level of collaboration between them on matters such as economic development and public transport, but much less so on water resilience. This is going to have to change because many of the solutions are Wairarapa-wide and require the combined heft of their resources to achieve.

  The Three Waters proposals from central government are likely to see municipal water and wastewater management taken over by a larger organisation potentially comprising the whole of the southern part of the North Island. This will have the effect of separating an important part of the water resilience mix from local control. South Wairarapa has already delegated the management its Three Waters responsibilities to Wellington Water Ltd[43].

[42] Infometrics

[43] Note, SWDC still owns the three3 water infrastructure assets.

The role to be played by Greater Wellington will prove vital, not only because it has statutory responsibilities for water and environment, but because it has scale in its resources and capability to address the resilience challenges.

- **Iwi**

  Water resilience is a high interest issue for iwi and hapū in the region. As tangata whenua they have a high level of interest in the region and its resources because they descend from these places. Iwi act on behalf of tangata whenua have a strong interest in the integrity of water and in, as much as possible, restoring and protecting the natural mauri of the water. They will be an important touchstone as we all adjust mindsets. Some iwi members have a very high level of knowledge of water and have been actively involved in prior planning such as the Whaitua. Iwi have their own issues in terms of the sustainability and resilience of their own communities and this needs to be recognised in the context of water resilience.

- **Catchment communities and environmental interest groups**

  There is a high level of environmental interest in Wairarapa linked to the quality of life values that are shared by many in the community. Many farmers who use water and have water quality challenges on their own properties are also fishermen and advocates for the natural environment, and therefore understand the importance of clean water. Māori are also farmers and landowners. Concern about the quality of the environment is widespread creating a strong base for cooperative and collaborative action.

  Catchment communities/river management groups are a growing feature of the Wairarapa scene. They generally comprise a group of local farmers along a road or within a sub-catchment. As opposed to care groups, catchment groups generally have a plan or are in development of a catchment plan of some sort. Their mission is to improve water quality and biodiversity on a catchment scale, with some wanting to get ahead of regulation. Examples of catchment community groups formed to date are[44]:.

  - Wainuioru Community River Care Group
  - Ahiaruhe EcoZone
  - Upper Waipoua Kaitiaki Group
  - Parkvale Catchment Group
  - Ruakokapatuna Catchment Group
  - Ponatahi EcoZone
  - Waiohine Action Group (more flood protection related, rather than emergent community led action)
  - Mangatarere Group (more flood protection related,

[44] Pers comm Tash Styles, Land Management Planning, GWRC

rather than emergent community led action)

There is also the Wairarapa Pukaha to Kawakawa alliance which is a community-led alliance which brings different groups together to focus on the health of ecosystems and waterways. In terms of local leadership the role of all these groups is likely to take on much greater significance, because effective resilience will often need to be implemented (and partially funded) at a catchment level.

- **Industries and enterprises**

  The number of large water users in Wairarapa is few. With the exception of about five or six notable enterprises (several of which are described in Addendum 8: Characterising industrial water use), most others are relatively small users. Further development of the region seems almost inevitably to involve increased food production ratcheting up the food value chain. Such enterprises can be significant water users and reliability of a clean water supply is usually important to them. How these enterprises "fit" in the future Wairarapa economy is unclear. There is an extent to which they are seen as an anomaly and their focus is largely on securing their current position.

- **Urban residents**

  There is no current research on urban or public attitudes generally, so we can only surmise. In the sense that quality of lifestyle is a region-wide priority, most residents are environmentally sensitive. With regard to water resilience, their behaviour current wasteful behaviour does not reflect that priority. The felt need to act on water resilience in urban areas is likely to be much weaker than in cities and so urban leadership is likely to be less forthcoming.

The key external players are:

- **Central government** – have just released a regulatory package about freshwater45, central government is a key player and probably even more so in the future. Local resources and leadership will not be sufficient to mount an effective resilience Strategy. Central government involvement is essential.
- **Tourism/visitor interests** – tourism businesses and the overarching organisation Destination Wairarapa have a direct interest in the state of the environment and its attractiveness to visitors and use for tourism activities. Leadership from this sector would be expected.
- **Food and product purchasers** – notably the large organisations such as Fonterra and meat processing companies.

[45] https://www.mpi.govt.nz/funding-rural-support/environment-and-natural-resources/protecting-freshwater-health/

Current governance

The key players in the governance of water management are:

- **Greater Wellington Regional Council** – regulatory obligations, especially under the RMA. Greater Wellington also has a cross-council region-wide responsibility. Greater Wellington also has a series of functions including science, flood, biodiversity, land management and environmental.

- **Territorial local authorities** – the primary focus of these councils is domestic supply of water (to towns) and disposal of storm and wastewater (from towns). Their engagement with rural water is minimal except for their interest in the water races management and the rates generated from rural properties as a contribution to overall funding requirements.

- **Wairarapa Regional Irrigation Trust (WRIT)** – originally formed as a vehicle to accept development grant monies from government is now the single shareholder of Wairarapa Water Limited. The trustees (seven) represent environmental, industry, local government and farmer interests.

- **Wairarapa Water Users Society Incorporated (WWUS)** – a collective representing approximately 60% of the irrigators in the Wairarapa catchment area.

The question remains whether there is sufficient connection and clarity around where leadership for resilience would come from among the current arrangements. Certainly, the collective effort is not sufficiently robust to support this Strategy. There is a great need for structure and focus.

Section VII – Building a Strategy

Chapter 11: Principles and preferences

In this chapter we seek to establish a framework for resilience management, then in the following chapters we apply this framework as best we can to the current situation in Wairarapa.

High level outcome

The high-level outcome chosen for this Strategy to be:

> **"To develop secure, efficient and resilient supplies of freshwater for all people of the Wairarapa, in a way acceptable to the tangata whenua and within accepted environmental standards."**

The use of the word "supplies" is not meant to imply that the Strategy only addresses supply issues, but the more holistic view of the Strategy is challenging to capture into words without becoming very vague.

The Wairarapa Water Resilience Group sees resilience both as an end in itself (retaining the integrity of the natural environment) and as a means to ensuring human prosperity and wellbeing.

Principles

The Group determined a set of principles to guide their thinking. Nine core principles were identified:

- **Equity** – the load of improving resilience needs to be widely shared across the whole community, though not necessarily equally in terms of geography, seasons or use type. Access to water and the benefits of resilience need also to be widely shared. This includes rural and urban communities, enterprises and industries.
- **Natural resilience** – any measures taken need to blend natural and constructed solutions. There needs to be a strong emphasis on the enhancement of ecosystems that support natural resilience – that is, the capacity of the environment to renew and sustain itself. This includes ideas such as natural character and indigenous biodiversity. On the other hand, towns are an artificial concentration of people requiring specific, predominantly constructed, solutions.
- **Mauri** – the integrity of the water as water is vital to Māori. The gradually restoration and protection of the mauri of Wairarapa water is both a principle and an objective.
- **Prosperity** – actions that might emerge from the Strategy need to be measured with regard to contribution to community prosperity and the viability of businesses and enterprises, mindful of other principles such as equity and natural resilience.

- **Value** - the focus of the use of water needs to be on best value, though value needs to be assessed not just in economic but social and cultural terms.

- **Knowledge** - increasing and improving our knowledge and understanding of water and water resilience where knowledge includes scientific and cultural understanding such as Matauranga Māori. This includes public understanding of water resilience through information and education.

- **Reliability/consistency** - contemporary urban communities and farming enterprises rely heavily on reliability and consistency of the availability of water. The importance of this principle is increasing, while reliability, as a result of climate change, is abating. The gap is widening.

- **Multiple solutions** - no one solution is going to do the job. Multiple solutions add a security factor in that where one fails or partially succeeds, another might succeed. This principle also draws on the collective effect of multiple interventions which might act as multipliers of each other.

- **Rural and urban as one** - water resilience applies in both rural and urban areas and is a challenge in both settings. Solutions are favoured that add value in both settings.

Priority uses

The Wairarapa Water Resilience Strategy Group went on further to establish some priority water uses. It is recognised that real world situations are not clear cut and that there are generally many extenuating or genuine circumstances, but these preferences are a guide we can use to order our thinking.

The following uses are preferred ahead of others because of their role in sustaining life and environment. They are regarded as "givens" and in that sense can be removed from further prioritisation of water uses:

- **Environmental bottom lines** -The Whaitua established numerical bottom lines for some attributes and more of a firm sentiment for bottom lines elsewhere but until all their recommendations have passed through the various planning tests to an Operative Plan Change, it is likely numbers relating to bottom lines will change in, as yet, unknown ways. Nothing is a given in the policy/planning space until all appeals are exhausted.

- **Drinking water** - the quality of and access to drinking water is a priority both for urban areas on town supply and rural areas from rainfall, surface and groundwater or other forms of supply.

- **Stock drinking water** - the availability of water for stock in all situations is paramount.

- **Cultural uses** - these are uses that are fundamental to the social and cultural cohesion of communities including but not limited to tangata whenua. Example of cultural use are baptism and cleansing.

- **Non-consumptive uses** - especially those that add to the quality of life of the region and involve minimal

interference with the quality, location or availability of the water for other uses.

- **Capital uses** – this applies to the protection of root stocks, resilience planting and key natural assets from water shortages, which if lost due to lack of water would have long-term adverse impact on the economy and community. For example, protection of root stock for key crops, protection of new and experimental crops designed to achieve land use adaption or protection of resilience planting designed to maintain resilience values.

The Wairarapa Water Resilience Strategy Group believes these priority uses reflect the sentiment of the broad community of Wairarapa and support the principles of Te Mana o Te Wai.

Water resilience practice standards

The Wairarapa Water Resilience Strategy Group also identified a number of what have been termed practice standards. They are like another tier of guidelines beneath the principles outlined above:

- **Maintenance of natural integrity**
  Water has integrity in its own right. It deserves to be treated with respect.

- **Water quality protection**
  The issues of water quality were addressed by the WIP. Regulation creates a platform of fairness for everyone to contribute to the resilience of water quality. Resilience actions should not compromise water quality.

- **Best and responsible water use**
  Water is a common. The actions of one user affects other users. All uses of water are not equal. In a situation of pressure on the water resource, prioritisation of uses becomes important. There is already much careful assessment of best use and very good experience, but scarcity will drive best use even harder.

- **Reduced vulnerability to natural hazards**
  There are many threats to water resilience. It should be noted that protection from one hazard may result in vulnerability to another. Thus, narrowing river courses to protect against flood diminishes the opportunity to attenuate water through the use of river-based wetlands or flood plains. Trade-offs informed by science and technology will be required.

- **Adoption of technology**
  The water management situation in Wairarapa -and in the wider New Zealand context - is highly modified through generations of human activity. While strategies to restore natural processes can be used where possible, technologies to assist water management will become increasingly important. There is a responsibility on users to adopt technologies and practices that boost resilience.

- **Multiple resilience solutions**
  Avoiding dependence on a few favourite solutions. Nature is diverse and so must we be.

- **Adequate redundancy**
  Avoiding overworking particular solutions which could result in vulnerability if they happen to fail.

- **Robustness**
  We will under-estimate the power of climate change with high and prolonged temperatures, at our peril. Our solutions need to be strong, of scale, well designed and carefully managed.

- **Sound and enduring governance**
  To ensure all elements are well integrated and all parties are engaged. A key to resilience is having everyone involved as a contributor and a beneficiary.

- **Sophisticated practices**
  Well-conceived and delivered water management practices including more sophisticated dynamic forms of allocation than are currently enabled within the regional planning framework[46].

- **Culture of compliance**
  Adequate compliance strategies to ensure the integrity and confidence in the system. Many resilience measures need high participation levels to make them viable.

Identifying preferred solutions

A multi-criteria analysis of uses has been employed to help build preferences around solutions. A set of criteria was developed to do this. These criteria were then run against the various solutions to establish preferences. Five stakeholder groups were used for this exercise - the Wairarapa Water Resilience Group itself undertook the exercise and so did a group nominated by the Wairarapa councils, a group of scientists and experts from Greater Wellington, Ngāti Kahungunu iwi and a group of community stakeholders selected by the Wairarapa Water Resilience Strategy Group.

To undertake this assessment, the following criteria were developed:

i. **Multiple positive impacts**
   This criterion recognises resilience solutions that have multiple and wide-ranging beneficial effects:
   a. Flow recession curve – measures that attenuate the flow of water and encourage moisture retention in soil and groundwater
   b. Low flow augmentation – measures that augment low flows, particularly in dry periods
   c. Evaporation reduction – measures that prevent or slow evaporation
   d. Peak flood flow reduction -- measures that slow or spread peak flows, especially in dry period, thereby retaining water

ii. **Support for land use adaption**
   a. High value uses – land uses with sufficient value to enable water resilience management measures

[46] The regional allocation framework as currently conceived (and unlikely to differ much under the WIP plan change) is quite blunt and probably not fit for medium to longer term where climate change will require such an approach.

The current regime relies heavily on single numbers (minimum flows, allocation limits, annual volumes etc) whereas the future will require much more nuance and flexibility. Also, our knowledge of the hydrological environments/hydrosphere is not static, it is constantly evolving and therefore our resilience practices need to be as agile.

iii. **Cultural and lifestyle uses**
   a. Community cohesion – measures that have broad community benefits
   b. Cultural – measures that enhance cultural uses, building cultural trust and confidence
   c. Recreational – measures that enhance recreational uses, leading to happiness and wellness

iv. **Water quality**
   a. E-coli reduction
   b. P reduction
   c. Surface water N concentration reduction
   d. Sediment reduction

v. **Cost efficiency**
   a. Cost/scale efficiency and capacity – measures that have significant impact and benefits from critical mass savings

vi. **Productivity**
   a. Horticultural, agricultural and industrial production
   b. Volume for abstraction – measures that produce additional water for productive enterprise

vii. **Access**
   a. Equity of access – measures that broaden the range and type of access to water
   b. Spatial access – measures that respond to particular spatial characteristics such as landforms
   c. Water reliability – measures that supply specific amounts of water at water-critical times

viii. **Environmental improvement**
   a. Habitat protection – measures that support indigenous biodiversity
   b. Water temperature – measures that control water temperature and prevent excessive periphyton growth or algal bloom
   c. Te mana o te wai – measures that recognise the spiritual context of water and support natural resilience

The following (over page) identifies the potential benefits related to the criteria to help clarify why these criteria were used. They are not presented in the same order as above.

Influences (unranked)	Desired outcome
Community integration/cohesion	Community prosperity
E-Coli reduction	Trend towards limits
Equity of access	Access to water for new users and uses, throughout the valley
Evaporation reduction	Moderation of climate-driven evaporation
Flattening water demand curve	Retaining moisture levels longer into water deficit period
Flow Recession Curve Shape	Looking to flatten the curve
Habitat protection	Maintain and/or enhance
High grade supply (potable urban water)	Water security all year around
High-value uses	Improving the economy/prosperity through water
Land use change	Enable more profitable farming; support water availability
Low flow augmentation especially in water deficit period	Enhance low flows
Water deficit period enhancement	Shifts seasonal water requirements
P reduction in surface water	Trend towards limits
Pasture production	Enhances pasture and removes imported feeds
Peak flood flow reduction	Mitigates
Prevention from algal blooms	Mitigates
Productivity gain	Improves business revenues, production reliability and jobs (where applicable)
Recreational river use	Does not impede at a minimum
Sediment reduction	Does not increase
Strategic availability i.e. known water volumes	Reliability and consistency
Surface water N concentration	Trends towards limits
Surface water temperature	Maintains and moderates
Unit cost	Affordable for users
Volume for abstraction	Sits within allocation rules
Water security	Enhances the environment and productivity
Water efficiency	Drives efficient use and less water 'banking'
Scale – cost-efficiency	More affordable water
System approach	Working together
Water for animal health & welfare	Welfare maintained
Water use transfer - from wet to dry periods	Maintaining access to water throughout the peak-dry period

The water resilience solutions that these criteria were used to measure are outlined in the next chapter.

Chapter 12: Water resilience solutions

We have identified two high level directions to enhance water resilience. The first is through Water Resilience Adaptive Solutions which comprises changes to water and land use practice. The second is MAW Availability Solutions which increases the availability of water through a wide range of improved water management practices. Both practices have application in urban and rural settings and are inter-operable.

Increasing resilience with adaptive solutions

Adaption asks the question what changes are required to our land use, to production systems and lifestyle practices to improve resilience? To make every drop of water count as water scarcity increases, consideration will have to be given to uses and water management practices that are less 'thirsty', especially at critical supply times. Uses that require water in dry periods will need to be producing the value we are looking for from the investment required in MAW availability and the amount of MAW actually available. That value is not just financial but environmental, social and cultural.

High value uses are vital for the future because it is from the revenue of these uses that investment in adaption and MAW must flow. This must apply to land use and land management both in a rural and urban setting.

For Wairarapa this could mean a number of significant adaptive solutions:

a) Diversified land use

The move from monocultural land use practices to more diverse land uses with different water and nutrient profiles is gaining momentum in Wairarapa. Adaptive measures of this nature will be required and the Leftfield recommendations already discussed (p22) have current relevance.

Another element of land use is a move to lower volume higher value land uses. If crops are attracting more market value, then there is potential investment to be turned back into resilience measures. In Canterbury, seed crops have been very successful in this regard.

A variant which is beginning to appear in Wairarapa is the use of more resilient and deep rooting grasses. Substituting conventional rye grass for crops like chicory.

b) Seasonal adjustment

A situation of scarce water supply during the water deficit period is a powerful incentive to, where possible, plant at different times to the traditional growing season. Climate change should be an asset in this regard. It could involve winter crops or simply shifting summer

crops gradually towards the shoulder seasons when water is more plentiful from rainfall or irrigation rights. Some farmers are already adjusting the seasonality of some crops in response to climate change. This could lead to a prioritisation regime for scarce water in the water deficit period, preferring some crops over others at certain times.

This type of thinking is more evident in northerly areas of New Zealand such as Waikato and Northland. In these areas there is a noticeable increase in agricultural production in the pre-summer window. As the frost risk falls in Wairarapa in those months, the potential for it as an extended growing season will increase.

Land use changes
The Leftfield report outlines a wide range of different crops and land uses that have different water demand profiles and different value propositions. Their contention is that gradual changes to land use, driven down from a market lens, will use existing water more efficiently and gain greater value from MAW, particularly water from storage.

Changed land uses also open up the possibility of combining land use and natural resilience strategies in ways already discussed in this paper. Farmer meetings conducted by Leftfield have generated significant interest as their ideas address mainstream, not just fringe farming concerns. Their work is continuing.

The advantage of off-peak water deficit migration of economic activity is that the development costs may not be as high as some other strategies such as storage that require expensive infrastructure. Shifting farm growing practices to that period can be done incrementally whereas accessing reliable irrigation requires a major capital development. The judicious use of both strategies is conceivable. By moving crops earlier, rainfall may provide enough water at planting and through much of the lifecycle, with additional water required only for finishing. The availability of water through storage can also be used as an incentive to change.

Changes to other industries
The Wairarapa tourism and visitor season is tightly packed into the summer months. Climate change will likely result in more pleasant weather across a wider spread of the year enabling events and activities that normally rely on the settled months of January-March, to broaden their potential operational period, thus spreading water demand associated with the tourism and visitor peak.

Current practices in Wairarapa

It is very difficult to assess to what extent seasonal adjustment is being and actively pursued without surveying farmers. We assume that the pressure for water hasn't yet become so acute that farmers are being forced into this strategy although many farmers base their operations of a drought occurring every summer, i.e. stocking levels and supplementary feed. Timing of growing for products and crops is probably more determined by markets and prices than climate, but this will change.

c) Water reliability and land use management

Reliability is a key consideration in resilience. Some crops or land uses, for example, have very exacting requirements where a period without water of more than a week can stress them. Others need adequate water at a particular moment in their life cycle. Carefully calibrated reliability can make water very productive.

Reliability can be a trade-off for quantity and is a key consideration in this Strategy. This involves the right amount of water just at the right time. Reliability lifts farmer confidence, uncertainty depresses it. If farmers know the exact amount of water that will be available to them they can farm to that level. If they don't, they will farm defensively, mindful that water might be short. Productivity and efficiency suffers as a result.

d) Allocation

As part of its statutory obligations, water allocation is undertaken by the Greater Wellington as prescribed in the regional plan, and is done on a first-in first-served basis. This historical use approach is practiced around much of the country based on the RMA. This type of allocation system has been used in other arenas such as the establishment of the quota management system for fish species.

There are several weaknesses of this approach:

- It is inflexible and difficult to adapt to changed circumstances such as climate change.
- It makes it difficult for the entry of new users where all the available water is already allocated, but not necessarily used.
- It doesn't differentiate between high and low value uses.

There is a further complication. The current system evolved from an era when water was a 'common' and was plentiful. Water is still a 'common' although there is a national debate around rights and interests (including such concepts as management) of water, particularly by iwi. The outcome of this debate will be crucial to the future

management of water. We know that water is becoming less plentiful in certain locations at particular times. Scarce resources need to be wisely allocated. The current system is a blunt instrument. The Government has a work programme for water allocation reform, including resolution of rights and interests. It is unlikely allocation issues can be totally resolved at a regional level without further statutory intervention, which makes it important to start the thinking process early.

How we allocate water in a more general sense (surface and ground) is a really important part of future resilience and optimisation of water use. Without the right flexibility and innovation in the regulatory allocation framework, many of the other resilience solutions may be thwarted. One of many reasons, by way of an example, for reconsidering allocation is that in the future the re-charging of groundwater aquifers is likely to be done artificially to augment the current natural processes. Practices such as Managed Aquifer Recharge and Managed Retention could be part of the future, particularly the latter. This will mean, without change to the consenting regime, that the current beneficiaries would gain an added benefit at no cost to themselves. Appendix 3: Water banking and Payment for Environmental Services (PES) deals with the question of payment for environmental services.

These types of requirements are placing new demands on existing practices. A re-think of allocation practices is becoming more and more inevitable if a well-worked resilience programme is to proceed.

Allocation is handled differently in the Waitaki River. There, it is based on a plan, not consents. The plan allocates a quantity of water to, say, an irrigation scheme or a collection of irrigation schemes as with the Waitaki Irrigators' Collective (WIC). The quantity cannot be altered without a plan change or a review (which happens about every 10 years) which helps overcome the problem where consents are extended and increased resulting in incremental over-allocation. Neither is there a hierarchy of consents which we have at present. One key difference is that the hydro schemes of the Waitaki unlike the situation in Wairarapa virtually guarantee a year-round supply of water.

One final point which came up in the section on groundwater, is that there is no guarantee that water directed into groundwater will be available for productive use (that is, for farming). It may not be recoverable in the amounts that it is directed into the ground. The balance, however, may have

significant environmental benefits, such as maintaining rivers and streams above low flows for longer. Who pays for that benefit and how, is another question.

e) Good Management Practice

There are many practices farmers can use to optimise water supply and protect their plants and animals. These bring together a wide range of traditional and new practices. Precision agriculture involves the exact application of nutrient and water to minimise loss into groundwater and runoff. Rotational farming allows recovery periods for soil and vegetation and combinations of uses help build soil profile and moisture retention capacity. Variable rate irrigators (using soil moisture sensing technology) can save up to 20%[47] of water compared to traditional pivot irrigators.

In other parts of the country, Good Management Practice (GMP) incorporates a range of farming practices that control the release of contaminants, particularly nitrogen with the objective of improved water quality. Regenerative agriculture is gaining interest and draws on the practices of natural resilience. It involves using natural processes such as mulching and composting to retain moisture in the soil. Urban GMP applies to gardening and public amenity practices that retain water through protection from evaporation. Highly interesting work is being done in Melbourne and throughout the state of Victoria to retain water through good practice. Known as Water Sensitive Cities, it is a highly innovative programme of urban water resilience.

Current practice in Wairarapa
The idea of GMP evolved in the WIP where it is outlined in some detail and this provides a sound basis for the resilience strategy. Many farmers practice aspects of GMP. It is not, however, universally practiced as a discipline in the region and arguably should emerge more strongly in the future.

f) Other aspects of seasonal use

We know that demand for water in the Wairarapa will continue to rise sharply in the summer, usually starting in January. There are tourists, and prized gardens, to water. Some parts of the country have been successful in spreading the tourist/visitor load into the shoulder seasons. Besides helping the water situation, it also spreads the season for hotels, restaurants and other hospitality services.

[47] Mark Guscott, South Wairarapa breeding, finishing and cropping of cereal, feed and small seeds farmer with 150ha irrigated

In the report by the consultancy organisation Leftfield Innovation[48], commissioned by Wairarapa Water Limited there is an extensive range of suggested adaptive approaches for the best use of water in agriculture. Many of these are dealt with in later chapters. The core of their argument centres on reliability rather than volume of supply. "*Reliable water provides the opportunity to rethink land use in the Wairarapa by taking a holistic look at potential land use in the future and to design land use systems, predominantly farming systems, that are diversified and integrate a range of complementary land uses within a parcel of land suited to the soil type, water availability, climate, location and community.*"[49]Improvements in the reliability of water can be achieved through storage and changes to the consent regime.

The purpose of the Leftfield report is to identify the best use of water from irrigation, but the principles that they are applying are just as relevant to resilience for the whole valley. The report outlines those land uses that currently exist, where more value can be captured through a redesign of the value chain and more enabling collaboration between farmers, local processors and food companies.

They go on to identify ten value capture opportunities including grapes, olives, wheat, peas, ancient grains and pulses, eggs, meat and indigenous plantings. They also identify a further four value creation opportunities including hops, pipfruit and summer fruit, vegetables for export, sheep and goat dairy.

Leftfield make the point that *"the viability of the proposed water storage scheme will depend on the stakeholders across the proposed uses seeing the potential of the Scheme to establish a resilient environment for the Wairarapa community to the extent where stakeholders commit investment to build and operate the Scheme"*. It would be through adaptive land use enabled by reliable water that a storage scheme can contribute to the water resilience of Wairarapa as well as its productivity.

g) Soil decompaction

Less compacted soil allows the leakage of water into the soil and possibly into groundwater, thereby holding water in the ecosystem. Compaction of soil is a direct result of land use, particularly stock; it is

[48] 'Near-Term Opportunities for Value - Wairarapa Land Use Evaluation Study' - Leftfield Innovation Limited 2020 https://www.wwl.net.nz/web/documents/library/Land-use-Opportunities-Report_-17-June-2020.pdf

[49] 'Near-Term Opportunities for Value - Wairarapa Land Use Evaluation Study' - Leftfield Innovation Limited 2020 https://www.wwl.net.nz/web/documents/library/Land-use-Opportunities-Report_-17-June-2020.pdf

also a function of the particular soil properties in an area.
Decompaction can be achieved by changes in land use. Decompaction also allows plant roots to penetrate deeper, and oxygen to get into the soils by providing an enhanced habitat for organisms such as earthworms to aerate the soil.

The potential scale of contribution of soil decompaction to water supply is not known and any estimate would be speculative. Similarly, the cost and loss of revenue involved is not well understood. Nevertheless, soil decompaction strategies need to enter our considerations over the next 10-20 years.

These adaptive measures largely apply to rural activities, but the same thinking can be applied to urban areas. We have already referenced the "Sponge City" idea, which is adapting urban infrastructure and practices that retain soil moisture and create microclimates. Activities include increased green spaces to complement sealed areas such as in carparks, use of permeable surfaces in urban areas to allow soakage of rainwater, use of artificial shading to retain soil moisture, and indoor/outdoor structures that reduce the evaporation effects of hot sun.

The Chinese have developed extensive roof and vertical gardens. They have also developed water features to retain moisture levels in the air at critical times of the year. Some of these adaptive measures may be a bridge too far for Wairarapa, but illustrate the potential of lateral thinking when it comes to climate change adaption. The idea of domestic tanks for rainfall harvesting was recently considered (and rejected on the basis of cost) by South Wairarapa District Council, while more in the "MAW" category, is an example of creative thinking around adaption.

Domestic adaptive gardening practices including strategic tree planting and ground cover, together with mulching and similar practices to retain soil moisture both to protect vegetation but also to create microclimates especially during the water deficit period.

Increasing resilience with more available water ('MAW')

The idea of 'new' water has been developed to help us think about resilience. MAW is simply a way of describing more available water (MAW); this doesn't include water that is already allocated which may or may not be used. We can ensure more available water by, for example, re-allocating previously (unused) allocated water, using less to achieve the same outcome, or using water more than once, minimising wastage or storing it during high supply periods for use in low supply periods. Generating MAW will be vital with high rates of water loss due to climate change-induced evapotranspiration. MAW can also include newly discovered water sources such as deep groundwater sources.

Potentially we can use this MAW to trigger or support natural processes of resilience

as well as augment functional applications such as rural and urban supply. 'New' water is not without cost. It sometimes requires infrastructure, treatment processes and active management. There is also a challenge to ensure that it does not come at the cost of the environment (such as high energy costs), biodiversity loss and water quality deterioration or unintentionally cause detrimental effects on connected water bodies.

The most important methods of 'generating' MAW are:

1. Non-consumptive use

Some uses consume water, reducing its utility for other uses, some don't. This is the difference between consumptive and non-consumptive water use. Essentially, whether it's considered as a non-consumptive use takes into account the volume used (if any), maintenance of water quality, the distance between water abstracted and then discharged (if any) and the net ecological benefits of the water use.

Non-consumptive uses are those where the water is "used" but the nature of the activity or the access to it is not diminished. It is used but not "used up". Tourism is an obvious example of non-consumptive (or low consumption) use where we look at it, swim, paddle or ski on it, but do not consume it. Hydro-electric generation is another example of a largely non-consumptive use, although it's very limited in Wairarapa. Water comes out of the electricity generator in the same form as it goes in. There is modification to the environment to create the facility to generate electricity, but the water itself is not modified and could be used again.

Most uses in Wairarapa are consumptive, and in many cases, single-use consumptive, meaning the water, once used, is not available for any other use, or if it is available there is a significant cost in restoring it to sufficient levels of quality for other uses.

In looking at the future economy of Wairarapa, which is likely to be in the tertiary and quaternary sectors, then ideally that economy should be giving higher priority to activities that are non-consumptive, if at all possible.

Recreation, wellness, tourism and visitor activities score highly on non-consumptive applications, but also economies that have increasingly high levels of tertiary and quaternary activity (services and technology) apply less pressure on water than others such as manufacturing, industrial and primary industries. The point needs to be made that tourists might not consume water when swimming in it, but they do consume it back at the motel, in the restaurant and at the car wash. Non-consumptive use is a 'net' rather than 'absolute' measure.

The point is that water can create value without being consumed.

2. Water use efficiency

Water use efficiency is a key resilience idea. Too often we use far more water than we need whether that is in the rural

or urban setting. Where water meters have been introduced around the country[50] they have demonstrated that simply making people aware of their water use (and attributing a cost to it) makes them more careful and reduces volume use provided that the costing structure reflects that to occur.

We have shown per capita water use rates are high in Wairarapa. Modern spray irrigation systems support efficient use as do water regulators on toilets and showers.

Some uses produce far greater benefits than others. For example, different land uses require different amounts of water. The water required for horticultural products is generally greater than for arable products and so on. What can be produced from natural water supply (i.e. rainfall) and what is only possible with augmented supply such as irrigation, may be different. This formula will change with climate change, and between years i.e. wet and dry summers.

More efficient use potentially increases the amount of available water for other uses depending on what has been consented. The nature of that availability will vary depending on how the available water is 'captured'. For example, if more efficient domestic supply systems are achieved, less water would be required and the balance could be left in the river to support minimum flows, or it could be directed into wetlands during dry periods or for managed aquifer recharge. It could be held in storage for domestic supply to increase the resilience of that supply. In this case, resilience is maintaining supply during periods without rain.

There are examples from Asia and particularly India where halving water for rice growth, done well, does not impact production.[51]

Summary of available efficiency solutions:

- **Public education and water conservation including metering**
  - Metering is currently being introduced across Wairarapa and is expected to have a significant impact on public and consumer awareness of water use. All three councils are advanced in the installation of metering.
  - They are not generally using metering as a basis for charging, but that is the intention and is likely to happen soon and it is expected to reduce water consumption. One of the great benefits is that meters help detect leakage from the network.
  - Public education is practised by all the local councils, particularly in the summer dry periods,

[50] For example, Whangarei, Western Bay of Plenty, Nelson, Far North District Council, Hauraki, Selwyn, Kapiti Coast, Tasman, Auckland, Tauranga, Christchurch, Whakatane, Waipa and Central Otago councils have also installed water meters.

[51] BBC ibid https://www.newsroom.co.nz/water-meters-the-awkward-question#:~:text=Metered%20areas%20are%3A%20Whangarei%2C%20Western,Whakatane%2C%20Waipa%20and%20Central%20Otago.

sometimes leading to rationing. At present public education is around curtailing use temporarily during 'crisis' periods rather than long-term behaviour change.

- **Rural water use efficiency**
  - Irrigation infrastructure upgrades are happening all the time as irrigation technology improves.
  - The irrigation technology used in Wairarapa could be described as advancing, but somewhat behind industry best standards. Techniques such as border dyke (flood irrigation), and roto-rainers are no longer in common use; K-Lines are still quite commonly used - all have the common problem of over-watering as they are essentially static and/or deliver bulk water. Centre pivots are commonly used, but the variable rate pivots are still uncommon. One Wairarapa farmer who has recently installed such a system (together with soil moisture sensing technology) has reported a 19% improvement in efficiency, or to put it differently a 19%[52] increase in water availability from his consent.
  - Both carrots and sticks can be used through farm environment planning and education to educate rural users and this can be delivered through existing or anticipated structures such as is done through Fonterra and other bodies.

- **Urban water use efficiency**
  - Each of the councils is involved in a programme of infrastructure upgrades with improvements to municipal piping to reduce leakage. It is likely that there are some easy wins but part of the problem will be aged infrastructure requiring substantial upgrade and involving substantial cost.

- **Seasonal water rationing**
  - This is practiced in crisis periods and is a relatively crude and cheap method of improving efficiency. It is also short-lived. It is crude because it doesn't differentiate (except to a small extent) between uses, some of which may be more important than others. Other methods of efficiency are better than rationing, but they involve significant improvement to water management.

- **Seasonal public education programmes**
  - Wairarapa people are sensitive to water scarcity and awareness levels are high. Public education is most effective at times of crisis, but, like rationing, it is generally crude and can result in irrational behaviours. For example, irrigators, knowing that water availability is to be rationed, may deliberately over-water before

[52] Mark Guscott, Wairarapa farmer - verbal estimate

access to water is curtailed. Some urban gardeners are known to be midnight waterers.

3. Water re-use or multiple use

Once water essentially becomes sewage, it has too often simply been disposed of. Yet practices are changing. There are trends to re-use of treated wastewater where it is treated and sprayed onto land to water trees or grass for agricultural use. This method has become necessary because of restrictions on releasing treated sewage into waterways, not specifically for the purposes of re-use. If utilised correctly, re-use of treated effluent is a windfall benefit. At this point, the amount sprayed to land is relatively small (around 10%) as it is largely done in the summer low-flow period rather than winter when there are higher rates of dilution in rivers and soils are generally saturated. This percentage will increase as more infrastructure comes on stream such as the treated effluent ponds south of Carterton.

Re-use is particularly applicable to large water users or uses, but also has micro applications. The big users are the councils through domestic supply which generate sewage waste. Large industrial users face similar problems and are forced to treat their waste water to quite high levels or even re-use it in their processes. Water treatment is a cost of doing business for these types of enterprises and, given that many are large users, the ability to re-use becomes essential if they are going to have a place in a future-resilient Wairarapa.

Re-use has significant health, hygiene and contamination limitations depending on the nature of the previous use and the level of treatment applied. Some used and re-used water, such as that from farmland, can also be passed through wetlands that have significant filtration capability – an example of using natural resilience to strengthen overall resilience. Generally though, constructed wetlands are expensive to build and require knowledge how to operate them efficiently.

Water re-use as a result of sewage mining cannot be used for crops that lead directly to human consumption – at least not without significant controls and restrictions.

Summary of available re-use solutions

- **Domestic wastewater**
  Treatment and use for spray irrigation on land or for specialist uses such as nurseries (not groundwater augmentation) is being practiced by all three Wairarapa councils and the practice is expanding. Its use advantage is protection of rivers which would otherwise receive treated wastewater. Carterton in particular is currently significantly expanding its re-use capacity.

- **Industrial wastewater**
  In Addendum 8: Characterising industrial water use there is information on industrial use. Treatment and re-use by industrial plants is well-established. Several Wairarapa enterprises engage in re-use or treatment notably JNL, Premier

Beehive, Breadcraft and others. Enterprises that add value to primary products are likely to be a feature of the future economy and with that will come greater re-use.

- **Grey water**
  Grey water use is not common in Wairarapa. This involves the re-use of wastewater from washing machines and kitchen applications and applies in particularly water-short urban areas. The practice is promoted by the Council in Kapiti and is used to water gardens, but experience has not been wholly satisfactory with the build-up of contaminants in some soils.

- **Farm drains**
  Collection of water from farm drains and storing it in tanks for later use has been explored in Wairarapa. This has the advantage of recycling nutrients with the water. It involves the building of significant infrastructure, yet there are indications that in some circumstances it could be viable.

4. Managed retention

We can increase the availability of water simply by slowing its progress through the catchment system by directing a greater quantity of water into groundwater. This is consistent with a major thrust of the WIP. There are several advantages of this approach. It slows the water making it available for a longer period of time. It cools the water so that when it comes back to the surface it is less likely to spawn algal blooms and such biohazards that damage waterways. Groundwater is also protected from evaporation.

Managed retention solutions have a particular strategic role to play in a resilience strategy besides the advantages already listed. It has already been explained that "freshes" through spring and summer will continue to be a feature of climate change. These freshes have the ability to capture water in larger quantities than current practices would allow. This means that groundwater can be regularly replenished allowing it to be more available into the water-deficit period.

Retention can be practiced in all manner of locations: across the valley in suitable places; in hill country use of traditional dams (generally for stock water) is common. Leaky dams, nano dams (or mini-dams) that slow the runoff of water can also be used. Use of contour channels in hill country can have the same effect.

Water can be held (though for how long is not well understood) in groundwater, so the more water that passes into groundwater the better. Water can be held in rivers and more especially in the fringes of rivers such as in wetlands, associated streams and even constructed water races.

Summary of managed retention solutions:

- **Detention bunds**
  These are mini dam-type structures that delay the passage of water in streams and waterways, but do not totally obstruct it. For example, in a

moderate “fresh” streams will be obstructed by bunds and water will be held to pond for several days and leak into the aquifers. In this way it is retained. The temporary nature of the detainment of the water means that there is a low-level of damage to the farmland that is temporarily flooded.

Anecdotal evidence from farmers practicing this solution is that while few are doing it, it is neither difficult nor expensive. The problem is seen as motivating farmers to incorporate this type of activity into their practice.

There are some questions to answer:

- Is in-stream obstruction allowable under current planning rules?
- How will bunds stand up to severe flood events; do they risk getting washed out so tidy up works are required as well as constructing replacement bunds?
- How are they maintained on an ongoing basis?
- Would they require easements on private land and how would this be done?
- Will the bunds make a discernible difference to water infiltration i.e. does the cost benefit stack up?
- What cost structures would be required to reward farmers who build bunds but derive no benefit for themselves?
- What charging regimes for the downstream water users?
- Will their construction and operation require resource consent?

None of these is a game-breakers but they need investigation and proof of concept given that there seem to be very few live examples in New Zealand. Part of the reason for this, if Wairarapa is an example, is that the use of such bunds is not permitted and this would need to change if they are going to be recommended.

- **Accessing natural flood plains**
  Flood management efforts over the years have resulted in a network of stopbanks built to narrow river courses and speed the pathway of water to the sea. Their purpose was to capture river fringes (generally flood plains) for agriculture and to protect those areas and human settlement from flood. Natural flood plains were a valuable source of natural retention as water soaked into groundwater. Managed systems of using old flood plains are potential resilience solutions. For example, gates could be installed in stopbanks to allow controlled flooding of specified areas during freshes, or wider channels could be allowed for rivers. There is a proposal to allow the Ruamāhanga to empty once again into Lake Wairarapa which would involve using flood plains for water retention. This could involve some sort of managed retreat or

partial retreat, a technique that is used extensively in the UK.

Without identifying particular locations and assessing viability and cost, it is difficult to know the potential of this solutions. Anecdotal evidence suggests there is moderate and worthwhile potential to investigate this option.

Detainment or detention bunds

There are many forms of detainment or detention bunds (DB) in terms of scale, their exact purpose (target role), effectiveness, volume of water held, storage time, design, and their effect on farm productivity. They are not dams, as their purpose is to intercept and impound water only for a temporary period. They're also known as dry ponds as they are dry between storm events.

Detention bunds need fairly porous soils or subsurface drainage to assure that the bottom stays dry and live with vegetation between storms. They are not suitable in areas with high water tables or shallow depth to bedrock or on fill sites or steep slopes unless geo-technically checked.

Generally, they would fill when sufficient overland flows are created as indicated by the number of occasions ephemeral streams flow over farmland, i.e. only a few times a year. This gives an indication of how often soakage into groundwater would actually occur.

They can be used to control or mitigate sediment, nutrients, erosion prevention, and diversion of surface water into groundwater. A smaller scale of these are most commonly used as a means on control on projects involving earthworks. Numerous trials have been conducted over the past decade mainly by the Phosphorus Mitigation Project. In their experience, only one proposed DB site for every three sites investigated is actually suitable. The following link details the studies conducted by Phosphorus Mitigation Project: https://atlas.boprc.govt.nz/api/v1/edms/document/A3539038/content

There are no known full catchment scale, purpose-built detention bunds in New Zealand, although some structures (e.g. road or rail embankments) or natural landforms may inadvertently perform or operate in this manner; they are usually drained by small culverts which eventually drain any water backlog.

Issues such as cost to construct, land tenure/legal status, maintenance responsibilities, how they perform under extreme (flood) conditions would need to be assessed, i.e. could they structurally withstand such conditions, etc.

- **Nano dams, leaky dams and straw dams**

  These are similar to bunds, but in hill country. They inhibit water flow, allowing it to pond and soak away into the soil and groundwater. They also have the advantage of inhibiting the flow of sediment off hills and into rivers, thereby enhancing water quality. These can be associated with the contouring of sloping land to retain soil moisture.

  These are not common practices in the region (nor in New Zealand more generally) in part because many parts of Wairarapa hill country are too steep. Maintenance issues and failures can lead to sediment problems. The geology has to be suitable for them to work.

  Traditional stock water dams also have a role to play in slowing water down and collecting sediment.

- **Repurposing water races**

  The issues surrounding water races are dealt with in its own chapter. In respect of the future of water races this is a nettle that needs to be grasped because of their high water usage in times of scarcity. The WIP recommended (Rec 12):

"The Committee recommends that water use efficiency be improved among all water users in the Ruamāhanga whaitua, including by: Greater Wellington and territorial authorities working together to develop long term plans for the management of water races in the Ruamāhanga whaitua that meet the objectives of this WIP and provide for the values of the water bodies and communities".

5. **Natural attenuation**

Another method of holding water within the catchment is natural attenuation which comes in many forms. Water can be held in soil at different levels of the soil structure and in vegetation growing in the soils. Vegetation can protect soils from evaporation and enable them to carry more water longer. Water is also filtered and cleansed through natural attenuation such as wetlands, so there are multiple benefits. Natural attenuation practices are vital in restoring and protecting the mauri of the water because they both retain and cleanse water.

E KORE A REPO KI TE KORE A RAUROPI
The potential of wetlands to the potential of organisms

Summary of natural attenuation solutions:

- **Land cover and afforestation**
  This involves planting of vegetation to retain water in the soil, shade pastures and protect headwaters and is well accepted as a means of retaining water and soil moisture. This is different from forestation for timber or for carbon, although the uses could overlap.

- **Wetlands regeneration**
  The restoration and development of wetlands has multiple benefits of 'cleaning' and retaining water. Wetlands provide habitat and areas of public amenity interest. Interest in wetland development is expanding in Wairarapa, though it is still limited to a relatively few farmers. There are benefits in "cleansing" farm run-off, improving aesthetics, supporting indigenous biodiversity, game bird habitats, flood protection, climate change mitigation and dealing with problem areas on farms and all that with relatively little loss of productivity.

Kaiwaiwai constructed wetland, South Wairarapa

The construction of this wetland cost of $55,000 – 25% paid by the landowners, the rest by a diverse group of funders - the 0.75 ha wetland. It's a controlled wetland with 10 litres of water per second going through it every day of the year, providing an opportunity to monitor its effect through changing temperatures. Up to half a tonne of nitrates a year were being removed by this wetland. At times the discharged water contained no nitrates.

- **Riparian planting**
  Planting streams and rivers retains soil moisture, moderates water temperature and slows the progress of water through the catchment. In these respects, it plays an important function. Riparian development also provides shading to reduce evaporation and periphyton and algal bloom growth and has many of the advantages of wetlands. Riparian planting comes at a significant cost of averaging about $60,000 per linear kilometre to plant and fence both sides; this doesn't include the balance of the land 'lost' to production versus the value gained by the environment.

Wairarapa Moana riparian plantings

The Wairarapa Moana Project is incrementally restoring the wetland habitat around the edge of Lake Wairarapa and Lake Ōnoke, collectively known as Wairarapa Moana. As in the above photo, the works includes fencing and plantings.

- **Lake enhancement**

There are a number of lakes in the Wairarapa, with the most notable being Lake Wairarapa itself. Enhancement of the edges, redevelopment of wetland and transition zones all contribute to retaining moisture. There is significant wetland activity around Wairarapa Moana in a partnership involving Greater Wellington, DOC iwi and landowners.

- **Water Sensitive Towns**

This would involve an active programme of natural resilience development in urban areas including extensive tree planting on public and private land, wetlands and planted areas in and around town centres, all with the purpose of retaining moisture in the environment.

6. **Groundwater augmentation**

There are established technologies for directing water into aquifers. Known as groundwater augmentation or Managed Aquifer Recharge (MAR) it

involves either passively directing or actively pumping surface water into aquifers.

There are no known full-scale operational examples in New Zealand, but there are in other countries. At a minimum, MAR relies on a reliable water supply and suitable geology; the combination of both in the Wairarapa has yet to be determined, so its efficacy is unknown.

Summary of groundwater augmentation solutions:

- **Managed Aquifer Recharge (MAR)**

  MAR is the deliberate transfer of surface water into aquifers; the two main approaches to achieve this are by surface infiltration or deep well injection. Sometimes, the water is recoverable and this is discussed in the next chapter on groundwater.

  In New Zealand, three pilot projects are being investigated using both options, namely:

  i. The Gisborne Makauri aquifer project aims to inject water from the Waipaoa River into the Makarui aquifer to ensure its ongoing use for irrigation of 3,000 hectares of horticultural farmland.
  ii. Hawkes Bay Regional Council trials will capture surface water from streams or rivers during winter high flow periods, settling and filtering that water and then recharging it into the aquifers below the Ruataniwha Plains.
  iii. The Hekeao Hinds scheme in mid Canterbury is in its fourth year of trials now involving 12 active recharge sites. Goals for the scheme are to:
  • Reduce or maintain groundwater nutrient levels to the community desired levels
  • Increase groundwater levels and storage
  • Enhance lowland stream flows and biodiversity
  • Ensure that the Scheme is affordable and cost effective to the community, and
  • Establish and maintain community acceptance for the Scheme.

  The attractiveness of MAR may be that reliance on water naturally soaking into the groundwater such as through retention solutions is too slow and the volumes too small. Drilling reverse bores and pumping water into the aquifers is costly

and there is no guarantee that the water can be recovered. This water may have to be pumped into deep aquifers to be recoverable, of which there are few. If it were pumped into shallow aquifers the water could be lost as part of the dynamic groundwater profile and likely rise back into the rivers it has just been taken from.

To further complicate matters, the advantages of aquifer recharge is not necessary in the winter months because the natural processes are replenishing the aquifers. Artificial replenishment, if it is to be effective, is required immediately before and into the water deficit period at a time when the supply of water for Managed Aquifer Recharge is rapidly falling (unless it is drawn from stored water).

Finally, MAR can transport contaminants directly into the aquifers, which creates issues for human use. Environmental monitoring will be a large cost for any MAR project to consider.

If it is to be used it is likely to be very tactical in nature rather than as a region-wide solution.

Managed Aquifer Recharge - The Hekeao/Hinds Managed Aquifer Recharge (MAR) Project

The Hekeao/HindsManaged Aquifer Recharge (MAR) pilot project on the Canterbury Plains aims to replenish and improve the health of the aquifer and water quality by injecting alpine river water supplied by local water races. Such schemes can also be utilised when surface water storage is not an option. Trials are also underway for a MAR schemes in Poverty Bay, Gisborne. It is also being considered for Hawke's Bay's Ruataniwha aquifer.

The concept has been used all over the world with various forms of success and outcomes. As such, a pilot usually needs to be tested for specific sites to determine, amongst other things, that it works in that area.

Closely aligned to MAR is the Kapiti River Recharge scheme. As the KCDC website reports: the River recharge with groundwater scheme allows more fresh water to be taken from Waikanae River while maintaining the river's ecological balance and required minimum flow.

Rainwater is filtered through sands and gravels and seeps into the deep Waimea aquifer, which provides natural underground storage. In times of low-river flow, water from the aquifer will be pumped and discharged into the river downstream of the Waikanae Treatment Plant intake.

This means the taste and quality of the water that comes out of taps will not be affected by groundwater being added to the river, as it will not enter water supply.

As well as enabling consistent high quality water, the consented extra extraction allowed secures supply for future growth in the Waikanae, Raumati and Paraparaumu areas until 2048.

- **Deep groundwater**

  Although the 'discovery' and/or utilisation of deep groundwater is not the same as groundwater augmentation or managed aquifer recharge detailed above, it is discussed here because of the obvious linkage. To be clear, the presence of deep groundwater is natural; it does not involve an artificial direction of water to these depths.

  It is well known that there is natural deep groundwater is some areas of Wairarapa, though it is not well mapped due to the complexity of groundwater reserves. The proposed electromagnetic survey of the region will likely identify the extent of deep groundwater and whether it is useable and retrievable.

7. **Storage**

   Water can be stored naturally and artificially. Groundwater is a major natural storage facility. Groundwater is vital to resilience and is relevant to both storage and attenuation.

   Bulk constructed storage such as that proposed at the Wakamoekau site is intended for agriculture, industrial, municipal, amenity purposes. The proposed facility is small by New Zealand standards and smaller than the Opuha water storage reservoirs in South Canterbury (photo). Towns in Wairarapa currently have very limited storage for domestic supply, largely to control fluctuations in demand; future demands created by climate change especially means that larger or storage buffers may have to be considered by the councils; the councils have signalled need for further storage in their future budgets. Another option is for the councils to consider an integrated approach, or build their own storage.

   Smaller constructed storage facilities are also used such as on-farm storage ponds in rural areas or rainwater capture tanks in urban areas or on lifestyle blocks remote from domestic supply networks.

- **Bulk storage**

  The Wairarapa Water Project is currently undertaking a feasibility study for a storage facility at Wakamoekau. This will, if it proceeds, provide a significant increase in stored water in the middle to upper level of the Ruamāhanga Catchment. Appendix 4: Irrigation and constructed water storage is set aside for irrigation and storage.

  Such reservoirs can also provide a range of other services besides rural supply, such as commercial, domestic, industrial supplies, and amenity values.

- **On-farm storage**

  On-farm storage is relatively common in Wairarapa. Reticulation schemes aim to eliminate them. They are used for irrigation, stock water and frost fighting. These are ponds topped up at high-water times, perhaps from a bulk storage facility or groundwater or from farm drains and used for tactical watering.

  Private on-farm dams of reasonable size in the Wairarapa are currently located at[53]:

  - Carterton
  - Northwest of Masterton
  - Craggy Range (Martinborough)
  - Two in the eastern hill country
  - East Taratahi/Dakins Road.

[53] Pers comm Stephen Thawley, Environmental Regulation, GWRC. Specific examples provided to the Wairarapa Water Resilience Strategy Group include - Rupert Handyside on Upper Plains (400,000 cubic metres), Len French has one under construction.

Large scale community water storage

Lake Opuha is one of the few examples in New Zealand of a large scale dam built specifically for water storage purposes other than the network of hydroelectric dams, some of which also supply rural and urban water supplies.

Lake Opuha (pictured above) is a 700 hectare lake, built with the purpose of acting as an irrigation reservoir. The lake lies 12km from Fairlie.

Stored winter and spring river flows are released in summer for stock and crop watering, as well as for Timaru's domestic and industrial use. In addition to water storage, the lake provides electricity with a small-scale hydro 7.5MW electric plant on the outlet of the dam at the head of the Opuha River gorge.

Another example currently being constructed is the Waimea Dam close to Nelson. In addition to supply the Waimea Plains horticulture industry with reliable water it will also augment the Nelson and Tasman area urban water supplies.

Farm scale water storage

Individual properties can have their own water storage reservoirs. These are typically constructed and managed by the property owner, including construction, maintenance and pumping costs. Compared with other water deficit East Coast locations such as Canterbury, Hawkes Bay or Gisborne, there are very few examples of these in the Wairarapa.

Commonly, because of the relatively small volume they hold, use of the water is usually limited to specific events or circumstances such as frost fighting, crop watering or to carry over when consents prevent abstraction from surface or groundwater. Other than for frost fighting, they help to carry a farmer over water critical periods.

In such cases, if the reservoir is emptied, the water stored may not be able to be replaced until a later date once restrictions are eased.

- **Rural stormwater collection**

  Collecting water from farm drains and storing it on-farm as a hedge in the peak season is being considered in Wairarapa, but there is no known practice current in operation. This has an added advantage of recycling nutrients lost with water.

- **Rainwater harvesting**

  Tanks on domestic properties for rainwater harvesting is under consideration by all councils as they are all involved in the one (combined) district plan but is expensive. South Wairarapa District council is considering this option. Most rural users have their own rainwater capture. Although it is a tactical response, thinking of it in the long-term for new properties, it has merit.

  The use of potable water for watering gardens is wasteful, yet alternatives such as grey water use are unproven. This may be an application for rainwater capture in residential areas. A voluntary scheme might eventually segue into a compulsory one for significant users (based on metering).

Because of the controversial nature of constructed and particularly bulk storage, a number of principles have been developed by the Wairarapa Water Resilience Strategy Group to ensure that storage takes its correct place in the mix of resilience solutions. These principles are for guidance. They are not absolute.

The principles are:

- All things being equal, natural solutions would trump constructed ones, so natural storage would trump constructed storage.

- Adoption of constructed storage should not, as best as possible, impede the focus on natural solutions either in technical terms or in the minds of water users.

- Constructed storage should be used, as best as possible, for high-value uses so that water moves to the uses of highest value.

- Constructed storage can be used as a backstop to provide the needs of human health when other solutions either are ineffective or cannot supply the volume of water required.

- Constructed storage should try to include natural solutions as part of a package as it is developed, especially to offset environmental impacts. These could include riparian planting around the facility and wetland construction.

- Constructed storage is developed in the context of this Resilience Strategy and not outside of it.

Other resilience mechanisms

There are other mechanisms that can be used to manage the use of water – the allocation regime, regulation, education and price. Because water is a common and technically owned by no one, it cannot be bought or sold, just used. The RMA gives priority to existing consent holders on a first-in-first-served basis. Also, consents are a property right (for as long as they exist) so they are attached to the land, not the consent holder.

Utilities such as councils or Watercare in Auckland can charge for the supply of water – the cost of the infrastructure – but not for the actual water itself. They can and do charge for water on the basis of usage, but it is still for the supply, not the water. The Wakamoekau Scheme will also require payment for the infrastructure to deliver secure water, although the details of this are still under development.

As a result, there is limited scope in the rural setting where farmers source their own water to use price as a method of demand control. Rising demand and slowing supply will increase the value of water, but as water is a common – a free - commodity – this will not be reflected in increased costs for users, with potential compensating reductions in usage.

This lack of access to price mechanisms means that if supply is to be controlled, it has to be done through regulation. This is already the case. All bulk water users such as farmers, councils, and industrial users require consents from the regional council.

Farmers often have the expectation that because of historical use they have a right to renew their consent with roughly similar consent conditions - renewal of existing consents take their actual use needs into account.

Regulatory mechanisms of this nature are very inflexible. They do not, by and large, differentiate between uses. For example, they do not specifically direct water to higher value uses and they allow water for low value uses, or in some cases no use at all, where consent holders do not use their full allocation. Consents are subject to availability and water supply is constrained at low-flow periods. The changing demand and supply situation will be increasingly expressed in water scarcity such as seasonal shortages as climate change effects take hold.

While this arrangement was acceptable historically, in a situation of climate change and the need to consider priority uses of a scarce resource, it is less acceptable. Add to that the possibility that measures such as groundwater augmentation and various attenuation methods are used to build groundwater, then some control may be required over access rights. This is dealt with in more detail in Appendix 3: Water banking and Payment for Environmental Services (PES) on water banking.

Similarly, with weak price signals for municipal supply, there is little incentive for private residents to reduce rates of leakage on or under their land either because they are not paying, or they are

paying so little it doesn't much affect their demand behaviour. However, it's intended that this situation may change.

This is a deep irony in all this, because a commodity that is becoming more valuable and more degraded by the day is unable to realise that value even to protect itself from further wastage and degradation. If we are to become resilient we must solve this conundrum.

Ownership and management of water is a national issue subject to national political debate, especially around the question of tangata whenua ownership. The ownership and management status of water could change in the foreseeable future, but it may not.

Chapter 13: Optimisation

The most challenging aspect of this report is to establish not only the direction of a resilience strategy, but to indicate priorities so that it can be translated into policy and action by the various agencies responsible for resilience.

Essence of the solution

The core of the problem, we foresee today, is the water deficit period of January to March. From a rural perspective, if the water deficit period covers more and more of the current growing season for crops and pasture, growth will be adversely affected.

Despite all the actions proposed to moderate demand more water will need to be retained in the ecosystem. The key is the freshes that climate modelling tells us will still take place, but with somewhat less volume. Retaining as much water as possible from these freshes, especially in the immediate pre-water deficit period of October to December, will be vital to resilience. They will produce enough water, but how to collect, retain and distribute it?

They become even more important when it is considered that 'normal' recharge of natural water sources will likely be interrupted by drought conditions brought on by dry winters following dry summers. We are concerned about protection of supply for human use and environmental use.

We have two objectives:

- To minimise extreme effects of lack of water in the water deficit period when they arise; and
- Slowing the encroachment of the water deficit impacts into April (and beyond).

Every solution has its strengths and limitations, possibly accompanied by unintended consequences. For example, it is not clear just what the capacity and capability of aquifers is to store and supply water. If we put water in aquifers will it still be there when we want it? What are the environmental benefits of water passing through the aquifers? These are fundamental questions. Similarly, if we were able to retain moisture in and around waterways and lakes through the expansion or creation of riparian planting and development of wetlands, would we improve both water quality and the level of soil moisture in the vicinity?

Science is going to gradually tell us more and we will learn from experience, but at this stage we will have to make judgements on the basis of the knowledge we have and don't have. To help with prioritising, we have developed a number of principles and priority uses listed in earlier chapters and they should be borne in mind when reading this chapter.

This water resilience project is a learning process, but to learn we must first take action, then monitor, review and adjust.

Evaluating water resilience solutions

To prioritise water resilience solutions, a series of five workshops were undertaken with participants in Wairarapa drawn from a variety of backgrounds - people with a reasonable working knowledge of water management, farming or water policy. They undertook a multi-criteria analysis exercise (MCA). A report on the workshops is in: Appendix 2: Multi- criteria Analysis results.

Appendix 2: Multi- criteria Analysis results.

Basically, there were two clear groupings in terms of solution preferences, namely:

#1 Preferences – storage, natural attenuation, managed attenuation and land use adaptation with GMP
#2 Preferences – groundwater augmentation, re-use and water use efficiency.

Some immediate conclusions arise from the rankings:

- **All solutions are in play** – no solution was scored by any group so low that it was considered a non-starter. Solutions are not strongly weighted in terms of importance or efficacy.
- **There is a preference for green over grey solutions** – the green solutions were first and second in the rankings, but green is not supported to the exclusion of grey.
- **Natural attenuation** – is the most universally agreed among the Wairarapa Water Resilience Strategy Group, plus the most preferred solution. Working with nature not against it is a strong point of convergence.
- **Water use efficiency** – was least supported, but not universally so; Greater Wellington hydrologists and local councils still gave it a reasonable score.
- **Groundwater augmentation** – received the least universal support, largely due to uncertainty about its effectiveness in the Wairarapa setting; it would at least require trials to prove its viability.
- **Managed retention** – was highly approved primarily because of its whole-of-catchment potential, but the Greater Wellington hydrologists doubted its effectiveness on technical grounds. Their concerns were related to the complexity of aquifer structures, soils and geology, the feasibility of actually implementing it at a catchment scale and maintenance issues.
- **Water re-use** – was less well supported, but not by local councils and stakeholders, such as industry, who interestingly both utilise this solution.
- **Storage** – was ranked high, just below natural attenuation and managed retention.
- **Change of land use coupled with Good Management Practice** – received positive scores and was well supported but reactions to it were highly variable.
- **Managing adaptive land use, managed retention and natural attenuation solutions together as an integrated whole is more favoured.** This is part of the broader indication in the results that the participants generally believe that multi-dimensional solutions are desirable and recognition of the fact that some solutions might not work as well as anticipated leaving other solutions as a backstop.
- **Green solutions particularly, will rely on co-operation and/or compensation of some sort.**

Individuals who participate or dedicate land, their time etc. to make this happen may need to incentivised to encourage them to help assemble a catchment scale suite of solutions. This not going to be straightforward to implement because it will require a mindset change for many especially as many of the benefits will be realised downstream of the land they own and operate.

Water management dimensions

Other dimensions arose from the discussion in the MCA workshops that are worthy of mention:

- **Whole-of-catchment versus localised solutions**

  The importance of solutions that could operate at scale to match the scale of climate change impacts was reinforced. Climate change will impact all of the catchment and whole-of-catchment solutions are required as a response. Local solutions with local benefits are still important, but they would need to operate in tandem. The most obvious whole-of-catchment solution is managed retention with its focus on holding large amounts of water in soil, streams and aquifers.

- **Long-term solutions**

  Favour was expressed for a long-term view and the building of robust solutions that will last well into the future. This was not to exclude short-term actions, but thinking long-term was seen as an essential component of the resilience programme.

- **High cost versus lower cost**

  Because of the large costs involved and the need for the solutions to be well-funded, well-conceived and well-constructed so that they stay the course, it was recognised that work would need to start soon as possible, even before the full impact of climate change is evident.

- **Incidence of cost on land user versus incidence of cost on the community**

  This is really the question of cost-sharing, both in the immediate and generationally. Some solutions, particularly larger, long term solutions will require substantial investment.

  The incidence of cost will need to be apportioned in different ways, some to the immediate user (as in the case of a constructed storage reservoir and reticulation system) and some by indirect users such as managed retention that feeds the environment, domestic supply and civic amenities. The mechanism of Payments for Environmental Services has a section allocated to it in the appendices.

Characteristics of solutions

Combining these management dimensions, the results of the MCA analysis and the analysis to date in this Strategy document, a picture begins to emerge as to where we should direct our attention. The vital question is what role does each have to play in the total mix of solutions?

Some solutions are already in play:

- The installation of smart water meters by local councils.

- Enhancement of municipal water storage to create a buffer.
- MPI's Sustainable Food and Fibre Futures supports problem-solving and innovation in New Zealand's food and fibre sectors by co-investing in initiatives.
- One Billion Trees Programme including the Jobs for Nature. The Ruamāhanga catchment and the Wairarapa Moana Wetlands project will be targeted with the Greater Wellington contributing approximately $4m on top of $6m from the Government.

Managed retention

This is a key water capture (supply) solution and its importance is amplified by the fact that it is strongly green and catchment-wide in its character and potentially simpler to implement than some other solutions. This Strategy requires one or two solutions that capture of large amounts of water because of the expected scale of the water deficit.

Managed retention is relatively low technology and within the scope of many farmers and land users, thus some of the equity in the development could be 'sweat' equity not just capital, making it more financially manageable. It can be broken up into a series of individual projects, done incrementally as resources are available, implemented location-by-location.

There are questions around managed retention:

- Greater Wellington's hydrologists queried whether the water directed into groundwater via managed retention would be of significantly greater than is seeping in of its own accord at present
- Would it be recoverable?
- Can it be done at the scale required?
- It's untried and unknown
- Volumes might not be sufficient.

Managed retention on hill country is almost a separate consideration. The eastern hills are likely to be significantly adversely affected by climate change and whether managed retention solutions are cost effective in that environment it is difficult to know without in-depth investigation.

Land use adaption and Good Management Practice

This is a key water use (demand) solution. Its intention is to spread demand out of the water deficit period and reduce overall demand whilst enhancing production value. It is a mix of interventions. It is primarily a "green" intervention in the sense that it is about adapting production to climate change as it will be targeting water for high valued production.

It will be most effective at scale across many properties. It is potentially disruptive because changes to land use can involve change to the whole business model of an individual farmer including consideration of market demand. It has the advantage of being more local, based on individual land user priorities, preferences and locations.

There are some questions around adaption:

- New land uses can take a considerable time to become established
- Land users are unlikely to do it unless it is incentivised or unless circumstances mean they have to.

The idea of Good Management Practice has some real attractions. This could take the form of resilient farming guidelines which could be promoted as part of a changing land use package. It is not envisaged as a regulatory measure in the way it is used in Canterbury.

Natural attenuation

Natural attenuation scored very well in the MCA and was favoured across all groups. It has a great number of attractions. It applies equally in rural and urban settings. It mostly involves a series of discrete projects like a single or chain of wetlands or a riparian strip and is project-based, meaning implementation can be as large or small as resources allow. If done at scale, and that is the ideal, it would have a cumulative whole-of-catchment impact.

Questions which arose in discussion were:

- Cost
- Time required
- Commitment required to get to scale

One major advantage of these projects is their visibility and attractiveness. Natural attenuation projects appeal to a wider population – rural and urban – and are therefore more likely to attract public and community funding. It is not unknown for urban people to be involved in planting initiatives in rural areas and that would help immensely in building relationships between the sectors on resilience.

Storage

Storage, like managed retention, is a supply solution and has multiple roles to play. Its most important role is water volume. It effectively transfers winter water into summer diminishing the reliance of spring and summer freshes. Because there is a high-level of control over the water (compared to groundwater) it can be used for irrigation, frost fighting, augmentation of summer river flows (although with the downside of increasing water temperatures), stock water race flows, domestic supply, industrial use and natural resilience.

Reliability is its greatest asset enabling land users to get more from less. Generally, the larger the water storage, the cheaper the unit cost of that water; however, that can have counter outcomes. It is important to note that the water user/farmer funds that would pay for storage would not necessarily be available for other non-supply solutions, and with supply solutions such as managed retention where recovery is uncertain, the amount a user is prepared to invest may be lower than for storage. These are issues to be tested once feasibility is undertaken.

An important benefit of storage is that it can be used to incentivise land use adaption through controls over the distribution of water, and the cost of the water itself. Short-term and tactical storage such as on-farm ponds, tanks associated with tile drains and rainwater harvesting by residents have their place,

but because of the small amounts of water involved their impact is limited. It is likely, into the future, that the economics of short term storage will improve as climate pressure intensifies.

There are questions:

- Its limitations are its spatial location. It's essentially local as it applies to a particular command area, both urban and rural.
- The cost of storage is well known and is high but to offset this there is proven return on investment and the cost falls directly on the user.
- There are environmental impacts which need to be mitigated, some of which could also be mitigated through nature-based solutions.

Water use efficiency

Water use efficiency is immensely appealing as a solution because it feels like more water at little or no cost. It is primarily a grey infrastructure intervention relating to piping networks including repair, replacement and maintenance, metering and water conservation measures. If urban networks were improved and sensor-driven variable rate irrigation systems were more extensively used, there would be a quick, and short-term improvement in water availability, and that has real strategic value.

Water use efficiency is less significant when viewed from a whole-of-catchment perspective because of the modest real gains, but in terms of short term gains and building awareness of resilience it is very important.

The other dimension of water use efficiency is allocation efficiency. This is the allocation of water to users which is not used and the inability to move water around users. If successfully executed, it could improve water availability in short order.

Groundwater augmentation

Augmentation has benefits and deficiencies. Like several of the solutions proposed, the factor going against it most is its unproven nature in the Wairarapa (and New Zealand) context with its short groundwater travel times and lack of deep aquifers; the SkyTEM aerial groundwater survey will throw light on this matter.

Water re-use

Further extension of re-use in Wairarapa is certainly possible, over and above current re-use. The re-use regimes already in place or well-advanced, particularly the treatment of sewage and disposal onto land, were vital for environmental reasons, but now they are done, or almost done, this process is well advanced and the gains are about to come into effect. In addition, with the cessation of dumping treated effluent directly into rivers will means they will be able to revert to a more natural state.

The real advantage of the current emerging regime is that it keeps contaminated water out of rivers and waterways during summer; this is a huge advantage.

At a single-user level such as a factory or a farm (e.g. effluent pond) it may be a high

cost but it is an essential cost of doing business. In short, most examples of re-use are obligatory from a water quality perspective. The jury is still out on concepts such as grey water. The Kapiti experience where there are advantages and disadvantages, is an example requiring investigation before any actions are taken.

Four priorities

While there are indications of weighting on questions of importance and efficacy of the solutions from the analysis to date, it is not strong enough to pick one or two strong options at the expense of others. Instead, a framework or skeleton of parallel solutions has been developed, each relying on the other. It comprises four focus areas:

Focus area 1: Water Capture Focus Area
No matter how we look at it, the water loss from climate change has to be replaced with the capture of available water, and at scale. We have identified three preferred solutions within the capture focus area:

- **Managed retention**
  This solution has huge potential and is well supported as a long-term bulk collection method, especially for the capture of water from freshes but, and there is a but, it is unproven. There will need to be hydrological studies to identify ideal sites and designs, experimental sites to iron out problems and design experimentation to optimise their operation. Legal and funding issues will need to be resolved.

  There are other considerations too. Will bunds reduce river flows below the location of the bunds and what impact would that have on indigenous biodiversity and other natural resilience values? If so, will they be consentable or acceptable to the public? Who will be responsible for the construction of the bunds, where will the materials be sourced from, let alone their maintenance, what be the land ownership status for the bunds and access to them, etc?

The benefits of managed retention:

- If viable it represents a significant whole-of-catchment solution
- It is scaleable, though would need to have critical mass
- It is lower technology and potentially lower cost reducing barrier to development
- It engages river management and catchment groups

- **Constructed storage**

  The principal focus here is bulk storage for use specifically in the water deficit period, to offset the worst effects in that period and to incentivise adaption of land use to higher-value crops and off-peak planting. Its great advantage is to increase reliability which results in efficient use of water in the rural setting. It would also, in some situations, supply domestic uses.

  Bulk storage is a hedge against the risks associated with groundwater-based solutions such as managed retention and groundwater augmentation, though only for part of the catchment, unless a number of storage reservoirs is contemplated.

  The benefits of the water constructed storage:

  - Provides reliable water; a known commodity at the start of each season
  - Able to apply irrigation as and when plants require enables more efficient nutrient use, minimising leaching and run-off whilst allowing production to remain competitive
  - Provides water for multiple diverse uses e.g. municipal uses, the natural environment and agriculture
  - Opens up opportunities for greater diversity of crops than would otherwise be possible, especially with climate change effects
  - Known availability of water facilitates good contract prices for commodities.

- **Hill country attenuation**

  This is subset of natural water capture intended to keep the hill country as productive as possible. There will be issues around affordability relative to the potential productivity of hill country and any adverse impacts on small streams will need to be monitored and

managed to avoid unintended consequences. With growth in demand for use of hill country for trees (for carbon), the amount of hill country in pasture may reduce.

The benefits of the water capture focus area:

- Increased reliability of supply
- It has the potential of scale
- It is largely cumulative, so it combines short- and long-term advantages
- It builds groundwater availability - more water flowing through the groundwater and back into rivers and streams as well as use for irrigation
- It involves more water flowing into natural retention sites such as wetlands, riparian areas, thereby supporting other resilience solutions and providing better water quality and improved biodiversity
- It should improve water reliability
- Reduced sediment flows from the hill country could be expected
- Water will be available to incentivise land use change, although this is partially dependent on allocation solutions being in place

Focus area 2: Natural attenuation focus area

At the core of natural attenuation is a series of natural solutions:

- Wetlands
- Riparian planting/reversion
- Woodlot planting
- Strategic forestation
- Regenerative agriculture

These solutions retain moisture in the vegetation itself, in soil and water bodies are strongly supported both by stakeholders and science. There are enough examples of the development of these solutions to have confidence in their effectiveness.

The benefits of natural attenuation:

- Greater surface retention of water for longer into the water deficit period.
- Greater natural cleansing of water for environmental benefits.
- Reduced water temperature in rivers, streams and races through overhanging shading reducing algal bloom and other contamination issues.
- Reducing nitrogen levels (and other contaminants) by creating a buffer/filter from farm activities.
- Restoring and protecting the mauri of the water.

Focus area 3: Allocation focus area

Allocation is on the demand-side of the equation; who gets how much, when, over what period, and at what rate of supply? As the various capture strategies come into play, larger amounts of water will be collected, raising the vital question who can use what proportion (if any) of this water and on what basis? This is not only the allocation of a scarce resource, but the allocation of a resource that has potentially been deliberately augmented (such as managed retention) at a cost to someone in the form of green and grey infrastructure. A cost recovery mechanism may be required.

Aspects of allocation are:

- Moving water allocations and maximising beneficial use – encouraging transfer of allocations
- Allocation efficiency – being consented what is required, that is, not water banking for the future so that other users cannot access the water

The benefits of the allocation focus area are:

- More efficient use of water recognising it's a finite resource
- Higher value use of water
- Generation of value to fund greater resilience
- Greater innovation and flexibility in water use

Focus area 4: Land use adaption focus area

Land use adaption is also on the demand-side of the equation. It has been well established in this Strategy that more water simply and solely to maintain the status quo of land use is not viable in any long-term climate change scenario. Nor is it possible to consider significant additional water for any uses that increase levels of nitrogen leaching which is already a resilience problem.

This focus area involves adapting land use practices both out of the water deficit period or introducing land uses better able to resist the ravages of that period.

- Planting of new or different crops or pastoral regimes – crops that take advantage of the expanded growing season, that require less water or are deeper rooting; crops that are of higher value to meet the cost of water capture.
- Mixed farming – introducing new farming regimes that rotate or mix uses; that are better adapted to the changed climatic conditions; that are potentially complementary.

The benefits:

- Broadening of water demand into the shoulder seasons when supply is theoretically more reliable as a result of freshes.
- Smoothing the demand curve throughout the year to better match supply and storage capacity (natural and constructed).
- New higher value crops and pastures producing higher margins that can help finance water management improvements.
- Improvements in soil compaction/de-compaction.

The four rooms of resilience

These four focus areas need to be developed in parallel, not sequentially. To create a sense of purpose in each of these focus areas, they are characterised as "rooms" in the larger structure of water resilience. Different activities take place in different rooms and require different mindsets and management approaches. The diagram on the next page illustrates this approach and is proposed as a framework for connecting the various solutions into an action plan, as presented in the following chapter.

These four rooms are the backbone, the skeleton of the water resilience. They are the 'tight four' areas at the heart of the strategy. Around these four focus areas contributions are made by a mix of other

solutions such as water use efficiency, water re-use, groundwater augmentation and others. Further on in this chapter we to link these solutions altogether.

The challenges in these focus areas

There are questions to answer and challenges to meet. Here are just some of them:

Capture focus

- How to fund managed attenuation when the returns and benefits are not immediate?
- How to fund the scale of cost that will be required?
- How to incentivise land use change and get better value from land use change?
- How to persuade landowners to make land available for green infrastructure?
- Who will drive this focus area?
- How to undertake proof of concept that these techniques actually perform to a meaningful degree?

Attenuation focus

- How to fund developments on the scale required?
- How to persuade landowners to provide land for wetlands and riparian?
- How to move from the current lack of activity to high intensity activity in this area?

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Allocation focus

- How to match up water availability and land use adaption and move water to higher value uses?
- How to further advance the science sufficient to ensure the integrity of the information available on which any decisions are made i.e. exactly how much water do we have and where?
- How to establish an allocation regime that protects bottom lines but is sufficiently flexible and dynamic beyond that to achieve the objectives?
- How to develop some sort of payment regime such as Payment for Environmental Services as a form of compensation where benefits are gained 'downstream' at someone else's expense?
- How best to integrate iwi rights and interests? This will only be resolved by government water allocation reforms.
- How to avoid unintended consequences?

Adaption focus

- How to persuade land users of the benefits of adaption? By providing a mechanism to 'group' producers in a way that facilitates change – instead of farmers making changes on their own.
- How to persuade them of those benefits before adaption becomes urgent?
- How to incentivise adaption, especially amongst the more reluctant users?
- How to fund these changes?
- How to reconcile adaption with market pressures and expectations?
- How to gain benefits from provenance thinking?

The 'Four 'Rooms' of resilience - Translating priorities into Action

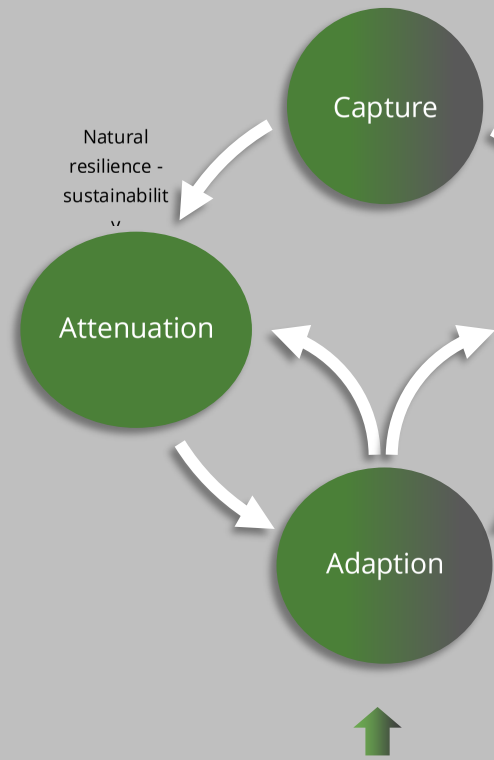
The 'Four 'Rooms' of resilience:

Capture

Attenuation

Allocation

Capture is the storeroom of resilience. If we are losing water we have to capture more water to offset the losses. We can capture water by natural and artificial methods. Expanding or restoring natural capture is in the Wairarapa's long- term interests because it is sustainable



Attenuation is the waiting room of resilience. We need to hold water in the environment and resist its loss to evaporation or to the sea. Retention in rivers, lakes, wetlands.

Allocation is the engine room of resilience. It shifts water distribution so that it is being used to best advantage. At present water for domestic use is based on demand. There are virtually no controls. With metering, an element of price control will enter the mix. Rural use

Adaption is the classroom of resilience. It involves learning and adapting land use and water use changes (rural and urban) which will spread water use into shoulder seasons, use water more efficiently and produce

Work is required in each of the 'rooms' simultaneously to secure a resilient future

Chapter 14: Governance and operations

In the previous chapter four key focus areas ("rooms") were identified that, when tied together, form the platform for the delivery of the Strategy. To remind ourselves, they are: Capture, Attenuation, Allocation and Adaption. To be effective, these areas need to be tightly integrated.

There are all sorts of potential linkages between them, for example:

- Rethinking aspects of allocation will ensure that water is used in the better ways and the right amounts of water are allocated, and in the 'right' places.
- Allocation can help drive land use changes and best practice through details of supply arrangements established in the context of the Strategy.
- Water capture and supply can drive reliability which in turn drives land use change and efficiency improvements.
- Water capture can also drive natural attenuation, which is essential for building the resilience of the natural environment.
- Natural attenuation, especially at scale, can hold moisture in the soil which can impact on land use change and good management practice.

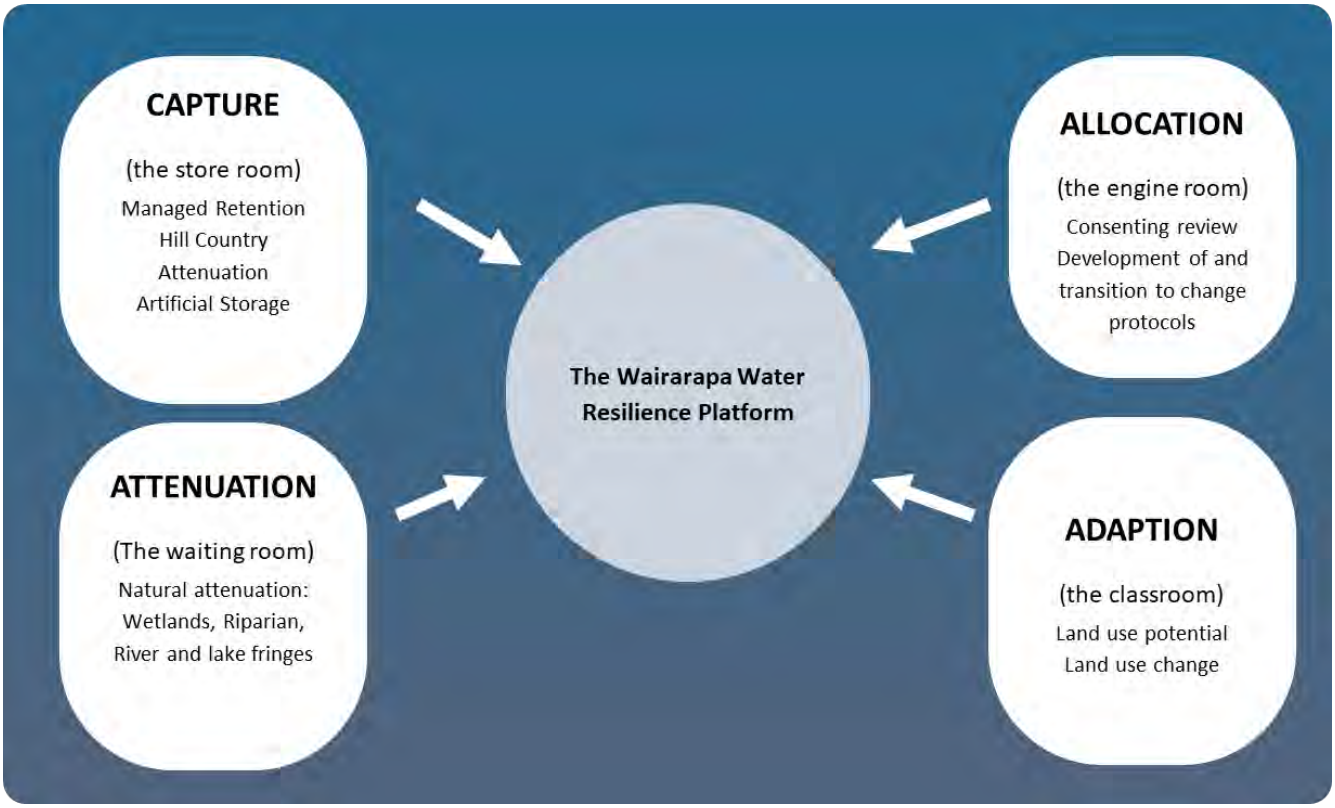
The list of possible linkages is very long and the more connections that can be made, the more effective the strategy. For this reason, the programme across the four key focus areas needs to be developed simultaneously, so that those connections are made and built into the model. The product will contribute to the "water management system", or to put it slightly differently, the "water management eco-system" which matches the ecosystem characteristics of the natural world. Water resilience is one part of an integrated approach.

The natural world has had millennia to develop its connections. We are only just starting down this road. It is for this reason that it has to be seen as a journey. It is, by definition, complex. Human beings have inbuilt resistance to complexity. This is a dilemma we need to solve, ideally through research, education and exemplars.

Another critical element is building on what we've already got, beginning with the least interventionist path – it's not as though we are starting off with nothing[54]. This would then be followed by actions which give the biggest impact in the least time so we get 'runs on the board' - the effects of climate change won't wait for us. In parallel with these 'proven' actions, we can also focus on solutions for which investigations or trials are required to establish whether they will be effective in the Wairarapa situation.

[54] Several community catchment groups already exist, the beginnings of riparian plantings and wetlands restoration, central government funding initiatives such as Jobs for Nature (part of the One Billion Trees Programme), municipal network pipe repair and maintenance programmes, increased water storage buffer, installation of smart meters, application of treated effluent to land, etc.

Each of the rooms has a different combination of interests and stakeholders around it.



Take "Water capture", the skills that are required in this focus area relate to the collection and distribution of water, to the building of grey infrastructure, whether they be bunds or an constructed reservoir, dealing with all the commercial and legal issues around supply such as supply contracts, easements on land for capture purpose and so on. This is a highly specialised area and requires an independent, non-commercial Wairarapa-wide perspective. The only current agency in this area is Wairarapa Water Limited (WWL), whose focus is primarily on the Wakamoekau reservoir but has the stated objective to develop other projects including nature-based solutions. It is conceivable however that an organisation such as WWL could broaden their operational focus across other aspects of capture. This would, of course, require them to have a broader remit and submit to contractual arrangements involving other requirements to constructed storage which is their current focus.

Alternatively, some sort of new supply cooperative could be developed to promote water capture practices and technologies, though it would have to start from scratch in terms of the establishment processes and costs.

In the "Allocation" area, the lead agency is clearly Greater Wellington because of its statutory responsibilities. It currently has responsibility for all consenting, including consenting for the local councils and even for their own use. It is possible that Greater Wellington is highly invested in the current system and may be unwilling to change it, and that may also be the case with many of the land users who have consents. Be that as it may, Greater Wellington is the obvious organisation to manage this element of the Resilience programme.

The "Adaption" focus area is more complex in that land use and land use change is a very individual matter to farmers and the farming system they operate. Clearly, they will have their own preferences and approaches. They will also respond to the limits and incentives that exist around them, especially regulatory limits. To be effective, land use adaption should therefore be farmer-led. This suggests that it should involve a cluster of individual farmers, sector groups, catchment groups, farm advisors and even processing companies. How that could be brought together requires consideration by the farmers and land users. This cluster may have an organisational form or simply be a collection of supportive relationships. Potential mechanisms exist whereby a grouping approach has the potential to be implemented; individual farmers can't be expected to do it on their own. Care needs to be taken to avoid over-managing.

Finally, the "Attenuation" focus area has huge potential. Currently there are active programmes of planting underway, in many cases led either by individual farmers or by initiatives from voluntary groups such as river management and catchment groups. For example, planting days are becoming a feature. The difficulty with the current arrangements is that they are limited, localised and voluntary. For this focus area to be effective a level of scale is required well beyond current activity, raising the question of priority and resources. As with Adaption, this will require combination of farmers and other land users, community groups, river management group and Greater Wellington combined together into some sort of operational entity, or operating independently.

Besides farmer and community initiatives, there are also agency initiatives. Greater Wellington has recently been granted funding under Government's "Jobs for Nature" programme in the northern part of the region including programmes associated with Wairarapa Moana in association with DOC. Other programmes include deer culling, afforestation, planting, farmer-built dams and the Fonterra riparian initiative.

Governance structure

The "Four Rooms Platform" is the glue that holds this together. As opposed to the operational matters and resourcing, it would seem logical that an existing entity should be utilised to lead the overarching governance arrangements – the "Platform". This is provided that its terms of reference are consistent with the meeting the challenges and implementing

the changes required to address water resilience in the Wairarapa.

The Water Resilience Strategy group suggested that the Wairarapa Committee of Greater Wellington could provide this governance role[55]; it has a suitable mandate and agency representation to perform this function. Not only this, but the committee already exists, so adding this focus to its dealings will certainly be complementary.

The Committee comprises eight members, with Greater Wellington providing its administration. The members are the councillor elected by the Wairarapa constituency and two other councillors from Greater Wellington and the Mayors from South Wairarapa District Council, Carterton District Council and Masterton District Council. It also includes one member each from Ngāti Kahungunu PSGE ki Wairarapa and Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) PSGE. It is proposed that the committee membership be expanded to provide co-governance with these two iwi organisations.

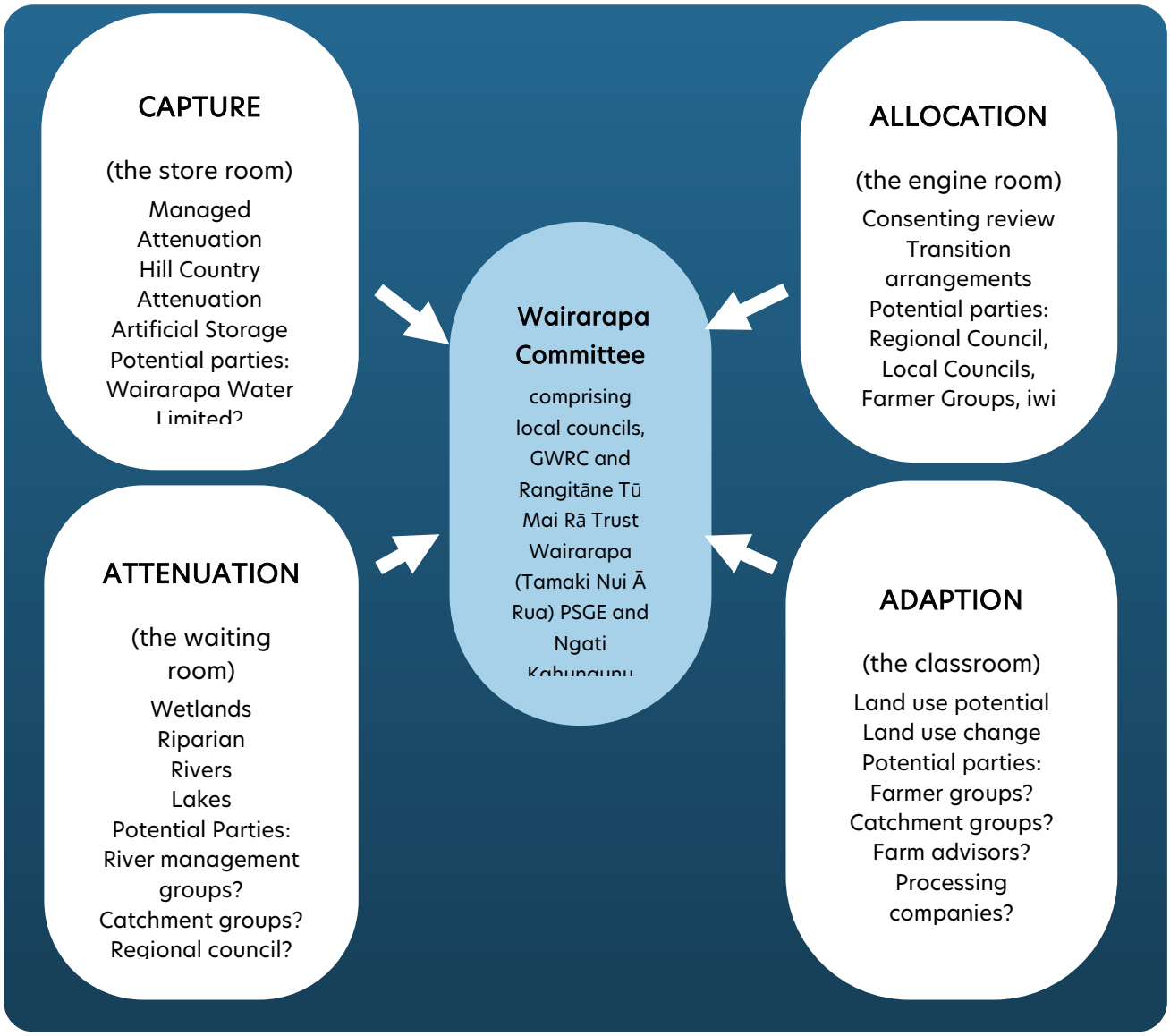
The purpose of the Wairarapa Committee is to consider matters of importance to the Wairarapa and make recommendations to Council on these matters.

Before advancing Water Resilience Strategy group proposal as the governance body any further, this possibility would need to be ratified by the individual parties that make up the Wairarapa Committee, as well as the committee itself.

[55] The Terms of Reference for the Wairarapa Committee are provided in the Appendices.

On that basis the above diagram would look rather more like this:

Where does the leadership come from?



How would this structure work?

The Wairarapa Committee would:

- Oversee the vision for water resilience in Wairarapa.
- Improve performance so that targets can be met as scheduled.
- Take a big picture view of the region and the Strategy.
- Ensure there is accountability and oversight of operations.
- Manage risk.
- Oversee financial resourcing and expenditure.

    - Find the right balance between making short-term gains and building long-term resilience.

In the proposed structure, the entities in each of the "rooms" or focus areas would be responsible for devising how their area would operate. The central resilience platform would be responsible for the integration of these elements into a single integrated system.

What happens to the other resilience solutions?

A number of solutions are not included in the tight four focus areas. They include the collection of solutions in the water use efficiency basket, including public education, conservation measures, network repairs and maintenance, metering and the various forms of water re-use or multiple use; nearly all these activities occur within the urban space. Even though it involves only a small proportion of the total water volume, 72% (33,900) of the Wairarapa's population is totally dependent on the urban network water supply. Compared with rural users, urban households have no back up supply – once they lose access to potable water, they are at the mercy of the local council to restore it.

These are regarded as important and as clip-ons to the main framework. These two groups of solutions are an indirect part of the capture focus area. The reason for this is that capture is about "more available water". Efficiency is a way of creating more water – less used is more available.

The two largest areas of gain in efficiency are in domestic supply and irrigation technology. Domestic supply is a clear responsibility of the councils and they are well appraised of this requirement. They can continue to work on this priority. Irrigation efficiency is closely linked to allocation and should be part of the considerations in that "room".

Other resilience solutions will come in the form of knowledge and the ability to build on that information base. This involves monitoring, testing, surveying etc.

Three Waters Review

It needs to be noted that Government has been reviewing regulatory and service delivery arrangements for drinking water, wastewater and stormwater services - its Three Waters Review. The review is to give New Zealanders confidence that:

- Drinking water is safe and risks to source drinking water are being proactively managed.
- Wastewater and stormwater networks support good environmental outcomes and Te Mana o Te Wai.

- Water services are efficient, sustainable, resilient, and affordable.

A key feature of this development is that it could operate from nationally coordinated regional centres. This could mean that the management of urban water in Wairarapa could be part of a south of the North Island unit with the assets and responsibilities of the three Wairarapa councils for urban water transferred to that entity.

This potentially adds a complication to the water picture in Wairarapa and particularly with regard to the dynamics of urban and rural water. At present, they are not in competition, but they could be in the future as supplies diminish and demand increases. This change of arrangements needs to be factored into thinking about water resilience and the water resilience project needs to remain flexible to these possibilities.

Appendices

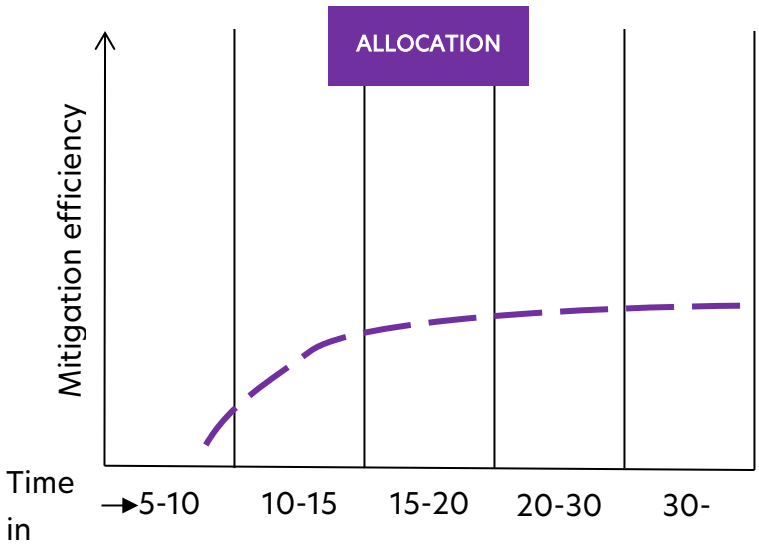
Appendix 1: Road map and scheduling

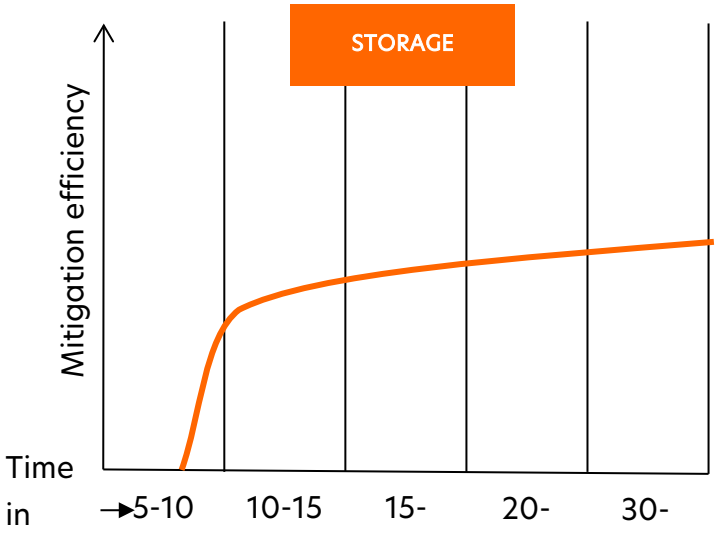
This chapter considers placing solutions on a road map for action together with scheduling of solutions at a high level. There is further analysis required to take this from a high level to an operational level.

In this chapter is a series of line graphs. They are notional graphs designed to illustrate the expected shape of the impact curve, rather than being evidentially based. They are not to scale at this point, the relative mitigation efficiency has yet to be identified.

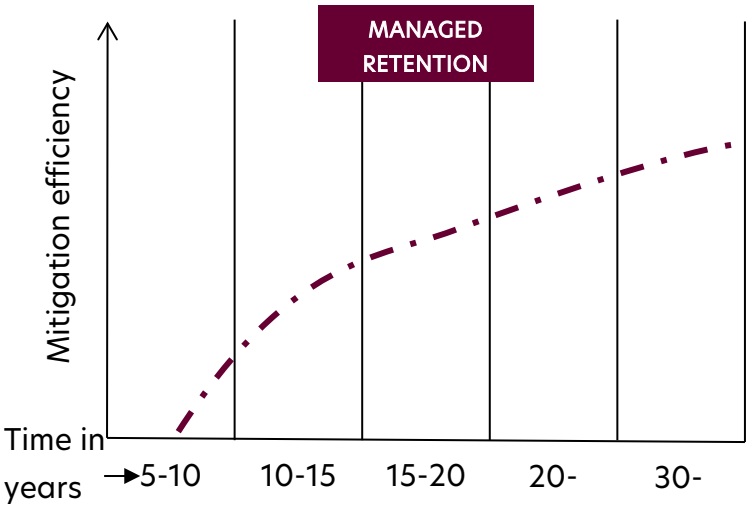
They are intended to depict relative timeframes.

In the Allocation Room, there is a one-off task to be done - a review of allocation is required with a view to introducing a modified regime in line with the Strategy. This requires background work, consultation with users and complex design activity, plus the notification and implementation of a plan change. Once completed and implemented, the refreshed system would become operational and continue forward. It is possible that further modifications will be required. Its ongoing contribution to resilience is depicted by the flat line.



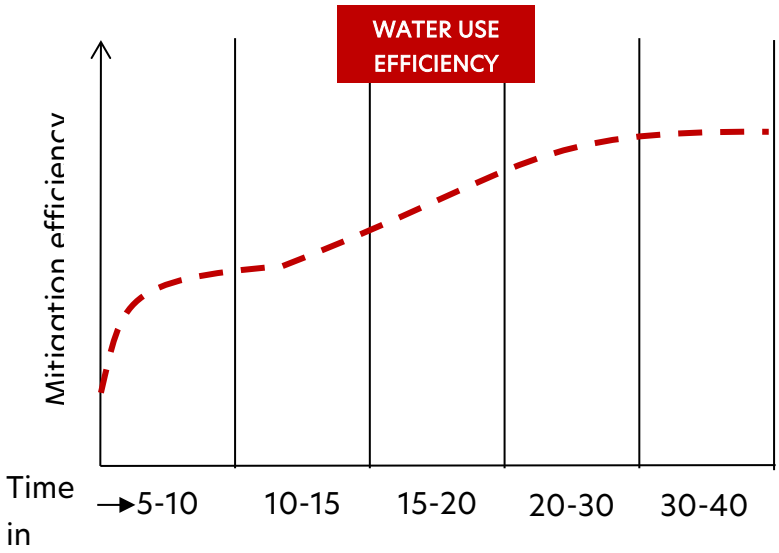


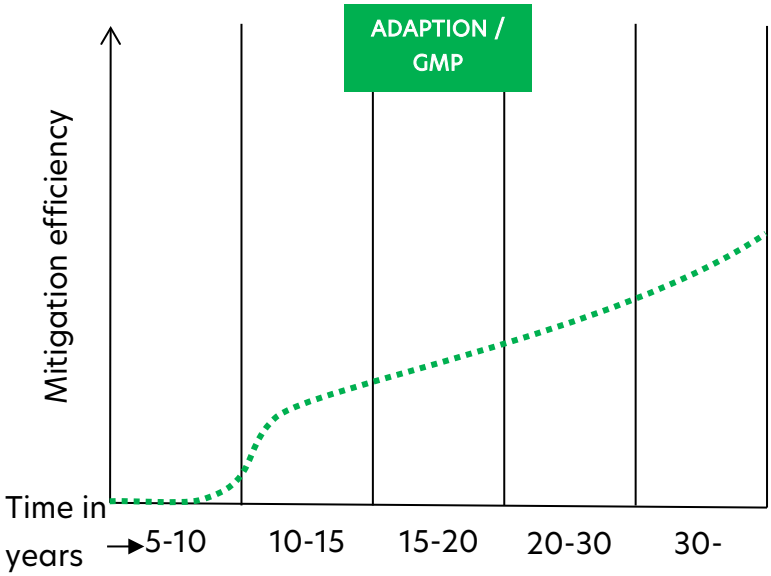
Storage needs to be considered relatively early in the mix because of its potential role in incentivising land use change and water use efficiency. Storage is responding to an existing need. Its contribution will become balanced out over time by other sources of water using nature-based solutions such as managed retention. The line flattens into the future because storage will have played its early strategic role. Tactical storage such as on-farm ponds or tanks associated with tile drains could be deployed on an as-required basis. It should be noted that large scale storage such as Wakamoekau, has a six year development period. Stopping and starting again would push that timeline back.



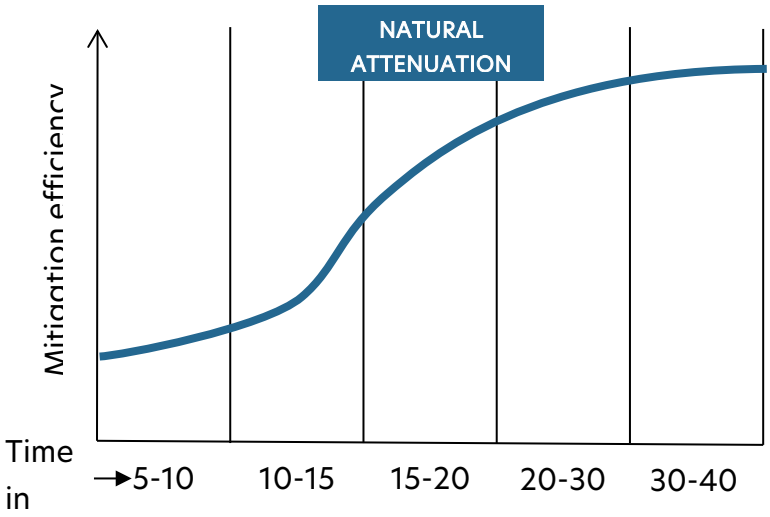
Managed retention is seen in the long-term as providing the "heavy lifting" of water capture pending successful feasibility and testing and whether the water will be recoverable from groundwater. Its development trajectory is gradual. If proven, its strajectory may be steeper; equally it could flatten off if only modest gains are able to be made on an on-going basis. Additionally, it may need a plan change in regulation to start and this needs to be factored in.

Water use efficiency is already active in the region through water metering. The principal gains still to be made are in the repair of infrastructure to minimise losses, and the upgrading of irrigators to moderate water loss through over-watering. The gains are relatively short term but very significant in that timeframe. There is a strong case for a real accent on efficiency in the first 5-10 years because it is so much more attainable and less complicated than other initiatives.



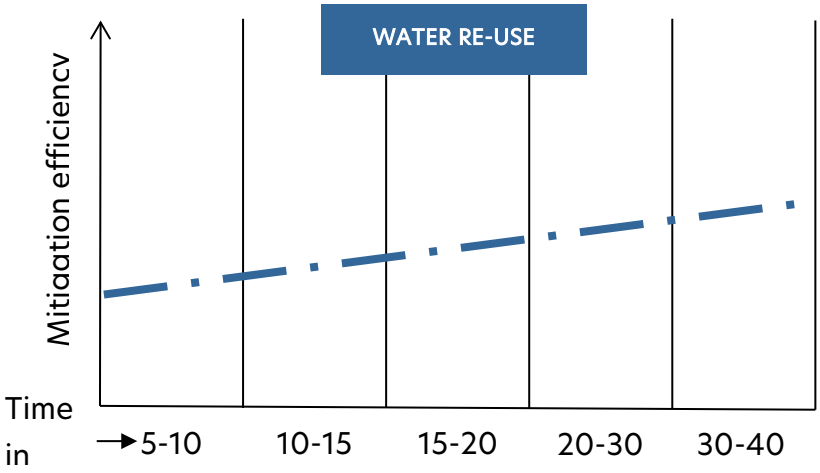


Adaption of land use is much more of a progressive matter. Land use change can be incentivised by control over the supply of water, but only within reasonable parameters. To change land use can often mean changes to whole farm systems. This takes time and investment. There are also market considerations which could frustrate the best laid plans. The graph identifies an early planning and feasibility process and then gradual application.



Natural attenuation is a vital part of the resilience mix. There is already activity in this area, though it would be fair to say that it is limited and largely the product of a few well-motivated land users making a voluntary contribution. To get it onto the scale required would require a major effort and probably large public investment. The investment in natural attenuation needs to be aligned with that in managed retention because together they are likely to have significant impact.

The graph for water re-use starts high because of existing activity, especially sewage treatment and industrial re-use. Given this is already significant, the gains over the short- to medium-term are seen as moderate. More enterprises using water may come to the region and technologies will improve, and these might release more water for other uses. No major increases of re-use such as treating sewage to a higher level are envisaged.



Road map

In broad term there are three categories of intervention:

- **Bolters** – these are activities that can get away early and actively. The main activity in this category is water use efficiency solutions and this should be an early focus.
- **Base builders** – these are the activities that other solutions depend on and which need to be commenced early to build the base. Probably the main activity in this cateogry is allocation and to an extent adaption of land use. Allocation will require pre-work to deal with equity and opportunity issues (and may have to wait for new legislation).
- **Bearers** – these are the "heavy lifting" solutions that will require a great deal of preparation and problem solving, but if these issues are resolved, their contribution could be considerable, long-term and steady. Storage and natural attenuation are proven in

terms of their effectiveness, while solutions such as managed retention and MAR need to be investigated thoroughly before they can deployed as a major player in this field.

These need to be brought together into an action map. Some thought needs to be given to the critical path and sequencing of these actions as there may be logical steps that must be taken first before other actions can occur. For example, if any of these actions need a plan change to implement, Greater Wellington will need to develop and notify a plan change which can take a number of years. The map looks something like the following and has 10 clear steps for delivery in the first 5-8 years within the three categories:

BOLTERS - EARLY ACTION

These are the early wins that will raise awareness of the programme and show tangible gains with the least interventions being required:

1. **Set-up - councils to understand their work programmes and ongoing commitments**
    a. Establish the "Platform" and the "Rooms"
    b. Get the 'wagon' rolling

2. **Get the most possible from immediate efficiency arrangements:**
    - Focus on urban water efficiency – identifying the most cost-effective efficiency activities and prioritise them into the LTPs of the councils.
    - Focus on rural water efficiency – seek to extend current irrigation efficiency with active promotion of the subsidies for variable rate irrigators.

3. **Natural attenuation programme development** – set up the waiting room
    - Build a comprehensive multi-decade programme of natural attenuation - rural and urban.
    - Seek Greater Wellingtonand Government investment in this package.
    - Look for areas where easy 'wins' could be gained to also help gain a profile.
    - Engage stakeholders.
    - Launch and roll out.

BASE BUILDERS - FOUNDATION WORK

These are the long-term projects underway that need to be started as soon as possible and which underpin other work:

4. **Undertake water balance study** – establish monitoring
    - Water balance information is part of the monitoring of the success of the programme and to help with ongoing design and priorities and should be seen as ongoing, not one-off.
    - This is required to get a strong handle on the quantification of water required and where it might come from.
    - This is unlikely to change the fundamentals of the Strategy but it will assist with detailing of the programme.
    - In particular it will help set the timetable as it becomes obvious how quickly the water balance will move in an adverse direction.

5. **Complete, analyse and interpret the SkyTEM aerial survey project**
    - This will provide vital data for the water balance study.
    - It will assist with the allocation project.
    - It will assist with assessing the potential of managed retention.
    - It is a key enabler.

6. **Undertake a study of funding measures** (water banking and PES)
    - This will provide a principled base for supporting and funding the project.
    - It will also provide a basis on which to engage with Greater Wellington, Government and other funders.

7. **Implementation plans** – integrate the Resilience Strategy into implementation plans
    - As catchment plans emerge through Greater Wellington resilience considerations need to be built into these plans.
    - Action is required to identify how this will happen and in what form.
    - This is necessary to ensure a long-term view of operations and funding.

BEARERS - MAJOR IMPLEMENTATION

These are the projects that require significant "heavy lifting" to get them to a point of feasibility and funding

8. **Managed retention** – set up the store room
    - Undertake a feasibility study of the idea.
    - Prepare and cost an action plan.
    - Seek Greater Wellington and Government input into the plan.

9. **Storage** – augmenting the storeroom
    - Wakamoekau storage is an established feasibility project with it own budget and timeline.
    - It will continue to move through its process.

- This project needs to be analysed in the context of this Strategy.
- The current feasibility and consenting process will decide whether Wakamoekau proceeds or not, or in a different form. Depending on the outcome of the Wakamoekau project, other tactical storage projects may comeinto play.

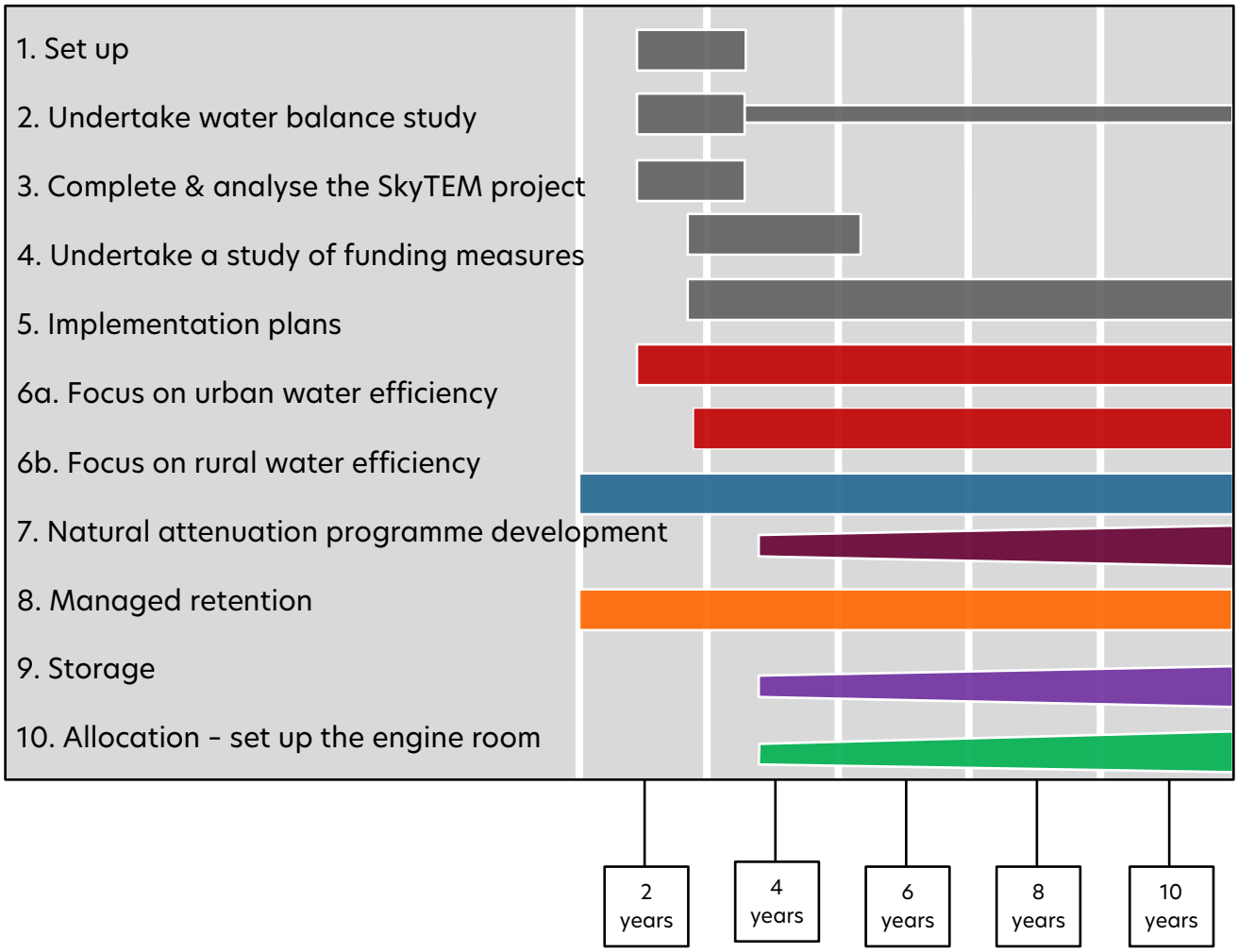
10. **Allocation** – set up the engine room
    - Design and set-up a project to examine and report on current and preferred allocation models.
    - Identify and roll out a preferred model so that it is operating to rationalise water use as quickly as possible. This will be a long hard grind so need to start early.
    - Changes to allocation will become the burning platform for water use change, particularly water use efficiency and land use adaption.

BEARERS - FURTHER MAJOR IMPLEMENTATION

These are the final implementation projects that will require a detailed process of setting up. Land use adaption is potentially evolutionary and requires a concerted programme of action and education. Land use adaption is not placed here to imply it is a late starter because work in this area is already underway. It's placement is more of a reflection of its gradual and evolutionary nature.

11. **Land use adaption**
    - Build on the work of Leftfield Innovation.
    - Develop an adaption strategy.
    - Seek to incentivise that strategy.

Scheduling of water resilience solutions



Appendix 2: Multi- criteria Analysis results

The Multi-criteria Analysis (MCA) comprised five workshops together engaging around 45 people. After extensive briefing on the criteria and the resilience solutions, they were facilitated to complete a group scoring exercise. The groups were:

- The Wairarapa Water Resilience Strategy Group.
- A selection of participants from the three local councils – officials and elected representatives.
- A selection of experts in hydrology and water management from Greater Wellington.
- A selection of community stakeholders comprising people with an interest in farming, regional development and the environment.
- A selection of participants from Ngati Kahungunu.

The participants, while drawn from these groups, were not there to represent the point of view of any organisation but to bring their knowledge and experience to bear on the priority setting task. The workshops used a well-known methodology termed Multi-criteria Analysis (MCA) to prioritise the resilience solutions. The resilience solutions were those outlined in this Strategy. The criteria were, developed with the Wairarapa Water Resilience Strategy Group.

The criteria and the list of solutions were simplified into categories to make for a manageable workshop. The workshops were three hours with the first two hours spent working through the criteria and the solutions so that they were well understood. The last hour was spent scoring.

The MCA was used to identify the general consensus around the solutions. It was not meant to be a statistical exercise and the results should be treated as indicative rather than definitive. It needs to be remembered that many, though not all, those involved had a moderate- to high-level of knowledge of water management.

Criteria

This set of criteria was used to measure the effectiveness and appropriateness of the resilience solutions:

1. Multiple positive impacts
2. Support for land use adaption
3. Cultural and lifestyle uses
4. Water quality improvement
5. Cost efficiency
6. Productivity
7. Access
8. Environmental improvement

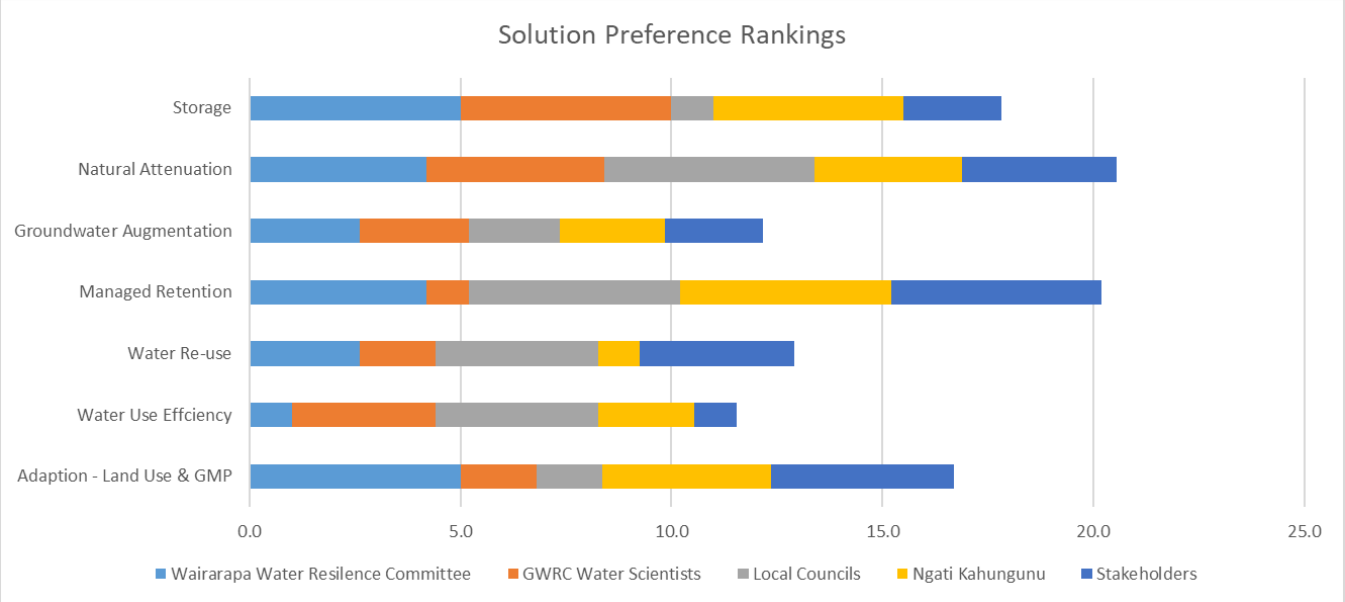
Resilience Solutions

The solutions were taken from Adaption and MAW categories:

1. Land Use Adaption / Good management practice
2. Water use efficiency
3. Water re-use
4. Managed attenuation
5. Groundwater augmentation
6. Natural attenuation
7. Storage

The list of the criteria and solutions used for the MCA follows. The solutions were not divided into adaption and MAW categories. In fact, only one adaption solution was used and the rest were MAW solutions. This is because in the water resilience strategy there is a strong, though not exclusive, focus on water-related solutions.

The graph below summarises the results of the MCA exercise for each of the resilience solutions:



Appendix 3: Water banking and Payment for Environmental Services (PES)

This appendix is intended as background for the strategy, rather than part of it. Funding of resilience is a major subject matter in its own right.

Water banking is the practice of foregoing water deliveries during certain periods, and "banking" either the right to use the foregone water in the future, or saving it for someone else to use in exchange for a fee or delivery in kind. It is usually used where there is significant storage capacity to facilitate such transfers of water. The term "water banking" has dual meanings. It refers on the one hand to the storage of water for future use, as in a water bank, but more importantly, it refers to the method of financial transaction where an investment in water is deposited on the expectation of recovery at a later date.

Water banking is largely a foreign concept in New Zealand but is widely used in other parts of the world, particularly the US. It is used to enhance water supply reliability for irrigation. It is most applicable where water is drawn from groundwater and then replaced from surface water through techniques such as managed (or natural) aquifer recharge.

The groundwater supply is then managed through the purchasing and selling of groundwater rights in the same way that water supplies from surface storage might be purchased.

In a Wairarapa context water banking has difficulties. Groundwater storage has more complications than surface water. These complications are exaggerated by some landform and aquifer characteristics. There can often be a large discrepancy between the water being pumped into aquifers and that which is available to come out. There are significant natural flows into groundwater. There are also significant losses. In particular, groundwater that is taken near rivers is regarded as part of river water. Groundwater naturally rises back into rivers and streams in their lower reaches. There is also leakage to unknown parts of the groundwater system.

Aquifers in Wairarapa are fractured and obstructed by the effects of earthquake-driven land movements.
The proposed SkyTEM aero-magnetic survey may identify greater deep aquifer water resources which could be regarded as more stable, but they pose problems with recharge because of the difficulty of access. For further discussion on this matter refer back to the section of the Strategy on groundwater.

Another way of looking at groundwater is the substitution effect. In the event that surface storage is available, its use is given priority and groundwater is held back until surface stored water supplies are dwindling. At that point, drawing of groundwater could kick in. This has the advantage that surface water is used

early in the dry weather cycle reducing losses to evaporation with groundwater not subject to evaporation until it is brought to the surface and spread onto the land. The disadvantage is that much of groundwater (Category A) is really an extension of surface water.

There is also an attenuation factor in groundwater supply. For example, water from freshes may flow through groundwater for a period (perhaps only a few weeks). If those freshes are in November and December, then that water may be available in the middle of the peak-dry period, if it can be recaptured.

Water banking becomes relevant when surface and ground water are to be managed together. To achieve this type of inter-operability, infrastructure would be necessary to transfer water. Further, at present the cost structures for extracting groundwater compared to what they would be for surface water are quite different. Arguably, both would have to operate under the same, or a closely aligned regime. The cost of managed retention or managed aquifer recharge would have to be included in the cost of extracting groundwater. This is not a water cost but an infrastructure cost. There would also be a portion of water from storage finding its way into the aquifer when it passes down the river from storage as proposed in the Wakamoekau Storage Scheme.

In Wairarapa there is another level of complexity to add to the picture. Carterton and South Wairarapa towns draw a large proportion of their water from aquifers through the use of bores. The current system of allocation of water consents recognises the primacy of water for domestic use, but there are limited controls on that use. There is further complexity around the condition of some ground water. In the south, natural contaminants such as manganese are present in the water which have a corrosive effect on pumping equipment and in large quantities have some health implications.

Water banking is a concept that is probably before its time in Wairarapa, but this is a Strategy with a horizon of 30-50 years, so it needs to at least be "on the table" for discussion. It has the advantage of sharing the cost of accessing and supplying water. It could assist with bringing measures of real cost into the equation and this increased value can begin to fund advances in natural resilience that are going to be difficult to fund as long as they are seen as an "extra" rather than "integral" cost of water.

Water banking could assist with greater equity between rural and urban users and it would assist with getting the most expensive water to the most valuable uses. The immediate assumption is that this is 'code' for farmers will pay more. In point of fact, it may be a way of increasing the contribution of urban dwellers to the overall resilience effort, thereby sharing the costs and the benefits. In the same way that rural users may have to pay more for water in the water deficit period, so might urban users. Some of those funds would go to ensuring the integrity of the

water they are using and the environment from which it comes.

Cap and trade mechanisms are already in use in some parts of the country to control water use and limit contamination issues. This could be another approach to equitable distribution.

However it is conceived, water banking would require a governance and regulatory/allocation system that stretches across all managed water – supply and demand. Water banking requires a broad strategic view of water, rather than a short-term tactical problem-solving view.

Finally, it is recognised that for some, using terms like "banking" portray a strongly utilitarian (or even "ownership") view of water which is contrary to the current trend towards natural resilience and common ownership. Language has to be used carefully, but one of the big challenges of a resilience strategy is how resilience will be funded. It will only ever be funded properly when it is integral to the use of water and is levied on an equity basis. Water banking should not be seen as a wholly commercial view of water management, but instead it should be viewed through a social investment lens designed to support the economic, social and cultural capital of the community. We still have a long way to go before society will accept this type of view.

Payments for Environmental Services

The idea of payment for environmental services (PES) has been alive for several decades internationally but has made limited progress in terms of application and delivery[56]. PES has been defined as "voluntary transactions between services users and services providers that are conditional on agreed rules of natural resource management for generating offsite services". [57] Most commonly they have consisted of incentive-based payments to a land user to protect agricultural soils and retire environmentally sensitive lands. There are far fewer examples where PES is used for punitive reasons, to deter poor practice.

There are examples of these activities in New Zealand. The payment of incentives to farmers in the Taupo and Rotorua catchments by their respective regional councils to reduce nitrogen flows into the lakes is the best example. These examples are interesting. Where in the Taupo example farmers were obliged to change their land use, the incentive was more of a compensation payment. Whereas in the case of Rotorua, where it was a genuine and substantial incentive, only a little over half the fund was taken up. This was principally because there were many extenuating circumstances including political and community considerations.

[56] "The Effectiveness of Payments for Environmental Services", Borner J, et al, World Development Vol 96 pp 359-374, 2017

[57] Wunder, 2015 p241 quoted in Borner et al

Tree planting is another example and the Billion Trees programme initiated by the current Government is an example of a subsidy targeting an environmental outcome. Once again take up has been an issue. South Wairarapa district Council approached the scheme with great enthusiasm until they realised that there wasn't the public land available to plant the trees and private landowners were generally not interested, for financial and cultural reasons.

Subsidy schemes have been used in other parts of the country. ECan, for example, introduced in 2010 a 50/50 fund to support environmental initiatives. This fund was chronically underused because the sponsors of projects could not come up with their 50% share. It was felt that reducing their required share would send the wrong message, until it was realised the incentive was simply not working. Money was not the only problem. Some regional councils provide support to farmers to install variable rate irrigator technology. Greater Wellington offers such assistance in specific cases.

International research has pointed to many examples of unintended consequences from PES. One of those side effects is that PES can achieve environmental outcomes but at the expense of socio-economic outcomes. Another is high transaction costs (including recruiting participants, monitoring and non-compliance) that consume financial resources.

In the Wairarapa context there is a case to explore incentives. For example, incentives to change land use. In that situation the incentive may be access to water or higher level of water reliability. There are questions whether water, a natural and common resource, can be used in this way, though irrigation schemes around the country reserve the right to control the supply of water to shareholders on the basis of non-compliant behaviour with scheme rules.

There are also equity examples. Farmers who build bunds to direct water into groundwater but have no access to that groundwater might expect consideration from those farmers who do. This scenario is a real possibility in Wairarapa and in this situation the receiving farmer would be benefitting from a service that has a partial environmental content – the use of the groundwater medium for distribution. This particular example has the potential problem of recovery. Water induced into aquifers may not be available to those who wish to extract it due to a whole range of hydrological and geomorphological reasons.

The learning from the literature is that care needs to be taken in design and that PES tends to be high on promise but somewhat lower on delivery.

If PES is a difficult concept to introduce, there are other options, though they are less attractive. Greater Wellington could apply a target rate, but this would be across a whole area and would not easily differentiate those benefitting from water

recovery. Another alternative might be developing a farmers' cooperative where they 'socialise' costs and benefits. This would suffer from the freeloader problem. A system that attached payments to consents is complex and would be difficult to introduce. It would require regulatory support.

The whole question of directing costs to those who benefit from water is a difficult one and conversations on it will evolve over the coming years.

Appendix 4: Irrigation and constructed water storage

Irrigation and constructed storage are not the same thing, despite the fact that they are often confused in the public mind. There is extensive irrigation in the Ruamāhanga catchment, of which a very small portion is provided by constructed storage presently. Irrigation will continue to play an important role in a climate change future because despite strenuous attempts at adaption, more water will be required to offset losses to evaporation.

Conversely, constructed storage can be used for uses other than irrigation such as domestic supply, industrial and environmental uses or for augmenting low flows in the dry season.

The proposed Wakamoekau water storage scheme sited approximately 10km NW of Masterton is currently being investigated at feasibility level by Wairarapa Water Limited. That work was largely completed by December 2020 and used for the consenting process.

The consenting/procurement phase will then proceed between January 2021 and December 2022, followed by three years to construct and fill the project, which may become operational in 2026. These dates are all estimated at this stage.

Initiated by farmers and initially intended for agricultural uses, but since modified into a multiple uses community scheme, this project has the potential to provide stored water for other uses such as to the Masterton District Council treatment facility for reticulated urban demand and to associated rural areas to replace unsustainable water races. Approximately a quarter of the water would be captured from the Wakamoekau catchment and released back through the dam wall as minimum flows, existing allocations, flushing flows and shareholder allocations, while the remainder would be pumped from the Waingawa River during supplementary flows.

Status of constructed storage

Irrigation and constructed storage have been given a separate section in the appendices because the construction of storage dams around the country (and the irrigation from them) has been controversial and the position of constructed storage in a resilience strategy needs to be carefully defined. The particular point of controversy centres on water quality issues. Constructed storage is seen to be associated with irrigating dairy farms which in turn is seen to be a primary source of diffuse contamination in rivers, lakes and waterways. Opposition to storage has also become a point of leverage for some to press for full consideration of other types of resilience solutions besides constructed storage. Those opposed also believe that there are better solutions than constructed storage.

In this Strategy, as must be clear from the approach contained in this document, constructed storage is seen as just one solution to providing irrigated water, with

particular attributes, downsides and risks. In the multi-criteria analysis, it has been treated as one category of solution amongst a total of eight.

There are several issues that constructed storage throws up and which must be addressed:

- **Modification**
  It is a form of artificial modification of the environment at a time when greater emphasis is being placed on either nature-based solutions or low impact modification. There is a widespread desire to give priority to nature-based solutions. The extent to which constructed storage infrastructure disturbs natural landforms and processes is an important consideration.

- **Denial**
  The push for constructed storage is seen by some as an implicit denial of the importance of a natural resilience perspective. Giving priority to constructed storage ahead of other solutions implies a continuing solely functional view of water.

- **Narrow spectrum**
  It has been conceived as a solution for narrow interests, that is, dairy farming and some intensive horticulture, both of which are seen as high nitrogen emitters. This is changing as a role emerges for stored water for domestic (potable) supply and even for augmentation to support natural resilience at times of low flows. It is moving from being perceived as a narrow to a broader spectrum solution.

- **Inter-operability**
  The resilience perspective which has a whole-system view of water increasingly sees constructed storage and natural storage (groundwater) as being potentially inter-operable, meaning that constructed storage is not seen as a separate solution.

- **Dominant discourse**
  There has been criticism that the technical nature of grey infrastructure and built storage has led to technical considerations dominating the discourse. The approach of this Strategy is designed to avoid such a situation. The real costs and benefits of storage must therefore be carefully considered and expressed with transparency so that all stakeholders can participate in the discourse and their views are valued.

If constructed storage is to have an ongoing role in water resilience, these issues must be considered, debated and resolved. The role, scale and contribution of constructed storage to the Strategy needs to be carefully assessed through which a basis of trust and confidence in this resilience strategy can emerge.

Irrigation use

This section provides the number of farms (hectares) under irrigation, types of irrigation, time lapse volumes of water used for irrigation back 20-30 years, irrigation and land use patterns. The amount of water allocated through resource consents across the region increased significantly between 1990 and 2010 but has largely remained stable since

then. In the Ruamāhanga, irrigation is the dominant use. Currently, approximately 18,000ha is irrigated in the Wairarapa, but this only accounts for a quarter of Wairarapa water use.

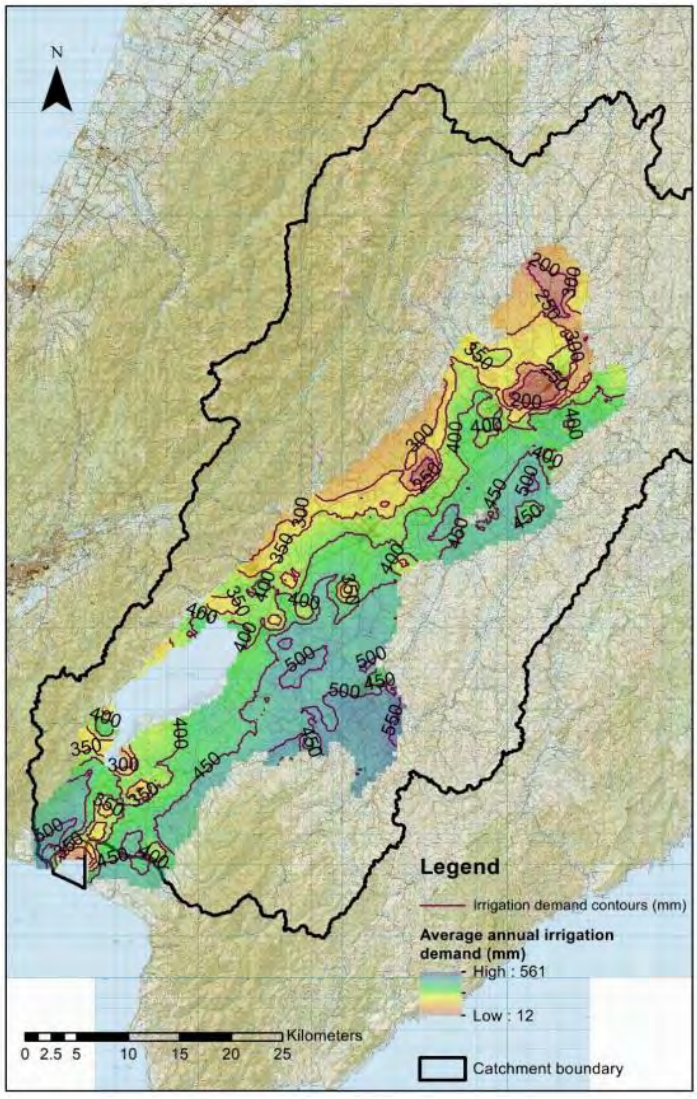
Most of the region's major surface and groundwater resource is now near or fully allocated, meaning that for rivers at normal to low flows there is just enough water to meet all consented water takes while still maintaining the environmental health of these waterways.

The amount of groundwater that can be safely allocated is likely to reduce in the future because we now know much more about the linkages between groundwater and surface water, and how groundwater abstraction affects nearby river and stream levels. That knowledge will increase further following the proposed aerial survey.

The pNRP splits surface water allocation into overall catchment management units which are in turn split into sub-units. The overall catchment management unit in this case is the Ruamāhanga River and all its tributaries, and is currently 107% allocated. Several of the sub-units (highlighted in red) are, 'on paper', also markedly over-allocated.

Irrigation demand

Current modelled average irrigation demand

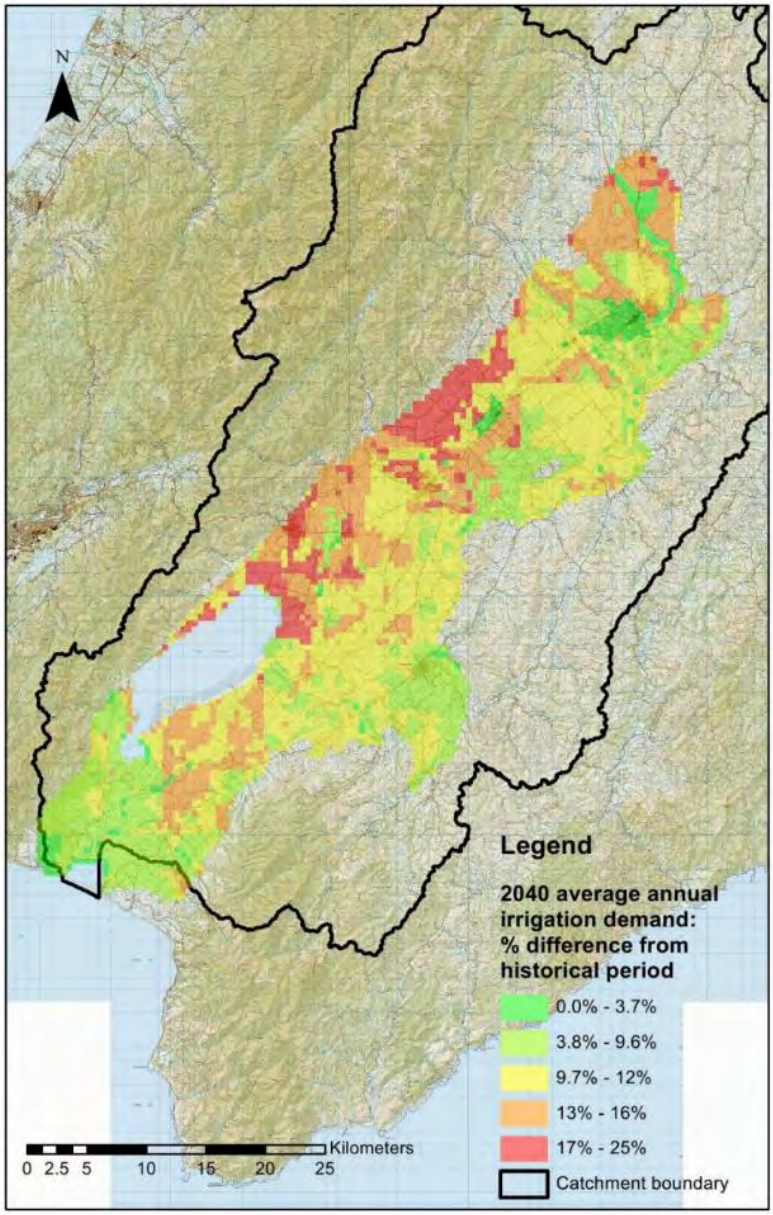


Source: Groundwater recharge and irrigation demand modelling: Ruamāhanga Collaborative Modelling Project, Aqualinc Research Limited 2017

The map above depicts the current demand for modelled average annual potential irrigation water in an 'average' year - in some years it will be far less that that shown, while in others such as the 2019/20 summer it is far more.

The highest irrigation demand (561 mm/yr) is in the eastern part of the catchment where the rain shadow effect is most dominant, the lowest in the west. This pattern exists now and is likely to continue in the same pattern in coming decades.

Projected % difference in average irrigation demand through to 2040



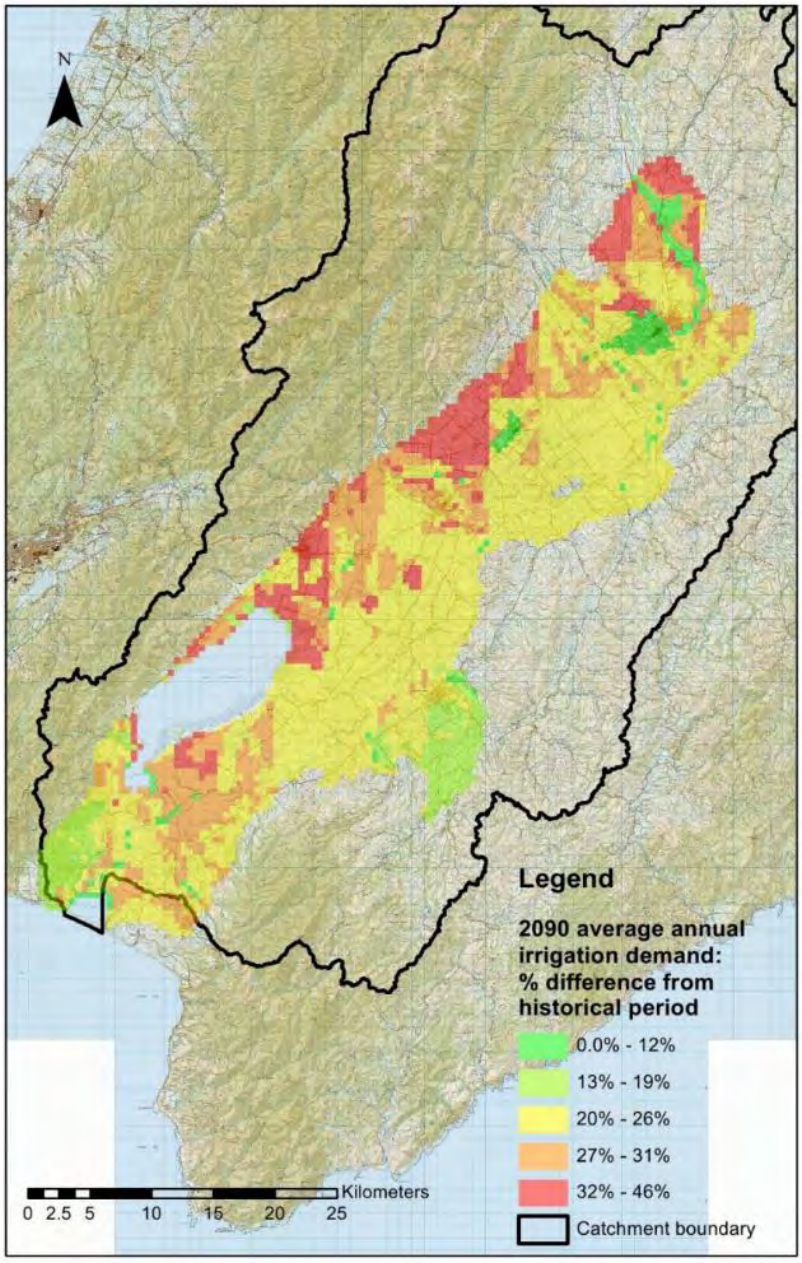
Source: Groundwater recharge and irrigation demand modelling: Ruamāhanga Collaborative Modelling Project, Aqualinc Research Limited 2017

As shown on the map above, the modelled percentage change in average annual irrigation demand between the projected levels for 2040 and the modelled historical period shows an increase in demand of up to 25% in the north and west of the catchment, with smaller increases in the south and east. That is a substantial increase in demand from an already fully allocated resource.

The modelled percentage change in average annual irrigation demand between 2090 and the modelled historical period is shown below. Even though the spatial pattern of increases is similar to 2040 period, the magnitude is greater, with an increase of up to 46% predicted.

Projected % difference in average irrigation demand through to 2090

Note the colours used for the 2040 and 2090 maps have different values.



Source: Groundwater recharge and irrigation demand modelling: Ruamāhanga Collaborative Modelling Project, Aqualinc Research Limited 2017

Irrigation technology is advancing all the time and it can produce good results. Irrigation farmer Mark Guscott reports that the installation of a variable rate irrigator and soil-sensing probes saved him 19% of water. He said the largest savings are in the shoulder of the season or in the wet seasons, rather than in the middle of the dry season when large amounts of water are required, especially when irrigating pasture.

He says that the best results can be had on mixed arable farms where there are multiple crops in different soil zones with different water requirements at different

times of the season. It can be quite complex to manage the effective 'dosing' of water. He makes the point that once you are using technology you are wanting to upgrade it as equipment needs replacement. The costs of new irrigation gear are high. Replacing a pivot is now close to $100,000.

In terms of where Wairarapa stands with regard to other regions, Stephen Thawley of Greater Wellington says that Canterbury has about 53% of irrigation under centre pivots and K-Lines/long lateral which are at the more efficient end of the irrigation spectrum. The Greater Wellington region has about 55%. There are more pivots in Canterbury but that is more to do with topography.

These figures indicate that there is certainly room for improvement in Wairarapa, but that local irrigators are up with the pack on a national comparison.

Irrigation from storage ponds

The use of storage ponds and other forms of tactical irrigation is relatively undeveloped in Wairarapa. The 2014 Opus Report[58] talked of these as "secondary storage". It envisioned that they would play a smaller role than a primary storage and would generally only supply one property. OPUS considered secondary storage to be a security measure to offset the risk of the primary storage not being able to meet peak demand.

Secondary storage is generally considered to be a much more expensive option and, due to lower water volumes, to act mainly to offset extreme adverse conditions, rather than providing a sustained supply of water.

Both primary and secondary storage have the potential of alignment with water races. OPUS notes that Taratahi River Races network's principal purpose, and consequently design parameters, was to supply stock drinking water. "Over time, however, ancillary uses have also developed, including: domestic and industrial (non-potable) purposes, firefighting and irrigation."

OPUS makes the point that at first glance the race network may have potential for distributing water for irrigation, but there are a number of significant constraints. They say it is unlikely the network of stock races could be easily adapted to convey irrigation water.[59]

As an aside, potential exists for water resource efficiencies to result by combining with the water already allocated to the Taratahi Water Race and Masterton's municipal water supply, both currently sourced from the Waingawa River.

Some vineyards have frost fighting ponds which they use to protect spring budding, while a few farms have limited purpose-built water storage capacity - the latter generally only have sufficient water to last a few weeks at best.

[58] OPUS, "Wairarapa Water Use Project On-Plains Storage refinement" 2014

[59] OPUS, pp2

Irrigation from groundwater

A significant proportion (60%) of water used for irrigation is from groundwater. In general, particularly in the past, groundwater sources are very reliable water. However, close connections between surface water and groundwater means that many groundwater takes are becoming more restricted, i.e. some takes are less reliable than they were. Some groundwater zones, as already explained, are over-allocated and some clawback of allocation is required.

Further investigation is required to see if there are opportunities to take more groundwater, potentially with higher reliability, if the spatial distribution of takes is shifted, particularly from shallow to deeper sources. Of course, there are higher pumping costs in moving to deeper sources.

The WIP identifies flow levels for the rivers in the region. Most rivers hit low flows in the summer and abstraction is no longer possible with the water being returned to the environment and some used for domestic purposes. The number of days without any water allocation could have significant implications for some activities involving a dependence on water for their survival especially during January to March. Even with climate change, on average, the key period of water deficiency will be in January to March and not before it.

Appendix 5: Unintended consequences

The whole question of unintended or unforeseen consequences deserves separate treatment. We need to remind ourselves that good intentions are no substitute for good practice. This could double as a risk register for a resilience strategy.

In a strategy like this we are embarking on a series of actions that will continue to modify the environment around us. Even nature-based solutions will mostly be man-made. Because we don't have the same level of hindsight and foresight of nature nor the time of evolution, we are likely to make mistakes or oversights. We have to protect against such possibilities.

It is the unforeseen consequences of many water supply (and disposal) measures in the past that have brought some of these solutions into disrepute. In today's world, unintended consequences have to be fully considered prior to action to modify land and water systems.

Notable examples of unintended consequences from other activities are:

i. **Flood control** – building flood control infrastructure that neutralises natural resilience. An obvious example is the redirection of the Ruamāhanga past Lake Wairarapa with the consequent loss of numerous wetlands and the drying of lake surrounds. The goal of reducing flood risk by speeding up the passage of water through the catchment has resulted in the narrowing of river channels and loss of natural character.

ii. **Loss of production** – some aspects of resilience implementation will impact on productivity, particularly those related to water quality. This is already happening as a result of Whaitua, but productivity provides the financial resources to build resilience and care has to be taken not to unnecessarily bite the hand that feeds.

iii. **Loss of industry** – food-related industries are likely to be an important part of the Wairarapa economy of the future. Unless industries not even currently present in Wairarapa are thought about in terms of available water, our actions may prevent their arrival and the benefits to employment and wellbeing that they might bring.

iv. **Amenity facilities** – that require constant replenishment of water at times when availability is low. The example of Henley Lake illustrates that point.

v. **Clearing hill areas of trees** – resulting in loss of shade for animals, loss of moisture retention, and accelerating water run-off taking with it contaminants and sediment that end up in rivers and streams.

vi. **Tile drains** – that have the beneficial effect of draining paddocks to avoid saturation in the winter and retain soil

structure, but in so doing losing nutrients from the soil which end up in rivers and lakes and then have to be replaced with mineral fertilisers.

vii. **Pivot irrigators** – requiring the removal of trees which provide shading and resilience benefits.

viii. **Energy costs** – the high energy requirements of a number of strategies such as water re-use and pumping of deep groundwater, which could work against the broad matter of CO_2 release into the atmosphere and climate change reduction, unless the electricity is renewable.

ix. **Spoiling of culturally significant waters** – this especially refers to waters for the collection of mahinga kai, the use of Waitapu (sacred water) and Waiariki (chieftain water). Another example is swimming water (Waitoko) where Māori have traditionally bathed. The blessing of babies in sacred water, often near the confluence of two rivers, depicts the joining of two blood lines.

x. **Treated sewage** - the disposal of treated sewage into rivers making river water unusable for stock water for the dairy industry. It also disrupts cultural use.

There are always upsides and downsides in innovation. These have to be looked at carefully and a balance struck. The answer is not to halt activity and innovation, but to think about them from the perspective of natural and constructed water resilience working together for best effect, and to see resilience as part of a total system rather than as separate individual solutions.

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Appendix 6: The Wairarapa Water Resilience Strategy Group Membership

Adrienne Staples
Alastair Smaill
Alex Beijen
Alistair Cross
Amber Craig,
Andy Duncan
Bruce Geden
Carlene Te Tau
Chris Lewis
Chris Peterson
Dame Margaret Bazley (Chair)
Daran Ponter
Dave Gittings
David Hayes
David Hopman
David Perks
Elizabeth McGruddy
Geoff Henley
Greg Campbell
Greg Lang
Harry Wilson
Jane Davis
Jim Lynch
Jo Hayes
Kathryn Ross
Leo Vollebregt
Lyn Patterson
Marama Tuuta
Michael Player
Mick Williams
Mike Birch
Neil Fisher
Norris Everton
Peter Gawith
Rawiri Smith
Richard Kershaw
Robin Potangaroa
Robyn Cherry-Campbell
Robyn Wells
Sean McBride
Tim Lusk
Wayne O'Donnell
William Beetham

Occasionally these people used alternates.

Appendix 7: Terms of Reference Water Resilience Strategy Group

The following Terms of Reference were developed at the beginning of the project, but never formally agreed due to changes of resilience group membership. They have been a guide to the project.

Status

The Wairarapa Water Resilience Strategy Group has been set up under the auspices of the four councils of the Wairarapa region - Masterton District Council, Carterton District Council, South Wairarapa District Council and Greater Wellington Regional Council. The Strategy is also closely aligned with the Wairarapa Economic Development Strategy (WEDS) which provides a regional context for consideration of water management and resilience.

Development of the Strategy was being funded by the Provincial Growth Fund through a grant awarded to the four applicant councils.

While being under the aegis of the councils, they are not under any obligation to accept the findings and recommendations of the Strategy until such time as they have had the opportunity to consider the Strategy in its entirety at the end of its completion. This is a non-statutory strategy.

This Strategy will sit beside and draw on other statutory and non-statutory water and land use initiatives in the region such as the Ruamāhanga Whaitua Implementation Plan.

This Strategy has to straddle two sometimes conflicting requirements - to be sufficiently detailed to be technically credible particularly for its use by councils and technical audiences, and to be sufficiently simple and obvious to be understandable to community and non-technical audiences.

Te tiriti o Waitangi and tangata whenua

The Wairarapa Water Resilience Strategy group acknowledges te Tiriti o Waitangi and the foundational principles of partnership, participation and protection guaranteed by the Crown.

These principles are outlined below:

- **Partnership:** interactions between the Treaty partners must be based on mutual good faith, cooperation, tolerance, honesty and respect
- **Participation:** this principle secures active and equitable participation by tangata whenua
- **Protection:** protection of whakapapa, cultural practices and taonga, including protocols, customs and language

These three principles will guide the Strategy Group in its approach. The Wairarapa Water Resilience Strategy group will work with Rangitāne and

Kahungunu in the design of solutions and be mindful of the impact on the wellbeing and mana of whanau, hapū, iwi to ensure these solutions uphold the above principles.

The Wairarapa Water Resilience Strategy group, through its iwi representatives, will engage with whānau, hapū and marae while ensuring the identities and whakapapa of both Rangitāne and Kahungunu are maintained.

Coverage

The scope of this strategy is for the Wairarapa region, however the primary focus of the Strategy will be on the Ruamāhanga Catchment. This is because it is the primary catchment area. There will also be other catchments in the region such as those in the eastern hills which empty out on the east coast of New Zealand and the sources in the Tararuas.

Purpose

The purpose of project is to prepare a Strategy including action recommendations that will guide the policies and practices of the four councils around resilient water management and is intended to be a guide to private land and water interests including farmers, sector groups, water-related enterprises, water management groups and water storage enterprises such as Wairarapa Water Limited.

Mission

To create a road map and programme of action and responses that sets the Wairarapa in the best direction possible to meet the challenges of climate change.

Focus

The Wairarapa Water Resilience Strategy will address a number of fundamental points regarding water resilience in the Wairarapa region:

- The wide range of impacts of impending climate change (preservation, adaptation and mitigation) and matching regulatory constraints such as those that might emerge through the Carbon Zero Bill, the emerging National Policy Statement (NPS) for freshwater and other legislative actions.
- Create a framework and implement this to analyse all water resilience solutions to ensure we understand the impacts from an economic, cultural, wellbeing, environmental and tangata whenua points of view.
- Collaborating on methods for water preservation, while adhering to our committee values, and moderating those impacts against economic, culture, wellbeing, environmental and tangata whenua points of view.
- What land use management practices may need to change to meet the water quality expectations described in regional and national regulatory instruments and how this impacts on water usage and requirements.
- How a collaborative water resilience regime in the Wairarapa Region will be implemented and managed sustainably into the future.

This Strategy is first and foremost a water resilience strategy. It complements, but does not overlap with, the funds granted by the PGF for prefeasibility work on the Wakamoekau Community Water Storage Scheme (WCWSS) and the feasibility and

consent work to follow. The two projects are quite separate, though sharing of relevant information will be encouraged. If this project is to be part of a true water resilience programme, as intended, then work is required on how water will be used and by whom, specifically for what and how this integrates together into a total water resilience picture for the catchment. Water supply is only one portion of our total resilience picture.

These additional points made by members of the WWRSG and reflect the approach that is expected in the preparation of this Strategy:

- Doing nothing is not an option
- Despite other work being done on irrigation, the Resilience Strategy should start from first principles and the four wellbeings will be at the foundation of considerations.
- It is noted that the immediate felt need for water is probably strongest in the rural community, but this reflects the stage we are in the cycle of climate change. Impacts are expected right across the Wairarapa community and these need full consideration in this Strategy.
- Water storage should be seen as part of a range of possible interventions. The Strategy may turn those interventions into a hierarchy of priorities.
- Public information and education should be an important part of the Strategy both in creating it and in the recommendations for action.
- Efficient use is an important consideration and is a matter of practice and a state of mind.
- An integrated catchment approach is to be used as a framework for the preparation of the Strategy and the extent of the catchment needs to be considered. For example, the eastern hills from where streams flow into the Ruamāhanga and the Tararuas should be included.
- Water balance should be a key concept in considerations of resilience.
- The appropriateness of central or diffused storage, ground or surface, needs to be considered and what role each plays.
- The role of nature-based systems for water management need to be fully represented in the Strategy.
- Catchment health needs to be a focus as reflected in the Whaitua process.
- Added-value and innovation in water use needs to be front of mind.
- The Whaitua Implementation Programme (WIP) is a core foundation document. The adoption of the recommendations of the WIP into the Greater Wellington Regional Council Natural Resources Plan (NRP) and the implementation of its recommendations will continue in parallel to the development of the Resilience Strategy.

Scope

Two outputs of this project are envisaged:

- **A strategy report**
  - This would be a comprehensive outline of the work undertaken, the methodology used, the results and the conclusions
  - It is anticipated as a comprehensive 90-120 page document and is intended for an informed audience

- **A summary report**

- This would be a brief paper outlining the key findings and directions of the Strategy and specifying the road map and next steps. It is estimated at 8-10 pages with a strong visual element to it.

Procedures

The Wairarapa Water Resilience Strategy Group will determine the final content and recommendations of the strategy document. They will oversee the Strategy document throughout its production. The WWRSG, chaired by Dame Margaret Bazley, will operate on a collaborative basis seeking to achieve agreement on the key matters in the Strategy.

Code of Conduct

The WWRSG is not a "representative" group, but a group of stakeholders who it is felt have a sufficient spread of experience, knowledge and skills to undertake the task. A Code of Conduct is appended.

Consultation and engagement

A programme of stakeholder and public engagement will be undertaken in parallel with and as an integral part of the Strategy and as resources allow. There will be a high level of transparency with relevant documents placed on a website for public access and comment and contribution will be sought from those affected. The details of management of the consultation and engagement programme will be overseen by the WWRSG.

A particular focus of engagement will be catchment or river management groups, about 36 of which already exist in the region. A wide range of stakeholders will be engaged from both rural and urban backgrounds.

The Water Resilience Strategy group should also look to engage with wider strategic committees in the Wairarapa region including Wairarapa Regional Economic Development Strategy (WEDS), relevant documents and data from all four councils, all relevant iwi strategies, Whaitua Implementation Plan and any other relevant strategies.

Addenda

The addenda comprise a series of background papers that were used to support the main text. They come under the general title of “Characterisation” as they are informational and descriptive in nature. They are referenced in the main text where relevant.

Addendum 1: Characterising mana whenua perspectives

The identity and wellbeing of Wairarapa iwi, Rangitāne ō Wairarapa and Ngāti Kahungunu ki Wairarapa are directly associated with Te Awa Tapu o Ruamāhanga (the sacred Ruamāhanga River) and its many tributaries. From the headwaters to the sea, local iwi and hapū identify with the river system as a source of mana and mauri. These traditional relationships of Māori with water are recognised in the Resource Management Act 1991 (RMA) and in the NPS-FM as matters of national significance. Recent Treaty of Waitangi settlements have also recognised the mana whenua role as kaitiaki in the future governance and management of Wairarapa Moana (Lake Wairarapa, including its wetland margins and connecting waterways and Lake Ōnoke) and Ruamāhanga.

Who is Ruamāhanga?

The mana (pride and strength) of Ruamāhanga is carved across the lower North Island. Ruamāhanga has massive scale, great diversity and a generative force that enables and empowers all life in the Wairarapa Valley. Ruamāhanga is the largest flowing body of water in the Wellington region. It extends from Pukematawai, a peak in the north-western Tararua Range, to Wairarapa Moana in south-eastern Wairarapa. This is a journey of more than 130 kilometres, taking in many thousands of hectares of land and a myriad of water bodies, large and small. Along the way the flow of Ruamāhanga is at times strengthened, as it receives water from many tributaries, and at others diminished, as water is given to the land, forming springs and streams that ultimately return to the main stem.

Te Awa Tapu o Ruamāhanga – the sanctity of Ruamāhanga

Ruamāhanga exists in a cultural and spiritual context described by Wairarapa iwi Rangitāne ō Wairarapa and Ngāti Kahungunu ki Wairarapa.

The breath of life (te hā o te ora) was placed within
the Ruamāhanga River at the beginning of time.
The hā is present in Papatūānuku the earth mother's
blood or the water that flows in through her main
vein the Ruamāhanga. If water can breathe, all other
life breathes and therefore ira tangata/humans are
sustained.

Ngā Taonga nui a Kiwa – Schedule B, Proposed Natural Resources Plan

Wairarapa iwi Rangitāne ō Wairarapa and Ngāti Kahungunu ki Wairarapa have regard to the sanctity of Ruamāhanga and how the health of the water is fundamental to human health and wellbeing. Iwi have a unique relationship with water and water is a consistent point of interest. Māori were active and influential participants in the formulation of the Whaitua Implementation Programme.

The integration of the mana whenua perspective with catchment planning was critical to the work of the Whaitua Committee, which worked with local kaitiaki and marae communities to ensure that Māori values are recognised and provided for in the WIP. The Committee's recommendations aim to ensure that active mana whenua leadership and participation is integral to the implementation of improved water quality and quantity in all places in the Ruamāhanga whaitua.

The recommendations of the Whaitua do this by requiring that hapū/marae have a structural role in freshwater management unit (FMU) implementation management processes and that their values are integral to reporting on progress at community catchment scale. The recommendations also require that hapū/marae capacity and capabilities to both lead and participate as mana whenua kaitiaki are supported and resourced through the development of a mana whenua-led kaitiaki support mechanism.

Stewardship

Mana whenua have responsibilities in the stewardship for water as kaitiaki and poutiriao.

Mana whenua o Wairarapa have cultural, spiritual, traditional and historic associations with the lands, waters, flora and fauna within their rohe and have a responsibility to preserve, protect and manage all natural resources within their rohe as kaitiaki in accordance with the principles and values set out below:

Ki te kore ngā poutiriao hei tiaki i te tūranga o ia mea, o ia mea, te haere a ia mea a ia mea, te mahi a ia mea a ia mea, nā kōnei i witi ai ngā mea katoa, mei kore ngā poutiriao kua taupatupatu ngā mea katoa ki a rātou anō, pēnei kua hē kua matemate.[60]

(If Poutiriao did not act to protect the position, the movement and the actions of all individual things, they would cross over and interfere with each other; without Poutiriao all things would clash and compete with each other, things would not be balanced and everything would self-destruct.)

Further helpful text is drawn from the "Values for Wairarapa Waterways" Report, November 2011 by Caleb Royal[61]:

> *"Māori values associated to a particular river, place, or community, are most commonly generated through the occupation of an area, and the cultural requirement to behave in a manner consistent with kaupapa Maori (foundation of cultural normalities). The values identified in this project include;*

[60] Ra Smith, Ngati Kahungunu

[61] http://www.gw.govt.nz/assets/Our-Environment/Environmental-monitoring/Cultural-Values-for-Wairarapa-Waterways-report.pdf pp 3

- *Wairua (spiritual) - Tohi rites, removal of tapu associated with war/death, baptisms and blessings of people and items.*
- *Tinana (physical body) – washing after child birth or menstration, water for cleaning and cooking, collection of food and weaving resources, preserving/storing food.*
- *Hinengaro (mental wellbeing) – collection of rongoa (healing plants), drinking water (mental clarity), teaching and learning (education), meditation.*
- *Whanau – transportation (waka), recreation, gathering of building resources, positioning of Pa, manaaki (sharing) the bountiful resources.*
- *In addition to the themed values of; wairua, tinana, hinengaro, and whanau, there were values identified that recognise the ecological importance of the Wairarapa waterways. Iwi identified the concepts of; ki uta ki tai (mountains to the sea), mauri (life essence), and habitat protection as key values for the future management of the water resource."*

Māori values attributed to the rivers and streams throughout the Wairarapa Valley are consistently being compromised through low flows, poor water quality and loss of biodiversity. There is a distinct difference between minimum flow values determined from a Greater Wellington perspective and an iwi Maori perspective. The report affirms that minimum flow volumes from Greater Wellington are based almost exclusively on the habitat space for fish which should provide for the ecological values associated with the waterway. Conversely, Maori values, whilst acknowledging the value of ecology of the waterway, also attribute significant value on a waterways ability to nourish the spiritual, mental, and community wellbeing. When discharges of pollutants, algal blooms, and flood protection works compromise these values, raising the minimum flow is unlikely to address the problem determined by Māori. There is an expectation from mana whenua that the rivers and streams which once provided this nourishment for their community should be available to support their cultural identity.

Addendum 2: Characterising the physical geography

The Wairarapa is contained and compact in nature with a 130 square kilometres fertile alluvial flat valley floor bounded by relatively low mountains in the west and hills in the east with a long coastal strip. North/south fault lines are responsible for the shape and much of the valley has been uplifted, some as recently as the 19th century.

The compact geography creates a sense of integration within and separation from without. The faulting and tilting has sharply modified land forms including rivers and groundwater areas. The location of Wairarapa east of the main divide is crucial to understanding its climate and response to climate change.

Climate overview

Westerly weather systems dominate the climate and during summer produce fohn winds (the 'Nor'wester' to locals) and high temperatures. Wairarapa has always experienced hot dry summers. South-easterly rain-bearing winds can produce heavy rainfall events resulting in flooding, otherwise winters are dry and cold. Rainfall is highest in the west near the ranges and diminishes eastward, creating quite different conditions over a relatively small land area.

While the Tararuas catch snowfalls throughout winter, the snow does not lie for long. Water storage in snow fields, characteristic of the South Island and which feeds irrigation well into the spring and summer, is not a feature of the Tararuas.

Wairarapa has been pre-disposed to drought conditions long before the advent of climate change effects. The dry and relatively low wind (compared to neighbouring regions) in parts of Wairarapa makes it attractive as a visitor destination in summer and winter. Climate change will gradually move the climate from a "continental" to one with more "Mediterranean" characteristics.

Characterising the economy

As every year goes by Wairarapa looks increasingly like the rest of New Zealand in economic terms. Urban populations are increasing as a percentage and employment is moving from the primary and secondary sectors to the tertiary and quaternary sectors. The ANZSIC Level 1 industry which created most jobs over the last ten years (2009 to 2019) was 'Healthcare and Social Assistance'. 'Professional, Scientific and Technical Services' are ranked second and 'Education and Training' third. By contrast, sheep-beef cattle farming shed 79 jobs between 2009 and 2019, whereas it had seen the largest growth of any industry over the previous period since 2000 (+359 jobs).[62] Agriculture will always be a significant part of the local economy, but over time Wairarapa will become more urbanised and an extension of the

[62] Source: Infometrics

Wellington economy. Urban people have a different relationship to water than rural people.

Wairarapa is a small economy and if per capita living standards are to be maintained at or near the New Zealand average there is going to be a need for a constant flow of wealth into the region from outside in the form of consumer spending and business investment. Similarly, significant viable businesses are going to have to find markets outside Wairarapa and possibly outside New Zealand. There are already significant enterprises in the area in meat and timber processing locating close to their supply of raw material (like animals and trees). There are limited prospects for additional major plants because there are few other locally sourced raw materials. With a skinny labour market and located off the main transport arterials, Wairarapa is unlikely to be the site of new large plants. The type of urban population of the future is likely to be less connected to the land (and water) than the current population.

The other potential raw material is the fertile alluvial soils of the valley which, if well managed, could be used for sustained specialist cropping, horticultural and fruit production. Increasingly that resource will only be accessible with the natural resource of water, otherwise with climate change the productivity of soils will become constrained.

Future rural-related development is more likely at the boutique and artisan end of the spectrum based on specialist crops and agricultural products, selling added-value products to visitors (tourists) and outside the region with a high-value proposition. The potential consumers of these good are likely to be educated and sensitive on environmental and sustainability issues and Wairarapa enterprises will have to meet these expectations to prosper. Food provenance will become more and more important and the treatment of water and the environment will have to be exemplary.

Characterising the community

Wairarapa is not intensively settled, although much of the population is concentrated in the mid-reaches of the Ruamāhanga River. Low population density may well be a temporary situation. As New Zealand's population increases past five million and people are moving out of main centres like Auckland, population pressure is building in places like Wairarapa.

All local Wairarapa councils are opening up sub-divisions in response to demand and the population is moving upward from inward migration, which is a very different scenario to even a few years ago. The local councils report very moderate population increase predictions out as far as 20 years, which is surprising. This reflects Infometrics' view that growth will tail off over this period which is a sentiment we don't share. New Zealand is becoming an attractive destination in the context of COVID-19, climate change, social upheaval and other disruption in many western countries.

There is still a traditional rural population (agriculture, forestry and fishing is still the largest sector for employment), but it is dwindling through farm amalgamation, automation and urban spread. In addition, the aspirations of farming families are increasingly about what urban living has to offer than the bucolic rural experience. Values and beliefs are changing.

The impacts of the proximity to Wellington cannot be under-estimated. While some forms of transportation will become constrained by emissions considerations, there are massive upgrades of public transport underway. As a result, Wellington will continue, in fact may increase, in significance for Wairarapa.

Significant numbers of young people leave Wairarapa for education creating a hollowing effect in the post-teen population. On the other hand, there are two types of situations where people migrate from Wellington to Wairarapa – lower income people seeking cheaper housing and lower cost of living, and higher net worth people seeking lifestyle living experiences. Both these groups are in the 30 and 40 age-group. The combination of these dynamics leaves a gap in the 20s age-group which has an acute effect on businesses seeking lower cost young labour, particularly farming. On the other hand, growth in the 30-40 age group will drive tertiary and quaternary development.

Gradually these imports will exceed the locals. This is already happening in places like Greytown and Martinborough. Add to this influence that of weekend visitors with properties in the region, especially the south. There is strong evidence that all the population categories, though some more than others, seek quality of life and environment and that matters of water and environment will be of continuing importance to them.

Characterising Wairarapa's water systems

This section deals with what's in and what's out of water resilience considerations. While the emphasis of this Strategy is on the Ruamāhanga Catchment, consideration is being given to the whole of the Wairarapa including the eastern hills and the eastern coastal strip.

It also recognises that the water bodies of Wairarapa are very much part of a system based on both 'natural design' in the sense of a confined valley, but also 'artificial design' where modifications have been made to change flows and volumes of water to achieve public or private benefits.

Groundwater and the water races are dealt with in separate chapters.

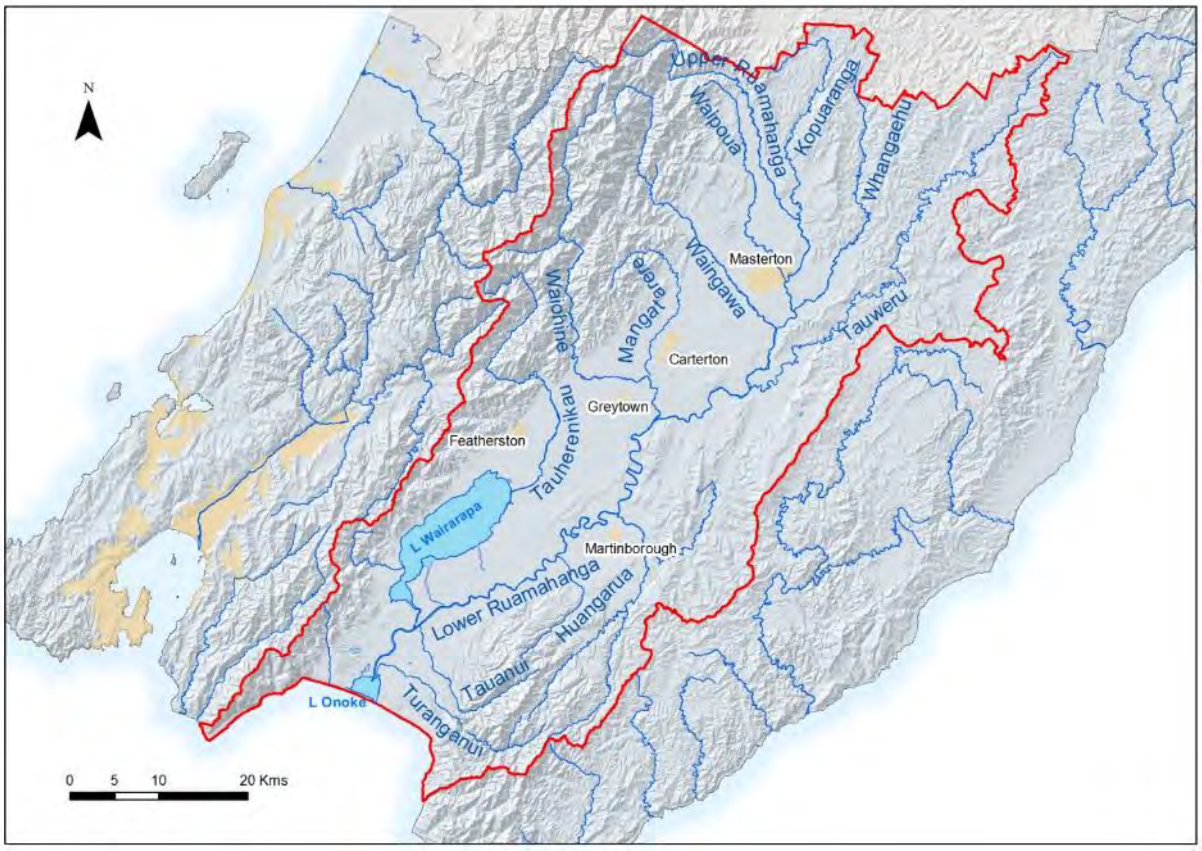
The river and groundwater systems of Wairarapa are what could be termed a closed system. What goes in must come out as rivers and streams flow through the catchment to the sea. As a result, water moves actively between rivers and groundwater depending on climatic conditions and water demand. Water loss from this system is through evaporation.

The Ruamāhanga catchment is the agricultural powerhouse of the region, although there are around 340 rivers and streams in the region. Dairying, drystock farming, orchards and vineyards all play a significant role in the area's economy. The area covers a massive 3,555m2 (44 percent of the region's land area) and is home to around 37,000 people (eight percent of the region's population). Most of the people reside in the towns of Masterton, Carterton, Greytown, Featherston and Martinborough.

The Ruamāhanga River is a central feature – with its headwaters in the Tararua Ranges near Mt Dundas, north of Pūkaha Mount Bruce and emerges into the Wairarapa Valley west of Mauriceville.

The river has a total length of 162kms flowing south and then southwest before emptying into Palliser Bay via Lake Ōnoke. The river is therefore the water source for the natural environment, town and rural water supplies but is under increasing pressure from population growth and climate change.

The catchment has an area of 3,430 km2. In its upper reaches the river has a wide, semi-braided channel, although in places it is confined by terraces and assumes a single-thread form. In its lower reaches, the Ruamāhanga River has a meandering, single channel contained within stopbanks.
The map below shows the main rivers and the Ruamāhanga Whaitua boundary.



The catchment contains several significant tributary catchments of the Ruamāhanga River, including the Waipoua, Waingawa, Mangatarere and Waiohine rivers that rise in the Tararua Range and the Tauweru and Huangarua rivers that originate in the eastern hill country. These rivers join the main stem of the Ruamāhanga River as it traverses the Wairarapa Valley floor before discharging to the Cook Strait on the south coast. The rivers and streams rising in the Tararua Range tend to have relatively high base flows and frequent freshes whereas rivers coming out the eastern hill country typically have extended periods of very low flow. Spring-fed streams (such as the Papawai, Otukura and Parkvale) are also a prominent feature of the Wairarapa Valley floor.

The western tributaries are subject to the cool, wet to extremely wet climatic conditions that occur in the Tararua Range, and have catchments clad with indigenous forest, with some alpine shrublands and tussock land in the highest reaches. In the upper reaches, these rivers have steep gradients and incise into the hard greywacke bedrock before traversing the younger alluvial gravels that dominate on the valley floor. The exception is the Waipoua River, which originates in the foothills of the Tararua Range. The Waipoua, Waingawa, Waiohine and Tauherenikau rivers vary along their length between single-thread and semi-braided channel form and carry high loads of gravel.

The main tributaries entering from the eastern hills are the Kopuaranga River, Whangaehu River, Tauweru River, Huangarua River, Tauanui River and Turanganui River. The first of these three differ greatly from the western tributaries. Their catchments are subject to drier climatic conditions, are of lower elevation and slope, and are predominantly pastoral in land use with an underlying geology of soft, sedimentary rock. In their lower reaches the Kopuaranga, Whangaehu, and Tauweru rivers are generally sluggish and have meandering, silty channels. These rivers tend to have poorer water quality – in particular, higher nutrient concentrations and suspended sediment loads – than the western tributaries.
The Huangarua River (with its major tributary, Ruakokoputuna River) is sourced in the Aorangi Range, but flows through sedimentary hill country before entering the Ruamāhanga River. The other small rivers flowing off Aorangi Range, Tauanui and Turanganui rivers, enter the Ruamāhanga River in its lower reach. The rivers carry high gravel loads and tend to flow below bed level during dry periods. The major lowland streams, which commonly emerge from springs within the valley, include Makoura Stream, Parkvale Stream, Papawai Stream, Otukura Stream and various streams around the south Featherston area. The lowland streams are often interconnected with the Wairarapa water race systems, which are artificial waterways fed from the Ruamāhanga River and its major western tributaries.

Lakes Ōnoke and Wairarapa are major features of the catchment. Lake

Wairarapa, known to Māori as "Glistening Waters", is the largest lake in Wairarapa. Being a shallow lake, it is large in area (78 square kilometres) but low in volume and provides little in the way of water storage for surrounding farmland. Its large surface area makes it prone to evaporation and to significant warming in the summer. Both Lakes Ōnoke and Wairarapa have been considerably modified and their water qualities have become degraded. The flows into the lakes and lake levels are now highly controlled, mainly for flood control purposes. The Ruamāhanga River now bypasses Lake Wairarapa and flows directly into Lake Ōnoke, which discharges directly into the sea through a modified outlet. Until the 1960s the Ruamāhanga flowed into Lake Wairarapa, but the Lower Valley Development Scheme, designed to protect surrounding farmlands from flooding, cut it off. Lake Wairarapa levels are artificially maintained through control gates (known as the barrage gates) at the south end installed when the Ruamāhanga was redirected. The Whaitua Committee has recommended investigation of the question of the Ruamāhanga being redirected back into Lake Wairarapa.

Beneath the Wairarapa Valley floor is the most significant and heavily used groundwater resource in the region. The permeable nature of the gravel and sand aquifers near the rivers means that there is a significant amount of exchange between surface and groundwaters in this zone. In addition to water being abstracted directly from rivers, pumping from groundwater bores is also known to further deplete river flow.

Management of abstractions by the Greater Wellington in the catchment is focussed on treating surface and groundwater as a single, connected system. While the area is split into three sub-zones (Upper, Middle and Lower Ruamāhanga River) and several tributary river units to help manage low flows and allocation limits, the linkage between these zones is considered at the whole catchment scale.

At the catchment's top end, around Pukaha/Mt Bruce, the water is clean and clear and in the top 25% of similar sites nationally for clarity, E coli rates, nitrogen and phosphorous levels. It passes the region's five major towns and through intensively cultivated country, and contamination levels from rural and urban sources depress the river's health. Each of the towns the river passes empty treated wastewater into the river, though in recent years more treated wastewater has been sprayed onto land. This trend will continue.

The riverbeds of almost all the rivers have been modified over the years, mainly for flood protection, but also to capture more of the flood plain into farmland. There are also extensive drainage works across the valley principally designed to drain marshy land. These drainage schemes, many of which have pump stations, are maintained by Greater Wellington , though a few are in private ownership.

For Rangitāne, the river is an ancestral waterway, which many hapū refer to as the awa in their pepeha. The waters of the river are seen as the blood which flows through the veins of Papatūānuku, the earth mother. The waters are referred to as 'Te Wai Ora', (the life giving water), which is important for maintaining the health and well-being of all life forms.

As well as being an icon of Rangitāne tribal identity, the river was vital for the existence of settlements established on both banks of the river. There were traditionally 25 Ngāti Hāmua marae along the river between Tawera and Te Whiti, each of which had associated urupā and other waahi tapu. The Ruamāhanga was known for the quality of its eels and fresh water koura. The Ngāti Hāmua taniwha, Peketahi, was last seen in the river.

Since Pākehā settlement, the course, flow, and nature of the river has changed significantly. Changes in the course, largely due to River Board activities, have washed away waahi tapu along the banks of the river. The most drastic change has been the diversion of the river away from Lake Wairarapa to lower the level of the lake and drain surrounding lands. The removal of trees from river banks caused flooding, and eroded river banks. The river is considerably shallower today than in the past, when waka landing places were used in areas now considered unnavigable. Physical changes to the river, combined with introduced fish species, have reduced the stocks of tuna and koura. This has impacted on the ability of Ngāti Hāmua to sustain them and provide hospitality to their guests.

Today, Rangitāne are concerned about the effects of pollution in the river, which make it unsafe for swimming, and affect the ability of hapū to gather kai from the river. In towns like Masterton for example, municipal sewage treatment oxidation ponds have discharged effluent into the river, which is both an affront to Ngāti Hāmua's spiritual and cultural beliefs and creates health hazards for swimming and traditional kai gathering.

Integrated catchment

There are 338 rivers and streams in the Wairarapa of varying sizes and volumes, but with the exception of the eastern coastal area they are highly integrated around the core spine of the Ruamāhanga. The natural river systems lend themselves to a catchment view and a catchment management approach to resilience.

Modifications to the river systems have arguably made them even more integrated with the intention of getting flood waters to the sea as quickly as possible. Impacts to the Ruamāhanga further up its course have implications further down on both volume and quality. A particular feature of the river and the lakes is the loss of up to 97% of wetlands as a result of modification measures. As natural treatment areas for contaminants, they no longer perform this function, although there is local action to restore some of these natural 'treatment' features.

Consideration of integrated catchment management is important to iwi. The catchment is seen as a complex system, like a mosaic, with inter-connected features. Ideally there should be a constant flow in the river with riffles and pools that provide habitat and protect from flood. Strategies for enhancing resilience could be used that mimic nature. Iwi would be seeking to retain or recapture as much of the natural flows as possible.

The rivers on the eastern coast are of a completely different nature. Each has their own catchment and river course. Apart from minor tributaries, none of them link up making them each individual (and generally small) river systems. Coming out of the hills near the coast they are generally fast flowing, carry a lot of sediment especially after rain and can generate severe erosion. They are prone to very low flows in summer and in some cases drying up altogether.

Riverbed degradation

There is a growing problem of riverbed degradation in the Wairarapa. It is thought that this is a cyclical problem but the local rivers are in a down cycle at present. This is a result of gravel takes from some rivers and a reduction in the amount of gravel coming down from the Tararuas, which in turn is governed by rainfall and seismic activity.

The effect of reduced river levels as a result of riverbed degradation is that gravity fed channels from the river become too high so that traditional methods of water distribution are not always operational, such as water races.

Addendum 3: Characterising water races

Five water race systems currently operate in the Wairarapa, namely:

- Opaki in Masterton District – 25km long (there is a proposal to close this race),
- Taratahi and Carrington in Carterton District – 240 and 36 km long respectively,
- Moroa and Longwood in South Wairarapa District 240 and 40 km long respectively

Previously the "Upper Plains" race system operated in the Masterton area, but this was decommissioned in the early 1990s and replaced by a piped water system.

On 12 February 2020, Masterton District Council backed a proposal to close the 100-year-old water Opaki Water Race network, leaving it up to users to come up with reasons it should stay open. The council chose not to pursue a resource consent from Greater Wellington to continue to draw water from the Ruamāhanga River to supply the Opaki Water Race. The man-made stream network which runs through 54 properties could face closure after new minimum flow recommendations. Later in the year, at the behest of a majority of the Opaki users, the council agreed to a two year moratorium to give them an opportunity to see if the storage project at Wakamoekau could provide a viable alternative to closure. It is expected to close before 30 June 2026.

Capacity

Although the spatial distribution of the races is well defined and mapped, there is very little information on the capacity of the races. Information is restricted to the consented volumes, which may or may not bear accurate relationship to capacity.

The consented maximum intake volumes are substantial and represent a significant redirection of river water:

- Opaki 230 l/s
- Te Ore Ore 300 l/s (since closed by Masterton District Council)
- Taratahi 481 l/s (new consent application seeks a "flushing" flow of up to 800 l/s)
- Carrington 113 l/s (new consent application seeks a "flushing" flow of up to 250 l/s)
- Moroa 500 l/s
- Longwood 250 l/s[63]

These rates apply to the intake channels; there is no evidence that sufficient capacity exists for these flows to be carried throughout the entire race network.

Ownership and control

The six race systems are managed by the Masterton, Carterton and South Wairarapa District Councils. They are empowered to operate the races and have access to them through the provisions of the Local Government Act 2002, and

[63] Greater Wellington report to Whaitua Committee 2014 "Water Allocation in the Ruamāhanga Whaitua"

resource consents from Greater Wellington. However, they do not generally own the land or hold easements across the land through which the races pass (although there is at least one known exception to this, at the head of the Opaki race).

Proposals to perhaps utilise some of the races as a form of managed aquifer recharge would involve ownership issues as the races would have to be widened to achieve meaningful recharge volumes, thereby further intruding onto private and productive land. Before any such moves were made, a considerable amount of investigation would be required to explore any such option.

Landowner views

Generally, races pass through privately owned land apart from where they cross under roads and railway corridors. While it is expected that some landowners will wish to retain the water races and may oppose their modification or change in use, others who may currently regard the races as of no value or even as a nuisance, might view modifications, or more particularly closures, more favourably. There is certainly an argument that the significant amount of water going into them is and will impact adversely on low flows in the portion of the river they flow past (most empty back into the river system) and for no apparent good purpose. This could become a stronger argument if other methods are used to augment groundwater.

Consent considerations

The operation and management of the races is affected through the use of local bylaws (by the district councils) and resource consents (granted by Greater Wellington). Use of the races for additional purposes may require either amendment of the current provisions, and/or possibly new bylaws and resource consents. Detailed investigation of these requirements would be required.

Addendum 4: Characterising climate change impacts

Because of its eastern coast inland valley location, in the New Zealand context, the Wairarapa is projected to experience some of the more extreme effects from climate change especially in respect of water. The main contributing factors to the progressive supply/demand imbalance on the valley floor are a combination of:

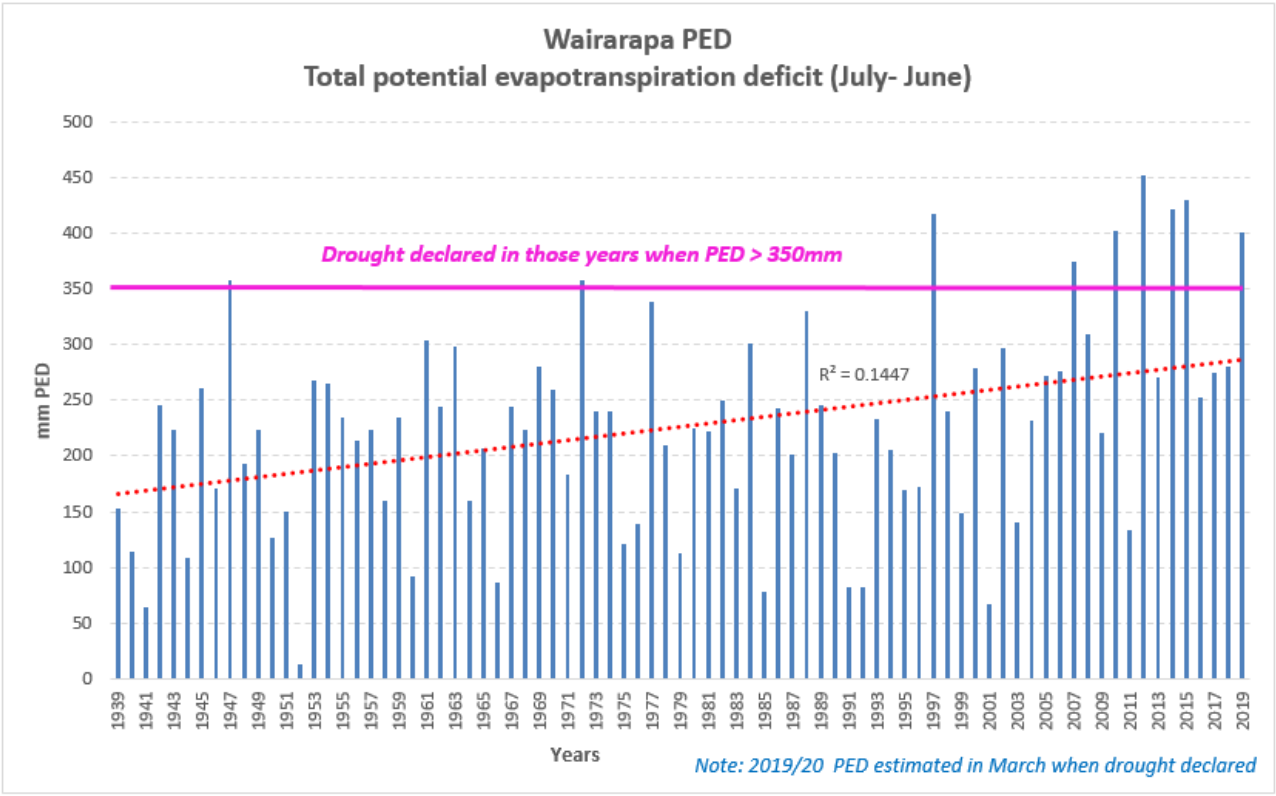
- Increasing mean temperatures – causing higher evapotranspiration (soils and plants)
- Increasing 'hot days'- i.e. days over 25 & 30C.
- Increasing minimum (night) temperatures – also less frost and therefore less chilling
- Day time temperatures increase more than night-time temperatures
- Decreasing mean river flows
- Decreasing median river flows
- Decreasing mean annual low flows (MALF) – most prevalent in summer droughts
- Decreasing valley floor rainfall
- Increasing fire risk – by 100 to 150%
- Decreasing number of rain days on the valley floor
- Slightly increasing heavy rain days (>25mm/day) – arriving more in concentrated bursts
- Proportionately, in future rainfall will decrease more in the west (near the ranges) compared with the east
- Increasing number of dry days (<1mm/day)
- Increasing total potential evapotranspiration (PED)[64]

Increased temperatures will lead directly to increases in evapotranspiration.

The chart on the next page illustrates the increasing frequency of potential evapotranspiration days. These are days when water loss to evaporation is high, rapidly depleting soil moisture levels. Drought conditions are becoming more and more common. This is expected to continue and worsen.

The combination of the above metrics will have implications for urban water supply, human and animal health and comfort, pests, diseases, terrestrial and aquatic ecology, seasonal shifts, drought and flood frequency and intensity, agriculture production (what can or can't be economically grown), recreation, fire risk and many other effects. Both opportunities and risks will arise and recognising these is critical.

[64] The effects of climate change and water resource limits on the Ruamāhanga valley floor, September 2018



Graph interpreted from NIWA data

With climate change, the frequency of flushing flows increases by 28%[65] from mid-century onwards which is positive for water quality. However, as both mean and median flows decrease (both volume-based, not frequency-based), the volume of water carried by these flushing flows is likely to be less than currently experienced. Overall, the flow volumes reduce, but the frequency of short, sharp freshes increases. These freshes are a key factor in a resilience strategy.

One of the most useful gauges of climate change especially in a predominantly rural area is the number of growing degree days (GDD) in terms of monitoring plant growth and planning harvests. Presently, assuming a 10 degree base, Masterton has 1,220; by mid-century it will be 1,460 and by the end of the century 2110 GDDs[66]. These additional growing days are not just in the water deficit period of January to March and will create the opportunity for changed land use patterns.

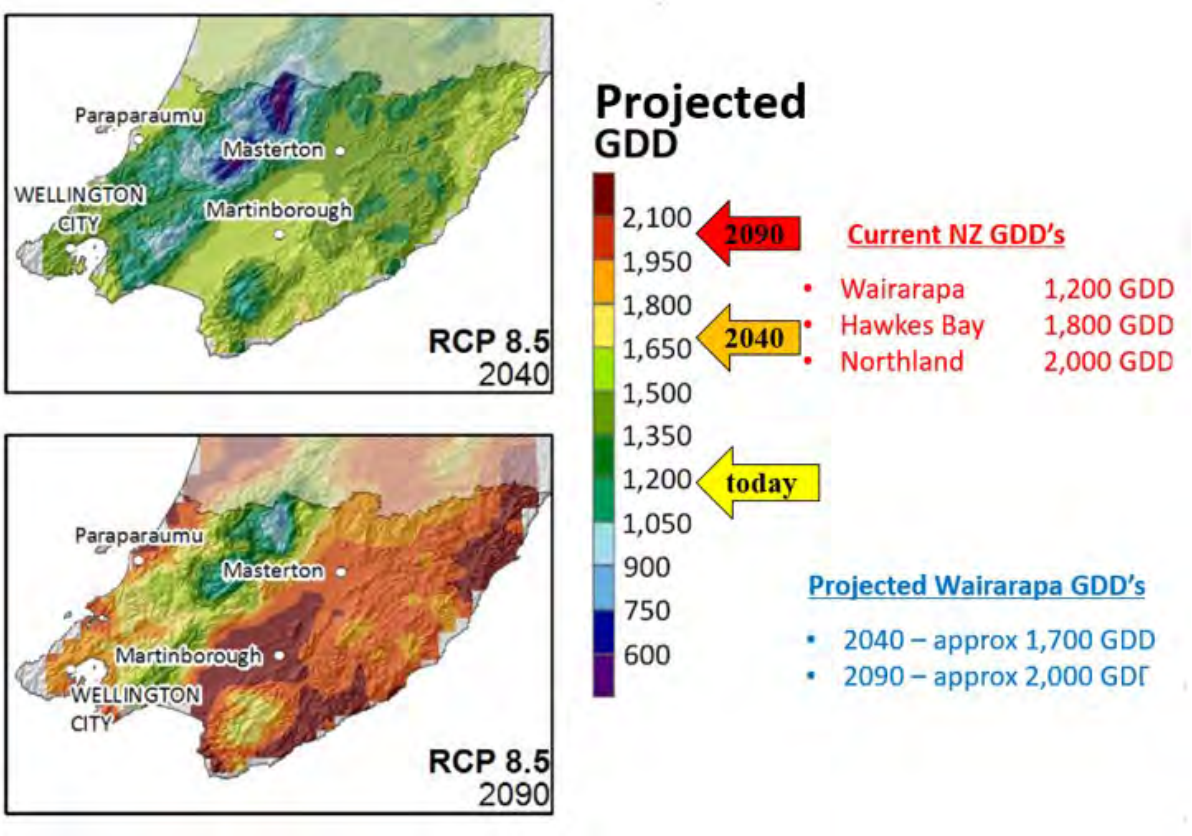
The diagram below indicates, by mid-century Wairarapa will mimic what Hawke's Bay and Gisborne experience now, and by the end of the century it will equate to Northland today. In short, there will be an almost Mediterranean feel to the climate. Immediate evidence of this is the growth of olives in the region which has taken off in the last decade. At one level this sounds attractive and improved

[65] Effects of Climate Change and Water Resource Limits on Valley Floor Water Resources by Aqualinc Ltd for GREATER WELLINGTONRCGWRC, May 2018

[66] Climate change and variability - Wellington Region prepared for Greater WellingtonbyWellington Regional Council by NIWA, June 2017

living conditions will certainly attract people, but it indicates a quite fundamental change in land use patterns and water demand. Mediterranean climates are not noted for intense pastoral farming.

Projected Changes in Growing Degree Days (10°C base) [67]



Water-related Impacts

In the New Zealand context, Wairarapa comes out at the more extreme end of changes that NIWA predict will happen, with hotter temperatures, slightly lower rainfall in the valley and increased risk of drought. The projected climate change effects will have a gradually increasing adverse effect on access to reliable water in the Ruamāhanga valley.

As a result of the reduction in water availability due to the WIP water resource limits alone (i.e. excluding climate change effects), average supply reliability for surface water extraction will decrease 9% during the summer months or 13% for shallow groundwater takes[68]. In terms of overall pressure on the resource, consumption of drinking water by 2090 is projected to increase 40% for Carterton, 30% for Featherston, 20% for Greytown, 40% for Martinborough and 11.5% for Masterton[69].

In a similar vein, by 2040, averagely up to 15% more water will be required to irrigate land assuming its used for the same land

[67] Source: the NIWA Climate Change and Variability series (various dates). RCP 8.5 is adopted as the current change trends most closely to follow that projection trajectory, not more moderate values

[68] Effects of Climate Change and Water Resource Limits on Valley Floor Water Resources - Aqualinc 2018

[69] Wairarapa Township Water Supply Demand Forecasting, Tonkin & Taylor Ltd, 2017

uses as today, this will increase to 30% by 2090[70].This is in a context of overall less rainfall. The active impact is temperature driving much greater evapotranspiration. This points to the need for improved water use efficiency, changed strategies to keep soil moisture levels high and/or growing the appropriate 'crops' for the conditions.

While the valley will experience less rainfall, it is predicted that the same volume of rainfall will occur in the catchment's headwaters, with less intensity but more frequency.

With climate change, on average, soil moisture deficits will not pose an issue prior to the new year, but during January to March inclusive it will become even more of an issue than it is at present. This means that the water availability pressure will be very seasonal and very acute in the dry season. River flows will certainly be affected. The table below[71] depicts the percentage changes relative to the historic period (1978-2014) to various metrics for the Waingawa River, by way of an example.

	Mean volume change	Median volume change	7dMALF volume change	FRE3 frequency change (flushing flows)
2040	-2%	-6%	-22%	+28%
2090	-6%	-11%	-21%	+29%

Climate indices projections

In 2019, NIWA compiled a report for a range of climate indices in the Wellington Region, comparing the recent past to modelled future conditions[72].

Temperature will be the most significant driver behind climate change in the Wairarapa. The following temperature changes are projected by late century for Masterton. The changes are more pronounced through time and with an increased greenhouse effect:

- For warm nights (Tmin >15°C), a 36-day increase p.a.
- For cold nights (Tmin <5°C), a 54-day decrease p.a.
- For cold days (Tmax <10°C), a 12-day decrease p.a.
- For hot days (Tmax >25°C), a 70-day increase p.a.
- For extreme hot days (Tmax >30°C), a 20-day increase p.a.
- For heatwave days (≥3 consecutive days with Tmax >25°C), a 67-day increase p.a.
- For extreme heatwave days (≥3 consecutive days with Tmax >30°C), there is a climate shift from the absence of extreme heatwave days to 11 days p.a.

It important to note that trends towards the above changes in these metrics have

[70] Effects of Climate Change and Water Resource Limits on Valley Floor Water Resources, Aqualinc 2018, pages 2 - 47

[71] Effects of Climate Change and Water Resource Limits on Valley Floor Water Resources by Aqualinc Ltd, May 2018

[72] Wellington Region climate change extremes and implications, NIWA, December 2019

already commenced, especially since mid-last century.

The delicate balance of natural effects has built up over millions of years and we as a species have now disturbed that balance. The pre-human settlement balance of Wairarapa was very different from today. There were vast forests from Pukaha/Mt Bruce to Palliser Bay interspersed with wetlands beside rivers, around Lake Wairarapa and in coastal areas. These features enabled ecosystems which fostered habitats for a wide variety of species of plants and animals. The fertile soils in the valley are a result of thousands of years of vegetation build-up.

Wetlands were abundant on low-lying land and depressions, adjacent to rivers and lakes with their own plant species and ecosystems. Wetlands included swamps, marshes, and fens in the lowlands, with bogs being mainly in the uplands. Rivers provided a diverse range of aquatic habitats containing diverse aquatic fauna and flora. Wetlands are estimated to be now 3 of their original coverage[73]. This was the "natural infrastructure" of resilience.

Wairarapa's original ecosystems were destroyed or significantly modified centuries ago. As described in the 2000 DOC report[74,] "Prior to human settlement, podocarp-dominant forest covered most of the Ecological District. Maori fires in the seventeenth century destroyed most original podocarp forest. Native grasslands, fernland, swamps and scrub then replaced the forests. Arrival of Europeans in the mid-nineteenth century brought further change to indigenous ecosystems. Much of the remaining forest was removed, smaller wetlands were drained, and native fernland and scrub cleared."

Wetlands such as marshes were drained and claimed for agriculture, urban development and infrastructure such as roading and bridges. Regenerating native flora was eaten by stock. Flood control schemes have halted the regular cycle of flooding which was part of the renewal and resilience process.

The loss of bird species has been significant. We think of species loss as being more recent, but it has taken place over a long period. The introduction of pests, either deliberately or inadvertently, has also impacted the ecosystems. Obvious examples are possums, feral cats, mustelids, deer and game fish, but there are many others.

A fuller description of the original and indigenous biodiversity of the region can be found on the Greater Wellington Regional Council and Masterton District Council websites[75]

[73] Land use and water quality report by Andrew Stewart for the Ruamāhanga Whaitua Committee, June 2014

[74] Wairarapa Plains Ecological District Survey: Report for the Protected Natural Areas Programme

[75] http://www.gw.govt.nz/wairarapa-8/ and https://mstn.govt.nz/council-2/projects/biodiversity-in-the-wairarapa/

Addendum 5: Characterising the groundwater allocation regime

A maximum amount of water that can be allocated to users (the limit) is set in the PNRP as an annual volume. Some sub-units are currently over-utilised are shown in red. However, the current limits are interim and will be revised on the basis of more recent modelling and trends analysis.

Category C Core allocation groundwater status (as at January 2021)[76]

Ruamāhanga catchment groundwater sub-units	Existing allocation (m3/year)	Allocation amount (m3/year)	Percentage existing amount/ allocation amount
Te Ore Ore	778,990	480,000	162%
Waingawa	1,206,345	1,900,000	64%
Upper Ruamāhanga	558,705	3,550,000	16%
Fernhill-Tiffen	1,200,000	1,200,000	100%
Taratahi	498,565	1,400,000	37%
Parkvale (unconfined)	340,000	350,000	97%
Parkvale (confined)	2,162,000	1,550,000	139%
Mangatarere	3,050,245	2,300,000	132%
Tauherenikau	8,230,885	6,600,000	125%
Lake	11,140,165	6,750,000	165%
Huangarua	1,119,400	650,000	172%
Martinborough	779,743	800,000	98%
Dry River	570,065	650,000	88%
Ōnoke	2,095,200	2,100,000	100%

[76] Source: Whaitua Committee June 2016-original source GWRC Environmental Department

Availability and allocation

Wairarapa has one of the most complex groundwater flow systems in the country. The first 30 metres or so is a dynamic flow system that is connected to rivers and streams where they are most productive. Deeper productive aquifers are more localised and not particularly extensive on current reckoning (although understanding of deeper groundwater systems is evolving and hopefully will be particularly aided by the aerial electromagnetic survey which will contribute to revised geological and groundwater models in the coming few years). Lower yielding aquifers (bores in them can generally only provide relatively small volumes of water) occur at all depths across the valley in formations that do not permit the rapid flow of water – although only a small volume of water is taken from them collectively, they still have a considerable storage of groundwater. Occasionally, localised 'pockets' of high yielding aquifers can be found in these formations.

High yielding aquifers tend to occur along/adjacent to modern water courses and at depth where the gravels are reworked (cleaner) by old river systems but have been affected by tectonics (faulting/folding).

Groundwater is categorised into A, B and C.

- **Category A** is applied to shallow, generally very productive aquifers that are directly connected to surface water and represents about 50% by volume of total groundwater allocation in the Wairarapa valley. Put simply, this is the easy water 15-20 metres down, near rivers and it is mostly taken – although it is the least reliable groundwater, being restricted at low river flows. Category A availability is controlled by surface water allocation availability.

- **Category B** defines aquifers that have a moderate level of connectivity to surface water than Category A as they tend to be deeper and further from rivers. Allocation from this zone is split between surface water and groundwater (Category C) 'buckets'.

- **Category C** is deeper groundwater that does not have a direct connection to surface water – the surface water depletion effects from Category C takes a long time to occur (building up over the irrigation season). Category C aquifers can often sustain large takes in particular areas, but often can only sustain relatively small volumes of abstraction – for example the Taratahi and Upper Ruamāhanga zones (table above) have high availability because the water is more difficult to access due to the lower permeability formations.

There are significant questions around the availability of more groundwater than is already used. Beyond Category A, the groundwater that is available is generally more challenging to access as it is both costly to pump and bores tend to have a low yield. Nevertheless, this may still be a reliable resource that is worthy of attention. The storage in these aquifers is potentially quite large, it's just harder to get at. It may not be that much more costly

to pump if only small volumes are sought. There may be a lot of land uses that could be sustained by lower yielding aquifers. Land use may have to adapt to availability and/or on-farm storage may have to be provided.

Addendum 6: Characterising the rural economy

Pastoral systems

Dairy farms use water for household, stock drinking water, irrigation and hygiene (cleaning the machinery and the yard) and they use large but monitored quantities.[77]

Wairarapa produces around 10% of the sheep, 7% of beef and 5% of dairy cattle in New Zealand[78]. Sheep and beef uses of water include household and stock water, where hygiene uses are relatively negligible compared to dairy.

According to Statistics New Zealand[79], there are currently around 140 dairy farms and 350 commercial[80] sheep and beef farms in Wairarapa. These represent 1.3% and 3.4% respectively of the New Zealand totals.

The size of the herds is as follows:

- Sheep 476,000 (5% of New Zealand total)
- Beef 123,000 (3% of New Zealand total)
- Dairy 88,000 (1% of New Zealand total)

Water usage by animals is outlined in the chart on the next page. It illustrates the huge variations between land uses. Variations to land use will be essential as water scarcity tightens and replacement is not readily available. Decisions will be required about where best to direct and restrict water. These are tough decisions and not ones we have had to face before at this scale.

Range for water requirements for the stock types[81]

Farming enterprise	Type of animal	Average Day Demand (l/h/d)	Peak Day Demand (l/h/d)
Dairy	Milking cows	45	70
	Dry stock Dairy shed utilisation	30 50	45 70
Beef	Mature cattle, herd replacement stock and bulls	30	55
Sheep	Ewes, hoggets and rams	3.0	4.5
Deer	Hinds and stags (all ages)	6.0	12.0

[77] Climate change could see the decline in dairy farming in the Wairarapa as a result of a climate that has become too hot, dry and with unreliable water supplies.

[78] Leftfield, pp50

[79] 2017 census data (this is the latest)

[80] "Commercial" is defined by Beef+Lamb NZ for its Sheep and Beef Farm Survey as those over 750 Stock Units. There are approximately 350 non-commercial or lifestyle blocks in addition to these.

[81] Reasonable Stock Water Requirements, Guidelines for Resource Consent Applications, Technical report prepared for Horizons Regional Council, December 2007

Horses	Working horses	55	70
	Grazing horses	35	50
Goats	Milking goats	5.0	10
	Dry goats	3.5	7.0
Pigs	Mature pigs	11	18
	Brood sows	22	35
	Pigs up to 120 kg	7.0	11
Poultry	Laying and breeder hens	30*	45*
all figures are for	Non-laying hens and chickens	18	29
1/100 birds/d	Turkeys	55	100

To maintain pastoral farm viability, adaptations are frequently needed to deal with changes to pasture feed supply – both the total amount grown and its seasonality. Both lower and higher feed availability need to be dealt with. Lower supply means that if there are no changes to stock numbers productivity will decrease while higher supply with no changes in stock number will lead to decreases in grazing pressure and reduce the subsequent decline in pasture quality.

Dairy farms are usually more intensive and profitable, and hence short-term tactical changes are able to be made, such as buying in supplementary feed, and utilising installed irrigation. In contrast, for sheep and beef farming systems, especially those on hill country, possible changes are more difficult because the topography is not conducive to intervention-type changes such as tactical fertiliser use or irrigation.

Tactical changes are short- and medium-term adaptations that involve modifying the existing production system using current management options. Typically, these are decisions that are made on short (day–month) timeframes. Examples include the buying and selling of stock, buying in supplementary feed, and deciding on the amount of feed to be allocated to different stock classes. Many of these potential changes are already used on a day-to-day basis by farmers to manage changes to potential future (months ahead) pasture growth such as low soil moisture levels in eastern areas; in such a situation farmers may pro-actively destock in anticipation of lower feed supply.

Strategic changes are the second level of adaptation: these involve changing a current system to another known production system or making substantive changes to the current system, where practices and technologies are well known. For example, a farmer may change the ratio of sheep to cattle; such systems are known (preferably in New Zealand) and the risks and issues relating to new systems can be anticipated.

However, these changes typically take a number of years, or new owners or managers to implement, hence may not have an immediate impact. In addition, other issues need to be considered: for example, changing animal type from sheep

to cattle may entail building new infrastructure such as fencing, cattle yards and better tracks. Other examples of longer-term strategic changes are increasing the next season's lambing percentage by the better feeding of ewes and changing stock genetics by introducing new, improved genetics. Examples of more wide-ranging strategic adaptations may include introducing irrigation or buying additional land in another area to make the existing system more flexible and resilient.

Last, there are transformational adaptations that involve innovation to develop completely new production systems or industries, which may include converting the farm from sheep and beef to a dairying operation or forestry. A prominent recent example in New Zealand is the planting of mānuka plantations for honey production. Potential future changes could involve sheep and goat dairy.

When changes to farming systems are made in response to climate change, there are likely to be changes to other impacts to the receiving environment. For example, changing from a sheep system to cattle may increase the potential for nitrate leaching (and nitrous oxide emissions) because of bigger urine patches with higher N loadings.

The key driver in pastoral farming, like most other farming, is consistency. The focus is on a high value and productive animal. The goal is fewer feet on the ground for more value. For sheep and beef farmers it is about producing animals that stick close to the "specs" - a 40kg lamb is too light. A 50kg lamb is too heavy and eats too much grass. The ideal is around 45-48kg. Consistent inputs produce a consistent product. Consistency of inputs applies to water so reliability is as important, if not more so than quantity. Looking into the future this demand for consistency will continue to intensify.

Arable industry

Currently there is very limited wheat production for human consumption in the Wairarapa. The 2020 harvest was of only a small quantity (200 tonnes) from three farmers to test a system of delivering wheat to the mill and understand the quality of wheat grown in the Wairarapa.[82]

Results for arable crops highlight the relevance of accounting for crop management, which can be seen as a representation of farmer tactic adaptation in response to climate change impacts. For example, the change in timing of crop growth in an agricultural system (e.g. spring crops as maize or winter crops as cash crop wheat) might imply different exposure to seasonal temperature in climate. In addition, insights into the importance of soil types, and how they are represented in biophysical simulations, are also key results from analysis. Specifically, soil with low water-holding capacity will be naturally more prone to the increase in

[82] Leftfield pp42

drought conditions but final outcomes depend on management aspects (e.g. use of irrigation and changes to sowing dates).

Finally, inter-annual variability was shown to be a key metric to consider when analysing arable systems because some impact variables, such as N leaching losses, could be more affected by extreme events without necessarily large changes in median values. For example, the magnitude and frequency of high N leaching events might increase if high rainfall amounts occur more often before cash crop establishment (early in the autumn/winter season).

In terms of production, consistency again is vital. The direction of the industry is towards higher value products such as moving from animal feed to human consumption products. Consistent availability and application of water helps to achieve better milling grades. It will also form a sound basis for alternative products such as vegetable seed and other similar products that are being experimented with.

Horticultural industry

A boutique region, Wairarapa has just 2.6% of New Zealand's land under vine and contributes 1% (4500t) of New Zealand's total production from just over 1000ha in grapes. There are over 20 vineyards in three main sub-regions in the area, Martinborough, Gladstone and Masterton. These sub-regions share a similar climate and soil structures yet offer subtle differences in character.[83]

Around 60% of the table olives in New Zealand are grown in the Wairarapa at around 4.9 tonnes.
With 50,000 trees planted this equates to a planted area of around 160ha. Of these only around 5,500 are actively managed.[84]

Fresh vegetable and berry production in the Wairarapa is small. Currently there is only around 12ha of berryfruit within the Wellington/Wairarapa region and 154 ha of fresh vegetables, the largest single crop type by area is brassicas.[85] Due to the pea weevil incursion Wairarapa has not grown peas for the last few years. Prior to the pea growing ban, the area grown was around 1200ha.[86] They have been replanted this year for the first time.

For wine grapes, noting the effect of climate change on phenology may require a change in cultivar to grape varieties adapted to warmer climate. One area of concern is the compressed time for fruit growth and the implications for sugar content and ultimately wine quality. Tactical adaptation may require controlling the vegetative/floral balance through winter pruning, or additional pruning in summer (Clothier et al. 201287). However, the warmer climate may also open new areas suitable for wine grape

[83] Leftfield, pp35
[84] Leftfield pp 37
[85] Leftfield pp 39
[86] Leftfield pp 44

[87] Adapting the horticultural and vegetable industries to climate chance (Brent Clothier, Alistair Hall and Steve Green
https://www.mpi.govt.nz/dmsdocument/4059/direct

that were previously too cool, though there would have to be significant change. The Martinborough region is dominated by pinot noir varieties with the climate not yet being able to compete with Marlborough for the production for export of Sauvignon Blanc.

The situation of the viticulture industry has been static in the last decade and it is looking for its next breakthrough. The water profile of different varieties is very different. Sauvignon Blanc, for example, is very thirsty, red varieties less so. The industry sees its next stage of growth potentially in events and food matching designed for tourists and visitors. Water supply, assuming current levels of availability, is not going to be a major concern in the next decade.

Thought is being given to the possibility that the changed climate may lend itself to high value crops in the Wairarapa such as kiwifruit and avocados. Significant plantings of these crops could transform the area, but would completely change the water demand profile of the horticulture[88] and fruit industry, both being thirsty crops. Leftfield talk of hops, pipfruit and summerfruit, vegetables for export, noting that these are not all possibilities simply because of climate change and may have been possible anyway.

Dryland agriculture

Dryland farming can be defined as farming in areas where evapotranspiration exceeds rainfall, and there is no irrigation to support such deficits.

While greater water resilience can be achieved in Wairarapa, there are limits, especially in the extensive eastern hills location. While there are isolated patches of bore water available such as at Wainuiouru, farmers will increasingly have to practice forms of dryland farming.

Dryland farming is practiced on the Wairarapa valley floors and hill country. In recent years research on dryland farming has increased significantly. Dr Derrick Moot, professor of Plant Science at Lincoln University has led research teams looking for solutions to the vulnerability of dryland farmers, particularly those on the east coast of New Zealand. He recognised that the combination of water and nitrogen that is required to increase dry matter production, but the problem for many hill country farmers is that water is scarce and regulations around nitrogen use are tightening as a result of its extensive use.

Moot has advocated the use of lucerne, as an alternative to traditional ryegrass and clover, because it is deep rooting and fixes its own nitrogen from the air. Pastoral farmers commonly start their ewes on hill country early in the season in a dryland format. However, as the lambs grow they are transferred to pastures on the valley floor that are more productive due to irrigation or various moisture retention practices.

The science around dryland farming has significantly advanced in recent years and has the potential to become a significant part of agricultural practice in the Wairarapa. Dryland farming is about best use of the water available and its year-to-year availability. There are various techniques for retaining water on sloping ground such as cutting contours into the slopes and building nano dams to slow run-off. Water can be captured in dams that can also be used for stock water. Strategic tree planting of hill country, not just for shelter, but to hold water in the soil and to shade the land from the drying effects of high temperatures are all part of the equation.

Tree planting has many advantages of retaining moisture, slowing run-off and protecting rivers and streams from sediment loading. Carbon farming is inevitably going to become a real option where dryland stock farming is not sufficiently profitable to make it viable.

Addendum 7: Characterising the urban challenges

This addendum comprises background resilience assessments of each of the councils of the Wairarapa.

Masterton District Council (MDC)[89]

Water Use Optimisation

Masterton is going through a transition not only with regard to its water supply, but in terms of economic and population growth. Unlike many rural centres in New Zealand, Masterton is experiencing growth and many of the challenges of growth. Masterton comprises the largest urban area in the Wairarapa, but also has a large rural hinterland by area, but not by population. It is a service centre for the whole of the Wairarapa as well as its own immediate hinterland.

Demand and supply

The Council is considering the future of its water supply – rural and urban. Its planning takes account of climate change assessments which the council sees as a combination of more and longer dry spells and weather events of greater intensity.

The Council anticipates a reduction of water demand by as much as 20% over the next five years. This will be the result of the:

(i) installation of meters (which is currently 70% complete) - charging through meters will commence by 2022, and

(ii) the identification and remedying of the leakage of water which is estimated to be over a third of that treated.

Roughly half this loss is from faulty council infrastructure and half from broken pipes, taps and other fittings malfunctioning and simple neglect by home-owners. The Council spends around $1.6m a year on repairs and upgrades to pipes and has improved the situation, but the scale of the problem is significant. The town has 190 kilometres of supply pipes, but 40% of these (in 2013) were classified as in poor condition.

Beyond five years it is expected that demand will settle and grow at about 1% a year, which doesn't sound a lot until it is considered that is 32% over 20 years during a period when water availability will be under greater pressure. No significant new large users are expected in that timeframe, including in the Carterton Industrial Area just over the river from Masterton, part of which is serviced by MDC.

Masterton is not fully using its consented allocation. They are using between 11,800 and 14,400 cubic meters a day out of a consented total of 40,000 cubic meters per day (the lower usage figure is winter average daily demand, the higher figure is summer average daily demand). At

[89] Information in this section supplied by Masterton District Council

present MDC doesn't use half the water its consented so could be classed as an inefficient allocation depending growth needs etc.

At present, the full amount of Masterton's supply is drawn from the Waingawa River and that is expected to continue although constraints to take at low flows may strengthen as a result of the PNRP and WIP requirements to reduce to human health needs and stock use below minimum flows. Consideration is being given to some form of water storage facility to increase the amount to be stored and the feasibility on that requirement will be done over the next 3-4 years. Other options include taking supply from the proposed community water storage reservoir at Wakamoekau, constructing a dedicated storage reservoir at the treatment plant or drawing from groundwater. Either way, more water will be required when the rivers are low during summer in the period beyond five years out.

Rainfall harvesting is being considered for domestic dwellings, but is not regarded as a significant contributor to efficiency or demand management. Council is giving consideration to rainfall tanks with new builds such as is being done in Kāpiti. The volumes of water are low and as a result it doesn't help a great deal with summer dry if the water is to be used for watering gardens, etc. Large scale use of tanks is an expensive solution compared to large bulk storage.

Wastewater and stormwater

Masterton's wastewater is treated and is disposed of to land and river. The current regime involves treated water being released to the river in the winter when flows are high and there is high dilution. During the summer approximately 90% of the treated wastewater is sprayed on land and used to grow feed for animals. Techniques are employed to ensure there is no contamination and regular testing is undertaken. The system is designed and consented to avoid waters entering aquifers.

Like other towns in Wairarapa there are significant soak pits around Masterton and storm water is currently absorbed into those soak pits. One in 10-20 year flows would saturate soak pits and the water goes directly into the river through 200 discharge points. There is one main stormwater system in the CBD.

Water races

Water races in the Masterton area, like other parts of Wairarapa, are more than 100 years old. They are relatively cheap to run and effective for what they are intended. In terms of providing stock water, they are not an efficient water distribution system in an age of efficiency, but as discussed elsewhere, they have other values which could offset their utilitarian deficiencies[90].

Resilience measures

MDC's principal water resilience foci is on efficiency and storage. Once the leakage

[90] Refer Chapter 9

problems are minimised the Council will be looking for other efficiency gains in such areas as water supply network management which could include pressure management and replacement of leaky mains. Re-use of treated effluent and planting are strategies that will be considered, with efficiency of use principles being applied to the irrigation of parks, sports fields and management of swimming pools. Optimising efficiency through pricing is a complex matter but will receive greater attention in the near future once the installation of smart metering takes effect.

With respect to Masterton District's water resilience, their 2018 LTP states:

> *"We need to be able to store more water in order to meet increased demand from a growing population, provide safeguards against any future changes to resource consent conditions and provide greater resilience in times of drought. To address this, we will investigate options for deep water bore(s) or reservoirs for urban areas and raw water dams. The LTP includes a provision of $100,000 in 2020-21 for investigation, and a further $5.6 million over 2023-25 to complete the work. The consequence of not undertaking projects to increase our water supply resilience is that Masterton will not having a secondary drinking water supply that is separate to our main supply. Causes of using a secondary supply could be, a natural event e.g. earthquake, infrastructure failure, or water supply contamination."*

The 2021 Draft LTP allocates an amount of $7m.

Looking ahead

The Council believes there needs to be an active resilience narrative – why it is important and what priorities the Council needs to consider. The next opportunity to consider these matters is the upcoming review of the Long Term Plan, part of which is the Water Supply Asset Management Plan. This will consider such matters as long term supply and the source of supply, plus efficiency and resilience measures.

Carterton District Council (CDC)[91]

As with other councils in the Wairarapa, there are challenges facing Carterton District Council's ability to meet future water needs. Changes in the management of urban supply that may arise through the Government's Three Water Initiative could result in fundamental changes for the Council. Other considerations are economic and population growth, the prospect of larger water users wanting to enter the district, particularly in the Waingawa industrial area[92] and pressure on water supply generally.

Carterton District comprises a large and productive rural area and a significant and

[91] Al information in this section was supplied by the Carterton District Council

[92] Note, reticulated water is supplied to Waingawa industrial area by MDC, not CDC.

growing town with pressure for lifestyle blocks on the town fringes. Carterton has a significant older population of retirees and this population is likely to increase. The Council currently provides water to 2,500 households.

Demand and supply

On the basis of current demand projections, Carterton will require an increase in urban supply within 10 years and the Council is looking to resolve what that might be by 2028. It will require an additional water source, either surface or groundwater. Current supply is roughly 50/50 with reliance on surface water in the wetter times of the year and reverting to groundwater in the dry period. Further surface take is unlikely due to lack of volumes in adjacent rivers. Incremental increases in demand are being met by development of the current bores, but there is a limit to this supply. Carterton is not fully using its consented allocation. They are using roughly 2,500 cubic meters a day out of a consented total of 5,000 cubic meters per day.

Where there is an immediate supply problem, is in meeting the morning and evening spikes in demand. This is because Carterton has very limited storage to even out these peaks. To help resolve this situation, their emergency storage capacity is in line for upgrading from just 12 hours at present to four days by constructing eight storage tanks during the 2020/2021 year.

Wastewater

Treated wastewater is currently discharged from treatment ponds into the Mangatārere Stream when consent conditions enable them to do so, as well onto land through an irrigation system during dry months. The current capacity of these ponds is just 65,000 cubic metres.

A new pond complex is being built that will boost storage capacity by a further 200,000 cubic metres. This will allow water to be held for an extended period when ground conditions are not suitable for land irrigation, principally in winter when the soil is saturated. Once, the land irrigation area is significantly extended, it's expected that stream discharges will reduce to discharges considerably. The Council's long term goal is to remove all discharges of treated wastewater from Mangatārere Stream.

Stormwater

There is limited stormwater reticulation in Carterton. What is there is open channel and open swale. The town absorbs most of its stormwater as it is built on natural soak pits. There are some flooding risks to the west of the town in the Lincoln Road area, but they are limited.

Infrastructure

Carterton District Council regards itself as having a good knowledge of the state of its water supply infrastructure which is generally in good condition. There is a project to improve the main pipe in the main street. Especially since metering was introduced, levels of leakage are not as high and are being reduced over time as infrastructure is replaced or upgraded.

Smart meters were installed in 2020 across the urban network, and the data from this will assist the detection of losses as they arise. Early results have identified around 75 low level constant flows.

Large users

There are limited large users in the district. Premier Beehive, a bacon and pork processing factory is one of those and it makes significant demand on wastewater system. JNL's wood processing factory are also large users but they take their supply from Masterton's municipal supply which is much closer to their location.

The demand from large users of the future is in the Council's mind. The most likely location is the industrial area on the Waingawa adjacent to Masterton, in which case supply is likely to come from Masterton or storage in the vicinity. There may also be future light industrial development to the south east of the town.

Water races

There are two water race systems in the Carterton District. These pose challenges for the Council. The existing consents for supply into these races expire in 2023. The races feed into what is deemed by the Greater Wellington to be modified waterways that now have natural characteristics and biodiversity. The Proposed Natural Resources Plan provisions place significant limits on the disturbance of riverbeds which makes maintenance of the races difficult.

The contribution of water races to stock drinking water remains important and the amount that is contributed to groundwater is unknown.

Resilience issues

Growth of the town is planned to be to the east rather than the west. This is drier and more stable land. The conversation on resilience of these new developments is a live matter. For example, the future use of rainwater harvesting will be considered through the District Plan Change process to open up this area for residential development. The growth of lifestyle blocks is also a matter of discussion as there is a moderate level of demand, which may continue as the Wairarapa benefits from migration from main centres such as Wellington of people looking for lifestyle benefits. This will also be considered in the upcoming review of the District Plan. It is expected that lifestyle block development will not be connected to urban water and wastewater services.

South Wairarapa District Council (SWDC)[93]

South Wairarapa, unlike the other two councils of the Wairarapa, incorporates three urban areas – Greytown, Featherston and Martinborough. These towns, though not greatly distant from each other, are in different geographic and climatic areas. Martinborough, in particular, is in a drier

[93] Information supplied by South Wairarapa District Council

area of the valley compared to the other two.

This portion of the Wairarapa has sustained significant population and economic growth in recent years from tourism and weekend visitors from Wellington. The Martinborough economy had a major boost back in the 80s and 90s with the development of the vineyards and this has flowed through into a significant visitor industry.

It would be fair to say that each of the towns has grown to the point that their water-related infrastructure has come under pressure and while some upgrading has been undertaken, more is required off a small rating base, to ensure the level of resilience expected by residents. This means that there is a limited capacity for dealing with shocks to the system.

Demand and supply

On average, 4.1 million litres of water is supplied per day to Greytown, Featherston, Martinborough and Pirinoa with a combined resident population of about 7,200 - on average about 569 litres per resident each day. Households use about 64% of the total supply with industry, businesses, schools, hospitals, the fire service and councils consuming the rest.

Demand for water has grown steadily with the growth of the population and economic activity, especially in the warm summer season. Water is supplied to these towns largely from bores. The Featherston and Greytown systems are linked.

Featherston has three bores with a fourth being installed, whereas Greytown supplements bore water with takes from bores adjacent to the Waiohine River but is dependent on river flows which are low in summer. Summer demand can spike by as much as 4.15 million litres per day in the summer above a year round average of 13.4 million litres per day (a 30% increase) at a time when water availability is under pressure.

South Wairarapa is not fully using its consented allocation across its three supplies.

- Waiohine (Featherston/Greytown) WTP – currently limited to 2,400m³/day but consented for 5,184m³/day.
- Memorial Park (Greytown) WTP – currently limited to 1,800m³/d but consented for 5,184m³/day.
- Ruamāhanga (Martinborough) WTP – currently limited to 2,400m³/d but consented for 4,320m³/day.

The constraining factor is water treatment plant capacity - the short term focus has been on ensuring quality more than quantity.

With minimal storage, there is little buffering of demand for Featherston and Greytown, which puts the supply system under pressure when there is sudden increase in demand. Plans are being made to incorporate a reservoir to reduce this vulnerability by providing 2-3 days buffering.

Martinborough has slightly more buffering, but historical factors mean it has overly

complicated arrangements such as a treatment plant on one side of the town and a reservoir on the other. There is also a small supply system at Pirinoa with 20 or so connections.

Martinborough draws its water from four bores. Its supply suffers from naturally-occurring manganese contamination. A recently installed plant to extract sufficient manganese to allow chlorination, will make the water quality more acceptable. Martinborough's consent to use the bore water expires in 2025 as a result of the Whaitua requirements, and this is yet to be renegotiated.

Historically the vineyards have been supplied from the town supply (a separate unchlorinated supply), but notice has been given to them that they will have to find alternative sources which will involve creating their own bores. This is likely to come up against the problem of over-allocation of groundwater, characteristic of this and many areas of the Wairarapa and will likely involve greater draw off in the summer months. Water use in Martinborough increased substantially in summer spiking up by as much as 2.8M litres per day above a summer medium of 1.3M litres per day - an increase of 215%.

Characteristic of the Wairarapa generally, leakage from the domestic supply systems is substantial. A 2020 Wellington Water Ltd report put Greytown's leaks as up to 69% (16.6 litres per second) Greytown. Steps are being taken by the Council to gradually remedy this problem, the most significant of which is the introduction of metering which helps identify where the leaks are located so they can be repaired or replaced.

South Wairarapa District Council recently tried to float a proposal with central government for financial assistance to install residential tanks for harvesting of rainwater. Regrettably, the request was denied. While the unit cost was high, the opportunity to build awareness with residents of the need for efficient use of water was lost.

The Council has however signed a memorandum of understanding with central government, allowing it to access $2.84 million in funding for water projects, to be completed by the end of March 2022.

Metering

South Wairarapa district's towns are now fully metered which is a foundation contribution to improving water use efficiency. At present, residents have a high 'free' allowance of water which means meters are not yet playing a significant role in building community awareness of water use efficiency. Further positive steps on this matter are being considered as part of the upcoming Long Term Plan. They will also help identify leaks and monitor large users.

Wastewater

As with other councils in Wairarapa, South Wairarapa fully treats its wastewater and sprays 90% of its treated effluent onto land. With three towns (and a small scheme at Lake Ferry) in its area, each has

its own wastewater system, making the overall cost very substantial. The council is in the process of applying to Greater Wellington for a new consent for the Featherston wastewater treatment plant to build a new plant. This will require significant investment. Cut and carry crops are grown on the land sprayed with treated effluent. Issues arise if the land gets too saturated leading to ponding; sufficient storage therefore needs to be provided to avoid this situation.

Stormwater

Stormwater in the district is largely unmanaged. Apart from some curb and channelling in the towns stormwater either finds its own way into streams and rivers or is directed into soak pits. Swales are used to direct the stormwater and it is not treated, raising concerns of contamination as the communities increase in size.

Water management

Since October 2019, South Wairarapa District Council has opted for a management arrangement with Wellington Water, whilst retaining the ownership of the assets itself. In a sense, the Council has effectively taken a first step in what may be a major reshaping of water management under the emerging Three Waters programme of central Government. This is the only Wairarapa Council to so far use an external agency to manage its three waters.

Addendum 8: Characterising industrial water use

There is a limited number of industrial scale plants in Wairarapa and most relate to the availability of raw materials in the region, or at least started from that premise. Because they are related to primary production, they are by and large significant water users and future production systems that might migrate to the region would also likely be significant water users.

The plants that are in the region are significant employers and are very important to the economy but also to the community providing a balance to the workforce[94]. We investigated water use for four of them as a sample of industrial use in the area:

- **JNL** – 370 jobs - includes those in the plant and contractors in the forests
- **Premier Beehive** – 300 staff in Carterton (varies seasonally). Beehive is the largest employer in Wairarapa
- **Breadcraft** – 92 staff plus a further 15 temporary staff
- **Cabernet Foods** – 70 staff in Carterton

Collectively these enterprises are small water users but represent significant employment in the region.

JNL

JNL is a wood processing company with a largely export focus, though it is growing its domestic market share. Producing sawn and engineered timber it is just like farming enterprises in the respect that production systems like theirs rely on stability, consistency and predictability, so control over their water use is vital. JNL is gradually building its water re-use capability with the objective of moving as close to self-sufficiency as possible. This involves treating water, settling out particulates and installing a reverse osmosis capability (which is currently being explored). They are also minimising the amount of waste leaving the plant.

At present, JNL receive water through the Masterton District Council reticulation system and that which they don't re-use is treated then sprayed onto land to support the growth of a nearby forest, which will eventually be millable. They currently use 250,000 to 300,000 litres of potable water per day.

Premier Beehive

Premier Beehive is a bacon-producing enterprise with a national market. They are well established in Wairarapa and see themselves as an integral part of the community. Their water consumption is about 3.38 litres per second. They have a daily consent of 200 cubic metres (1,400 per week), which they consistently use most days. Their annual consent is for 75,000 cubic metres, last year they used around 58,000. Usage is constant through the year and just varies with production.

[94] All data in this section has been supplied directly by the enterprises themselves

They are looking to reduce water use through staff education and process improvement. They have a current internal water treatment plant and are investigating new treatments – mainly to impact on discharge. Water can be re-used to a limited extent but is dependent on quality.

Their main concern is discharge as it includes high sodium levels (salt) and they are looking for solutions. Carterton District Council is concerned about this discharge. The irony is that if water discharge is reduced through conservation, sodium levels in the discharge are higher.

Breadcraft

Breadcraft is a major bread producer which distributes bread around the lower North Island.
Their water use varies quite a bit throughout the year depending on how busy they are. For the past couple of months (mid 2020) they have been using about 125m^3 of water per month. Which equates to about 4,100 L/day.

Their source for water is Masterton District Council, which in turn comes from the Waingawa River. They use water for production and cleaning. Their supply is suitable and reliable with no uncertainty about continuity of supply.

Cabernet Foods

Cabernet is a major provider of premium meat, based in Carterton. It is a family business which has been operating since 2002, building on a long history of farming in Wairarapa. They use bore water and consume 60 cubic metres per day, mainly for plant and processing hygiene to meet licensing obligations under the Animal Products Act.

Cabernet report that the current resource consent rationale prohibits business security. The uncertainty of low river flows will not enable a business to process and market animal protein within MPI regulations or to satisfy customer supply security concerns.

The company has installed additional water recovery tanks and reviewed water recovery initiatives but advises that initiatives that reduce water use will take away any ability to grow the business.

Conclusions

There are other major industrial users such as Higgins Contractors. They too are of a similar size and usage to these enterprises and are all significant employers in the region.

As a conservative estimate, these larger enterprises employ in total in excess of 1,000 people. They represent both primary and secondary earners in local families, but are critical to maintaining a population and occupational balance to the region.

All these enterprises are concerned about a reliable water supply (in terms of both quality and quantity) which is fundamental to their production systems. There is also the very important question of future industrial users and their potential

contribution to the Wairarapa economy. At present, water reliability poses a constraint on some new industries setting up in the region or existing ones expanding their operations.

Addendum 9: Characterising amenity use

The more intensively populated areas of Wairarapa are some distance from the coast, so river and lake-based amenities are important. Rivers are popular for swimming in the summer months and both Lakes Wairarapa and Ōnoke are used for recreational purposes for activities such as walking, boating and some other water sports. Their shallow nature doesn't lend them to the range of activities common on deeper lakes.

Walking and cycling trails are already in existence and significant extensions and enhancements are planned or underway. Rivers in particular, have high amenity values in the minds of people in Wairarapa.

While uses by mana whenua of the rivers could not be termed amenity use, they are nevertheless important and are dealt with elsewhere in this Strategy.

Henley Lake

Henley Lake[95]is integrated into the water systems of the region. Construction of Henley Lake, the site of a former quarry and prior to that a pā site, and its surrounding margins was initiated in the 1960s and completed in 1991 for recreation and wildlife purposes. Water is taken from the Ruamāhanga River via a gravel weir and a 1200 metre artificial channel. A culvert and control penstock is used to regulate the flow into Henley Lake. The penstock remains open at all times other than during heavy rainfall and high river flow events. Te Ore Ore and Hiona Streams also flow directly into Henley Lake.

The lake has three discharge points. The northern most discharge point distributes water to a wetland area. The southern-most discharge point distributes water to a wetland area. The only direct discharge back to the Ruamāhanga River is from the main spillway between the northern and southern discharge points. Nevertheless, there is likely to be some seepage from the two wetland areas into the Ruamāhanga River.

Currently, the PNRP provisions require the take from a river to cease when it reaches minimum flow. However, the Whaitua Committee considered that this a "non-consumptive" take, and on these grounds recommended Greater Wellington investigate whether water could be provided for below minimum flows.

At present, Masterton District Council only recharges Henley Lake when the river is high which means there is no recharging in the dry summer months. This has implications for amenity use as the water quality deteriorates during the summer due to the lack of flushing limiting its use. If climate change results in lower river flows, especially in summer, then this may have a direct impact on amenity uses.

[95] Information supplied by Masterton District Council

Lake of Remembrance

The Lake of Remembrance in nearby Queen Elizabeth Park suffers the same challenges. It receives a large portion of stormwater from the Masterton CBD throughout the year. The quality of that water together with the lack of summer flushing is likely to pose problems for the Masterton District Council.

Addendum 10: Characterising the future of Wairarapa

The following scenarios of the future are intended to bring together economic, social, cultural and environmental considerations and speculate on the likely future of Wairarapa and what it might look like and have informed the Water Resilience Strategy. There are two types of scenarios for consideration. There are scenarios for the future of Wairarapa more broadly and there are scenarios around the future of water use and management. The two are closely related.

The recently published *Draft Wellington Regional Growth Framework* 2021 highlights the anticipated population growth of the broader region of between 91,000 to 151,000 over the next 30 years, of which Wairarapa will experience at least its share and possibly a little more than its share. The Framework also highlights resilience issues. It describes one of the region's "key moves" as to "encourage a more sustainable, resilient and affordable urban form that makes efficient use of existing infrastructure and resources"[96]. The Framework also makes climate change adaption and mitigation key aspects of its focus. These considerations are part of this chapter.

Characterisation of the future begins to throw light on future demand and best use. There are wider trends that are impacting on Wairarapa. This draws on a paper prepared for Masterton District Council by a company named Tattico, Environmental Scan, (24 April 2020):

1. **Megatrends** – globalisation, urbanisation, equity and empowerment, technology, climate change
   While these may be international in their nature, all of them speak to the experience in Wairarapa.

2. **Political** – local impacts
   a. Trend to a focus on community wellbeing
   b. High-level of local collaboration
   c. Commitment to community engagement
   d. Post-treaty settlement opportunities
   e. Strengthening iwi relationships

3. **Social and cultural** – local impacts
   a. Growing population
   b. An ageing and a youthful population
   c. Growing urbanisation
   d. Areas of deprivation
   e. Affordability and availability of housing
   f. Poorer mental health outcomes
   g. Growing Māori population
   h. Increasing ethnic diversity

4. **Economic** – local impacts
   a. Growing regional economy
   b. Diversifying regional economy
   c. Connectivity to Wellington

[96] "Draft Wellington Regional Framework" 2021 pp25

    d. Deficits in education and training for young people

5. **Environmental** – local impacts
    a. Climate change impacts
    b. Freshwater regulatory changes

With these prompts in mind it can be assumed that there is a range of resilience issues faced by the region besides climate change pressures. Drawing on this and other information and data, the following scenarios are an initial attempt to build a composite picture of Wairarapa and what that will do to water demand and responses to climate change.

Scenarios like this are very subjective and everyone will have their own views. It is very easy to reject scenarios as being purely speculative and that is true, but such rejection can amount to an unwillingness to face-up to the challenges of the future.

These scenarios emerge from an essential idea that quite apart from how water availability Wairarapa will play out, a rural/urban separation of interests may emerge (unless the separation is carefully managed), where a traditional agricultural identity will gradually give way to a growing urban identity. This tension may not be able to be managed and will just find its own level, although decisions around water use and availability will be a significant factor as to what scenario emerges most strongly.

A robust response to climate change, that is, a Water Resilience Strategy, will require community wide support, rural and urban.

Here are the scenarios:

1. **The two-speed food and service-based growth economy**
    On the one hand, Wairarapa would comprise a verdant valley floor, extensively watered during the hot summer with reliable water. The dry hills and coastal strip would be devoted to dryland farming. This rural activity would support specialist food production and manufacture with a strong artisan economy and growing tourism (internal and international). It is expected this would require a high level of investment in environmental mitigation to minimise adverse effects of intensive high value (not necessarily dairy) farming in the valley.

    On the other hand, Wairarapa would also comprise a significant segment of the population working in tertiary and quaternary services in Wellington and Palmerston North and living in Wairarapa, or working and living in Wairarapa but deriving their business from outside Wairarapa (largely Wellington).

    This two-speed economy could grow quickly with a sense of buoyancy and economic progress. It would likely experience conflict between the two interests – a rural community wanting water and an urban or lifestyle community wanting some water, but more particularly, an exemplary environment.

    Water demand/supply – this is a high water-use scenario. There will be rural demand for irrigation and urban demand for domestic water.

Arguably a more prosperous community could invest more of its net worth in environmental protection, but rural/urban tensions would likely be high over who carries the responsibility for resilience.

2. **Sophisticated lifestyle-focused rural/urban community** - this scenario identifies Wairarapa as a lifestyle destination. The rural sector has a major role to play in the future of Wairarapa in this scenario, not necessarily just in its current form but perhaps as a more quality-focused and specialised economy including production and processing and making moderate additional demands on water availability and especially reliability for the production of food. However, its impact would be selective and tightly managed.

   Wairarapa would also continue to build an urban and lifestyle profile, but rather than the strong technology and service thrust of scenario one, the development would be balanced with an emphasis on retirement and relocation of high-net worth people into the region, rather like Central Otago, but more accessible.

   The emphasis would be on quality of life, a slower rural pace of life and an attractive rural and urban environment.

   Water demand/supply – a more sophisticated and less acquisitive regional population will be savvier around water management. They will place a lower value on high water-using enterprises to process primary products and be very aware of environmental values.

3. **Urban-overflow** – this scenario suggests that the future of Wairarapa is as an urban-based region in a rural setting. The core of economic growth will be in tertiary and some in the quaternary sectors providing a good lifestyle and living experience at a moderate cost. There will be moderately priced housing, and access to good quality food and services such as health and education. People with gravitate there as a counterpoint to the rapidly rising cost of living in the city and house prices.

   This urban population will have some environmental concerns, but they will be primarily pre-occupied with an urban way of life. Growth will come from urban industries as an extension of Wellington and to a lesser extent the Manawatū, providing middle-range support and servicing jobs. They would be pleased to have a growing rural sector which would contribute to the rates base and the cost of local services. In short, the rural and urban sectors would bump along together in a satisfactory manner each getting most of what they want.

   Water demand would grow from the rural sector in response to climate change and from the urban sector in response to population growth. There would also be demand from new industries which would provide employment for urban dwellers such as processing industries and (particularly domestic) tourism.

Water demand/supply – increasing demand from residential use, although overall demand will be moderate as new urban users will become more efficient users and affordability will be a factor. Rural demand will be significant as current land use patterns will tend to predominate.

4. **More of the same** – this scenario essentially postulates retention of the current 'shape' of the Wairarapa economy and environment by the augmentation of water into areas where climate change is producing deficits, or highlights loss or leakage from the system that creates deficiencies. There will be deficits in agriculture and domestic supply, but because it will remain a predominantly rural-dependent economy it will make significant demands on water.

   Water demand/supply – increasing water demand principally due to climate change and falling supply due to WIP recommendations. Eventually a point of crisis will be reached, first in the rural community but increasingly in the urban community as well. A balance between productive use and environmental priorities will have to be found and neither will be happy.

5. **The hybrid** – the most likely scenario is a combination of bits of a number of those scenarios outlined above. What might this 'hybrid' look like? What would be its demands on water? Changes won't be instantaneous but measured over the years.

Whatever the scenarios are that we select as the most likely, they will have implications for water resilience.

What are the experts telling us? Infometrics predicts slowing population growth after a period of increase in the last few years and the next one or two. Certainly, there are no indications from them that there will be an increase in natural fertility and in a post COVID era, after the flood of kiwis coming home has subsided, it is likely that immigration rates will be lower than in the last 5-10 years. This means that significant population increases could only be the result of internal migration – people leaving cities like Auckland and Wellington for a rural or a lower cost lifestyle.

We believe the most likely trend, and what we have based our resilience assumptions around, is an increasingly urbanised rural population. That would be more urban dwellers and rural people with urban expectations. There would also be significant growth in a professional group working remotely and being domiciled in Wairarapa for lifestyle reasons. These two groups will dominate the local culture. The things they have in common are strong lifestyle values and being strong on environmental values. Their lifestyle would be dependent on a strong economy which will need water. They will have enough in common to find a collaborative solution to water resilience challenges.

For a resilient community, Wairarapa ideally needs to have a diverse population

profile. It would be stronger with a deeper labour market and to take advantage of professional people seeking lifestyle values and bringing their jobs with them or commuting to Wellington for them. A balanced community needs a broadly-based skill set so that trade and semi-skilled people would be a great advantage to support local enterprises. Food is likely to be a continuing foundation of the economy, but service industries will too.

A water resilience policy may need to take account of the following:

- An urban-styled population with strong support for environmental values to preserve the unique character of Wairarapa. A rural population also with environmental sympathies balanced with prosperity concerns.
- Strong support throughout the community for water resilience following on from the recent drought and the prospect of further droughts in the future. Everyone is affected. This is likely to include support for water storage within an environmental context.
- Greater population of remote workers connected to Wellington and other centres, making Wairarapa the heart of their lifestyle and expecting to have water.
- Provision for increased visitor populations who would support the contemporary businesses such as hospitality and retail and who would also expect access to water.
- This visitor population would be moderate water users but high non-consumptive users – recreation and sports. Wairarapa is likely to continue as a visitor destination with a lifestyle rather than an adventure flavour.
- Provision for business growth such as larger food processing businesses would be required to support the economy and balance the populations. Such enterprises would likely be high water users – they will derive more value from local product further up the value chain and support prosperity through local employment.
- Provision for increased population on the urban fringes and on lifestyle blocks which will produce a significant semi-rural population with a rural location but an urban mentality.

Perhaps the major take-out from this discussion is that there is a strong base on which to build a mission-driven campaign around water resilience premised on a single idea – maintenance of an attractive lifestyle combining prosperity and environmental values.

Addendum 11: Characterising the Ruamāhanga Whaitua

The principal piece of work on water management of recent years is the Ruamāhanga Whaitua Implementation Programme (WIP)[97]. It is the foundation document for the management of land and water in the Ruamāhanga catchment. It involved a wide range of stakeholders and was debated in depth over four years before the current report was resolved.

The WIP does not provide all the answers to catchment management and there are some real challenges for the Greater Wellington and local entities in implementing many of its recommendations, however it advanced considerations significantly. In some cases, further decision-making processes will be required. The WIP provides the context within which further decisions are considered. Key sections of the WIP, as well as other background information, are presented here. This is no substitute for reading the WIP itself.

The WIP sets out the new approach towards "catchment thinking" (see above "Integrated Catchment") and increased resilience and identifies the direction and degree of change and the new mechanisms, objectives, limits, targets, methods and timeframes required to achieve that change. The requirements of the WIP, once in effect, will have a significant impact on the character of the region.[98]

For individuals and the community this means (in the words of the WIP): *"Implementation and compliance will require new costs, new work programmes and changes in practice that will inevitably affect some parts of the community more than others. It is anticipated that the new limits and management requirements proposed in this document will drive changes in land use, require additional funding from ratepayers and demand an "all in", whole-landscape, whole-community approach to achieving freshwater objectives."*[99]

"Doing nothing is not an option; our environment and economy are in danger of declining and we must find alternative ways of managing our catchment to ensure that future generations inherit a vibrant catchment, environment and lifestyle."[100]

The WIP sets out the water management challenges facing the Whaitua. It describes the existing state and recommends the extent of improvements

[97] All material in this chapter is drawn from the Ruamāhanga Whaitua Implementation Programme Greater WellingtonGWRC August 2018

[98] Greater WellingtonGWRC has been criticised for not having a comprehensive implementation programme for the WIP. This programme is still emerging.

[99] WIP page 17, http://www.gw.govt.nz/assets/Ruamāhanga-Whaitua/Final-Ruamhanga-WIP-August-2018-Pdf-version.pdf

[100] WIP page 8, http://www.gw...govt.nz/assets/Ruamāhanga-Whaitua/Final-Ruamhanga-WIP-August-2018-Pdf-version.pdf

required. It recommends management options to achieve these improvements. In particular, the WIP recognises the special relationship mana whenua has with the Ruamāhanga catchment.

Challenges identified in the WIP

The Ruamāhanga catchment is highly modified, and in many places degraded. It does not meet some of the cultural, social, environmental and economic expectations and needs of the Wairarapa community. In particular:

- The natural state of rivers and lakes is such that that low flows occur in the rivers that harm the ecology and natural habitat, affecting the use of the rivers for recreation and cultural purposes; climate change is likely to be contributing to this already.
- Mana whenua values and interests are not well recognised in the current water management system
- The reliability of water supply for town and rural supplies, are decreasing
- The current water allocation mechanism is not the most efficient or equitable method
- Use of water in the urban or rural settings is inefficient i.e. leaks, absence of latest technologies, traditional land uses etc.
- In some places, water quality fails to meet national objectives and community expectations for swimability.
- Water quality fails to meet the national bottom lines in Wairarapa Moana (Lake Wairarapa, including its wetland margins and connecting waterways) and Lake Ōnoke.
- As the effects of climate become more pronounced, this will exacerbate flood events, droughts, water reliability and habitat loss.

Existing water quality, as measured against the National Objectives Framework (NOF) banded framework, is shown in the appendices to the WIP alongside the desired quality (and shown as freshwater objectives). Where the existing state is shown as band D or E, this is below bottom lines. In these tables the desired water quality is shown in the freshwater objective column. In all cases the water quality must at least be in the same band as the existing state, or it can be better (as required by the National Policy Statement for Freshwater Management - NPS-FM).

The WIP notes that water quality has changed little over the last 20 years. Trends are small or inconclusive. There are some improving trends (again small), particularly in the main stem of the Ruamāhanga River. These are primarily related to a shift in discharge of treated sewage effluent from directly into the river to land disposal in Masterton and Carterton.

More recent research by Snelder 2017 notes: “The most notable trend in the Ruamāhanga catchment was in water clarity – 60% of sites showed an improving ten year trend and no sites showed a degrading trend. Lake Wairarapa showed improving trends for total phosphorous and total nitrogen and Lake Ōnoke

showed improving trends for total phosphorous and clarity.[101]

What the WIP is seeking to achieve?

The WIP (Chapter 4) identifies a broad range of freshwater objectives for streams, rivers and lakes that will apply up to the mid-century when climate change effects can be re-evaluated e.g. effects on minimum flows.

These objectives can be broadly summarised as follows:

- Water quality for recreation needs to improve across the whaitua so that waterways are swimmable. This includes improving the state of Escherichia coli (E. coli) in all river FMUs so that at least a National Objectives Framework (NOF) state of "C" is achieved by 2040
- Periphyton and macroinvertebrate health is improved in many streams and rivers, including to ensure that all water bodies meet the national bottom line for periphyton by 2040
- By 2050, sediment loads reaching waterways are substantially reduced in order to contribute to improving macroinvertebrate and indigenous fish health in streams and rivers and to improving ecosystem function and mahinga kai values in lakes
- The health of indigenous fish communities is improved in all water bodies, including to ensure that mahinga kai and cultural values are provided for
- The natural character of streams, rivers and lakes is restored, including to ensure there are healthy macroinvertebrate native fish and plant communities in these water bodies
- The health and resilience of Lake Wairarapa and Lake Ōnoke are improved, including to ensure all national bottom lines are met and the trophic level index state of both lakes is improved

The WIP policy packages

The WIP proposes three policy packages to improve water quality. They are:

2. **Discharges and land use**
    - Load limits for contaminants
    - Sub-catchment planning
    - Farm environment planning
    - Riparian planting
    - Storm water discharge

3. **Rivers and lakes management**
    - Slowing water down across the whaitua
    - Restoration of Lake Wairarapa and Lake Ōnoke
    - Restoration of the connection of the Ruamāhanga River to Lake Wairarapa
    - Creation of wetlands
    - Enhancing the natural character of rivers, including by aligning flood management processes

4. **Flows and water allocation**
    - Enabling attenuation and storage
    - Ensuring minimum flows

[101] Recent work by Snelder 2017 "Analysis of water quality trends for rivers and lakes in the Wellington region", followed up by the Greater WellingtonFairbrotherGWRC Fairbrother report of June 2017 "Are we meeting our environmental outcomes in the Ruamāhanga Catchment".

- Capping total allocation amounts from all water bodies
- Requiring takers of Category A groundwater to fully cease takes of water at minimum flow
- Further investigation of Category A groundwater takes
- Ensuring the protection of small streams at low flow through more clearly setting minimum flows
- Reducing the amount able to be taken as a permitted activity
- Updating all resource consents
- Reviewing conditions for resource consents to take water at appropriate intervals

What do we take from the WIP for a resilience strategy?

The WIP has comprehensively addressed the question of allocation of water to the environment (as distinct from users) and the protection of its quality as a regional asset. In so doing, it has drawn some bottom lines which are regarded by many as tough and by others as necessary. These are bottom lines to protect the environment, not necessarily bottom lines for resilience. The two are related but are not the same thing.

The WIP represents something of a breakthrough in the zero-sum argument with respect to water between community utilisation and production values and environmental protection values with the recognition that both imperatives can be jointly managed to a common goal. The legacy it has left us includes:

- The WIP is a strongly consensus-based and stakeholder-engaged document, establishing this as a credible methodology.
- The use of catchment committees in this process helped establish them as vital elements in water management.
- It addressed the whole system, not just parts of it.
- It strengthened the link between land use and water quality.
- It added strength to emerging more environmentally sensitive practices such as the application of treated effluent to land rather than into rivers.
- It recognised the contribution to contamination from rural and urban sources.

Essentially, the WIP identifies what (and why) needs to be addressed, not so much how (and exactly when) it should be implemented; Greater Wellington's Natural Resources Plan will provide the statutory mechanism for enacting these actions. The WIP also does not say who or how it should be funded or in what order. As such, it did not identify an action plan or transition process from many of the current practices to new practices without significant adverse outcomes to lifestyles, livelihoods and prosperity. This action planning is a key future challenge of which the resilience strategy is part.

Relevant WIP recommendations

The Whaitua Implementation Programme (WIP) compromised more than 100 recommendations. The following lists just

the key recommendations[102] (or relevant parts thereof) as they pertain to this strategy i.e. those that are directly applicable to the potential solutions and their implementation:

Recommendation 1

Greater Wellington will:

- Support mana whenua as active partners in the management of the Ruamāhanga whaitua

Recommendation 5

The Ruamāhanga whaitua integrated land and water management system should:

- Seek to be a comprehensive, catchment-wide system that increases ecological and social health and wellbeing as well as improving water use reliability
- Create resilience to the pressures of changing weather systems under climate change

Recommendation 11

The Committee recommends that:

- GMP be emphasised and innovation fostered as part of every farm plan and by the operational practices of Greater Wellington and territorial authorities in the whaitua
- Industry guidelines are the primary source of GMP guidance
- All sectors, including the three waters sector, actively design and progressively implement GMP, not just the primary sector
- Greater Wellington develops partnerships with industry, stakeholders and communities for supporting the implementation and adoption of GMP

Recommendation 12

... water use efficiency be improved among all water users in the Ruamāhanga whaitua, including by:

- Local councils (as suppliers of water) improving water conservation by residential, commercial and industrial users, establishing appropriate demand management strategies during water shortages, improving resilience and reducing demand in issuing of consents for new builds and subdivisions, and investigating opportunities for water re-use
- Group and community water suppliers appropriately managing demand during water shortages and supporting improved resilience of supply
- Irrigation users meeting at least 80% efficiency of application and further improving practices through recognised programmes
- Greater Wellington recognising that exceptions to the "80% efficiency of application" requirement may be appropriate where the financial return from a less efficient water application can be shown to be high (i.e. the water use is highly economically efficient) or where there are meaningful benefits for the environment in a less efficient water use, effectively offsetting the benefits of being 80% efficient
- Greater Wellington and territorial authorities working together to develop long-term plans for the management of water races in the

[102] The wording of some recommendations has been shortened where it doesn't affect the intent of the recommendation.

Ruamāhanga whaitua that meet the objectives of this WIP and provide for the values of the water bodies and communities
- Increasing education opportunities across types of water users

Recommendation 58

Greater Wellington works with territorial authorities on a suitable permitted activity rule for the irrigation of wastewater to farm land. This should include conditions on the standard of the discharged effluent, discharge rates and timing, and any restrictions on where this irrigation should occur.

Recommendation 70

To improve water supply reliability, the Ruamāhanga whaitua integrated land and water management system should:

- Integrate multiple management options for water retention, including attenuation, storage and harvesting at a range of scales, and efficient use in the long and short terms, rather than be dependent on any one mechanism
- Actively promote attenuation of water in soils, wetlands, lakes and groundwater systems across the catchment
- Ensure an equitable approach to improved water storage and water use efficiency by both rural and urban users

Recommendation 71

... recognises the importance of the role of attenuation of water in soils, wetlands and lakes and their riparian margins in the whaitua to support groundwater recharge and wetland restoration and help build resilience in communities[103].

Recommendation 72

... recognises the benefits of multiple mechanisms (such as storage, harvesting, attenuation and aquifer recharge) that increase resilience and water reliability of supply.

Recommendation 73

... provide for circumstances where water may be taken at higher flows for purposes wider than storage e.g. aquifer recharge.

Recommendation 74

... investigates integrated solutions to water reliability. These should include integrating storage, harvesting, attenuation and managed aquifer recharge, and facilitate pilot projects to prove feasibility.

Recommendation 75

.... requires users of water to manage their take and use in a more equitable manner and to ensure GMP, including to:

- Seek efficiency gains when consents are renewed for all water use activities
- Promote small-scale storage on urban and rural properties in order to increase resilience and to encourage everyone to take part in improving water use efficiency
- Require takes from directly connected groundwater to reduce and cease at times of low flows in rivers in the same

[103] The following recommendations also make reference to the need for an increase in riparian plantings, namely; recommendations 3,4,17,24,29, 44, 54 with respect to providing biodiversity corridors, slowing water and thereby helping decrease sediment loads, decreasing in-stream temperatures, and lowering nitrate and phosphorous loads in particular.

way that surface water takes are managed
- Require community supply takes to do more to reduce take at minimum flows, while protecting the ability to take water for people's health needs
- Reduce water race takes at minimum flows to only the water required to provide for people's domestic needs and stock drinking needs

Recommendation 76

…. the PNRP to provide for "non-consumptive" takes. Consideration will need to be given to:

- The volume of the take and discharge
- Ensuring that the efficiency of the water use is maximised in order to return a similar amount of water to the source
- Maintaining the quality of the discharge in relation to the quality of the source water
- The distance between the abstraction and discharge points
- Any net ecological benefits of the use of the water

Recommendation 103

… community water suppliers to improve water supply resilience by increasing the number of water sources, including water storage, particularly where a single source is relied on.

Addendum 12: Wairarapa Committee Terms of Reference

Terms of Reference for 2019-2022 Triennium

1. **Purpose**

   To consider areas and matters of strategic importance to the Wairarapa, and recommend to the Greater Wellington Regional Council on these matters.

2. **Specific responsibilities**

   The areas for consideration and recommendation to Council include, but are not limited to:

   - Flood protection
   - Land management
   - Biosecurity
   - Biodiversity
   - Climate
   - Public transport
   - Natural resource management
   - Broader areas of common interest to the territorial authorities and Council.

3. **Members**

   3.1 The Councillor elected by the Wairarapa constituency.
   3.2 Two other Councillors, appointed by Council.
   3.3 Three other members, appointed by Council as follows:
   a The Mayor of Carterton District Council
   b The Mayor of Masterton District Council
   c The Mayor of South Wairarapa District Council.
   3.4 Two other members, appointed by Council for each person's skills, attributes or knowledge that will assist the work of the Committee, being:
   a One member, nominated by Ngāti Kahungunu ki Wairarapa
   b One member, nominated by Rangitāne ō Wairarapa.

4. **Alternate members**

   4.1 For the members in sections 3.1 and 3.2, Council may nominate a pool of up to three alternate Councillors for appointment by Council. If one of those members is unable to attend a meeting any person from this pool may sit at the table, speak and vote in their place.

   4.2 Each territorial authority in section 3.3 may nominate an alternate elected member for appointment by Council. If an appointed member is unable to attend a meeting their alternate member may sit at the table, speak and vote in their place.

   4.3 Each iwi authority in section 3.4 may nominate an alternate member for appointment by Council. If an appointed member is unable to attend a meeting their alternate member may sit at the table, speak and vote in their place.

5. **Quorum**

   Four members, including two Councillors.

6. **Voting entitlement**

6.1 All members have equal speaking and voting rights.
6.2 Council's Standing Orders apply to the Committee; except that the Chair, in the case of an equality of votes, does not have a casting vote (and therefore the motion is defeated and the status quo is preserved).

7. Servicing

The Committee is serviced by Greater Wellington.

8. Committee consideration

8.1 Matters of strategic importance to the Wairarapa Constituency (that are proposed for consideration by each of the Climate, Environment, and Transport Committees) shall first be referred to the Wairarapa Committee or its members for their consideration.
8.2 Proposals developed by Wairarapa-focused advisory groups formally established by Council shall be considered by the Committee for direct recommendation to Council for decision.

9. Council's decisions on Committee recommendations

9.1 Council's decisions on the Committee's recommendations are reported to the Committee.
9.2 Where Council makes any decision that is materially different from the Committee's recommendation, Council's report to the Committee will set out the reason/s for that decision.

10. Remuneration and expenses

10.1 The expenses of the elected members shall be met by the council they represent.
10.2 Non-elected members (who are not otherwise being remunerated) may claim Greater Wellington's standard daily meeting attendance allowances and expenses.

11. Meeting frequency

The Committee shall meet quarterly, with additional meetings as required.

Addendum 13: Bibliography

A large portion of the data in this publication was received from individual contributors. Where this is the case the sources are footnoted in the text. This bibliography includes background publications used to build the resilience framework contained in this report.

Information and submissions were received from various parties. These are also noted in footnotes or acknowledged in the text.

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IMAGE ATTRIBUTIONS

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