Roadmap to groundwater quantity allocation limits for the West Coast region

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GLOSSARY

Attribute**: a measurable characteristic (numeric, narrative or both) that can be used to assess the extent to which a particular value is provided for.

Efficient allocation*: includes economic, technical and dynamic efficiency.

Environmental flows and/or levels*: a type of limit that describes the amount of water in a freshwater management unit (except ponds and naturally ephemeral water bodies) that is required to meet freshwater objectives. Environmental flows for rivers and streams must include an allocation limit and a minimum flow (or other flow/s). Environmental levels for other freshwater management units must include an allocation limit and a minimum water level (or other level/s).

Freshwater management unit (FMU)**: all or any part of a water body or water bodies, and their related catchments, that a regional council determines (clause 3.8) as an appropriate unit for freshwater management and accounting purposes; part of an FMU means any part of an FMU including, but not limited to, a specific site, river reach, water body or part of a water body.

Freshwater quantity accounting system*: a system that, for each freshwater management unit, records, aggregates and keeps regularly updated information on the measured, modelled or estimated:

a. total freshwater take;

b. proportion of freshwater taken by each major category of use; and

c. where limits have been set, the proportion of the limit that has been taken.

Limit**: either a limit on resource use or a take limit.

Limit on resource**: the maximum amount of a resource use that is permissible while still achieving a relevant target attribute state (see clauses 3.12 and 3.14).

Over-allocation*: in relation to both the quantity and quality of freshwater, the situation where:

a. resource use exceeds a limit; or

b. if limits have not been set, a freshwater management unit or part of a freshwater management unit is degraded or degrading.

Take limit**: a limit on the amount of water that can be taken from a freshwater management unit or part of a freshwater management unit, as set under clause 3.17.

Value*: meaning:

a. any national value; and

b. includes any value in relation to freshwater, which is not a national value, that a regional council identifies as appropriate for regional or local circumstances (including any use value).

Definitions as provided in the section ‘interpretation’ of the National Policy Statement for Freshwater Management (NPS-FM):

* NPS-FM 2014, amended 2017 (Ministry for the Environment 2017b), or

** NPS-FM 2020 (Ministry for the Environment 2020b).

MAIN ACRONYMS USED

Councils:

AC: Auckland Council

BoP: Bay of Plenty Regional Council

ECan: Environment Canterbury Regional Council

ES: Environment Southland Regional Council

Horizons: Horizons Regional Council / Manawatu-Wanganui Regional Council

GWRC: Greater Wellington Regional Council

NRC: Northland Regional Council

ORC: Otago Regional Council

TRC: Taranaki Regional Council

WCRC: West Coast Regional Council

WRC: Waikato Regional Council

FMU: Freshwater Management Unit

GMZ: Groundwater Management Zone

LWP: West Coast Regional Land and Water Plan

NES: National Environmental Standards

NPS-FM: National Policy Statement for Freshwater Management

RMA: Resource Management Act

EXECUTIVE SUMMARY

National water management regulations, in particular, the new National Policy Statement for Freshwater Management (NPS-FM 2020), direct that regional councils and unitary authorities include water quantity limits into regional plans as soon as reasonably practicable.[1]

The Ministry of Business, Innovation & Employment, through their Envirolink scheme, contracted GNS Science to provide a roadmap to groundwater quantity allocation for the development of an allocation framework for the West Coast Regional Council (WCRC).

The roadmap includes two major components: (i) the use of scientific information to delineate groundwater management zones (GMZs), assess the connectivity of groundwater and surface water and identify relevant management targets for these GMZs; and (ii) the development of relevant groundwater management policies for these management zones and targets.

The delineation of GMZs in the West Coast region could be identified with national datasets (e.g. the New Zealand Groundwater Atlas Hydrogeological-Unit Maps and groundwater discharge probability maps) supplemented with local data (e.g. bore logs, groundwater levels and river flow measurements) and new scientific information as it becomes available. Relevant WCRC groundwater management policies can be developed from other regional water management approaches in New Zealand. Therefore, this report provides review of selected regional groundwater management policies, particularly those related to water allocation and groundwater–surface water interaction in relation to the requirements of the current regulation, including the NPS-FM 2020.

Additionally, a roadmap was developed that identifies key science and policy steps towards implementation of WCRC groundwater quantity policies, including transitional processes.

A three-step approach is proposed to introduce a groundwater quantity allocation framework in the WCRC Regional Land and Water Plan: first, a framework integrating the science inputs and NPS-FM 2020 requirements is drafted; second, the draft plan is shared with the community to ensure it is understood and to verify that the proposed provisions will deliver the values that are of importance to the community and iwi; and third, the draft framework is refined to address community needs.

Overall, the proposed roadmap methodology aims to be consistent, transparent and reproductible across the region. The next steps with the groundwater quantity allocation framework will include the development of a case study in the upper Grey River Freshwater Management Unit, as part of a second study commissioned by the Envirolink Scheme.

1 Section 80A of the Resource Management Act 1991 requires regional councils to notify freshwater planning instruments by 31 December 2024 if their purpose is to give effect to the NPS-FM 2020.

1.0 INTRODUCTION

The West Coast Regional Council (WCRC) has the fifth-largest region by area but the smallest rating base in New Zealand and must deliver the same services and functions as the other regions. WCRC therefore prioritises its actions in specific topics and areas where the greatest resource pressures occur and as directed by Central Government policies (Beaumont et al. 2018).

Following the National Policy Statement for Freshwater Management 2014, amended 2017 (NPS-FM), which stated that "setting enforceable quality and quantity limits is a key purpose" (Ministry for the Environment 2017b), WCRC has made the improvement of freshwater resource quality in the region one of its main focus points. In 2018, Freshwater Management Units (FMUs) were delineated across the region. The Regional Land and Water Plan outlines the importance of the groundwater resource and its quantity to serve several recognised uses, including domestic and public water supply, stock drinking water, irrigation and industrial uses. Groundwater is further recognised as extensively sustaining surface water flows across the region. Since 2012, the demand for groundwater has doubled in the region and, while no significant negative impacts have occurred as a result of identified over-allocation, WCRC aims to improve the current management of the groundwater quantity across the region. The objective is to introduce allocation limits in collaboration with the communities to protect the freshwater resources and their community values, as per the NPS-FM requirements.

Due to groundwater technical expertise and resource limitation, the Ministry of Business, Innovation & Employment, through their Envirolink Scheme, commissioned GNS Science (GNS) to provide a 'roadmap to groundwater quantity allocation' to initiate the development of an allocation framework for the region that will subsequently lead to the introduction of allocation limits in the Regional Land and Water Plan.

During the development of the study, a new NPS-FM was released (August 2020) and is now in force since September 2020 (NPS-FM 2020), which requires that "freshwater is allocated and used efficiently" and that "all existing over-allocation is phased out, and future over-allocation is avoided." Hence, this study aims to provide a reference document for WCRC, integrating the requirement of the NPS-FM 2020, to select or develop a sound and evidence-based framework for regional groundwater allocation, by provision of:

- a brief description of the legislative background and latest developments and a literature review of groundwater quantity allocation regimes used in New Zealand, with respect to WCRC's needs (Section 3); and
- a roadmap to groundwater allocation limit-setting, with recommendation of tasks to implement in this process (Section 4 and 5).

The overall objective is to contribute to the improvement of WCRC's current freshwater management by 'capping' the current use of the regional groundwater resources to 'sustainable' limits, which will avoid future over-allocation adverse effects (e.g. drying-up of wells, reduction of stream and lake water flows and levels, deterioration of water quality, increased pumping costs, land subsidence) in an integrated approach (i.e. considering interaction with surface water bodies).

2.0 METHODOLOGY

As a first step of the study, we completed a review of the current regulatory requirements related to groundwater quantity allocation and the groundwater quantity allocation frameworks used in New Zealand, based on the information collected from:

1. National-level documentation that summarises the requirements of groundwater allocation limit-setting in New Zealand, including the NPS-FM (Ministry for the Environment 2017b, 2018a, 2020a, 2020b).
2. Regional council documents, such as regional strategic statements and regional (water) plans, that set up local allocation frameworks, e.g. Bay of Plenty Regional Council (c2020) and Environment Canterbury Regional Council (2019).
3. Other relevant documentation that could complement (1) or (2), including website information related to allocation; previous review studies, e.g. Kōmanawa Solutions (2020) and Hughes and Snelder (2018); and personal communication with regional council scientists or policy specialists.

For the purpose of the regional plans' review, a template was created to collect information related to:

- the status of the considered regional plan
- FMU and groundwater management zone (GMZ) delineation
- community and iwi involvement
- plan reference to water allocation
- environmental minimum flows and levels/limits
- groundwater and surface water interactions
- over-allocation and measures to avoid/phase-out over-allocation
- water shortage conditions
- efficient allocation and use
- water metering
- priority of use, and
- information and data (allocation maps).

The aim was to summarise the main plan provisions and provide easy access, via internet links, to source information for WCRC staff members who are interested to learn more about an aspect. Initial templates were filled out for ten regional councils and then sent to regional council staff involved in groundwater resource management for review and comments (the ten reviewed regional templates are provided in Appendix 1).

1. In a second phase, a roadmap was developed to introduce a groundwater allocation framework for the West Coast region, including recommendations for groundwater allocation zones delineation, limit setting and the development of policy and transitional processes.
2. This roadmap was built on the knowledge gathered as part of (1), i.e. the literature review, with recommendations to use the methods and frameworks that seem the most relevant according to our experience in relation to water resource management.
3. The drafting of this roadmap was also based on our knowledge of existing relevant national datasets that GNS or other research institutes developed and that could provide preliminary scientific information needed in the absence of local knowledge and studies.

3.0 GROUNDWATER QUANTITY ALLOCATION FRAMEWORKS IN NEW ZEALAND

3.1 Policy Setting

3.1.1 Freshwater Resource Management System

The legislative and regulatory instruments that influence the management of freshwater at the central government and local government levels and their connections are summarised in Figure 3.1. A short description of the main instruments is also provided in the following sections.

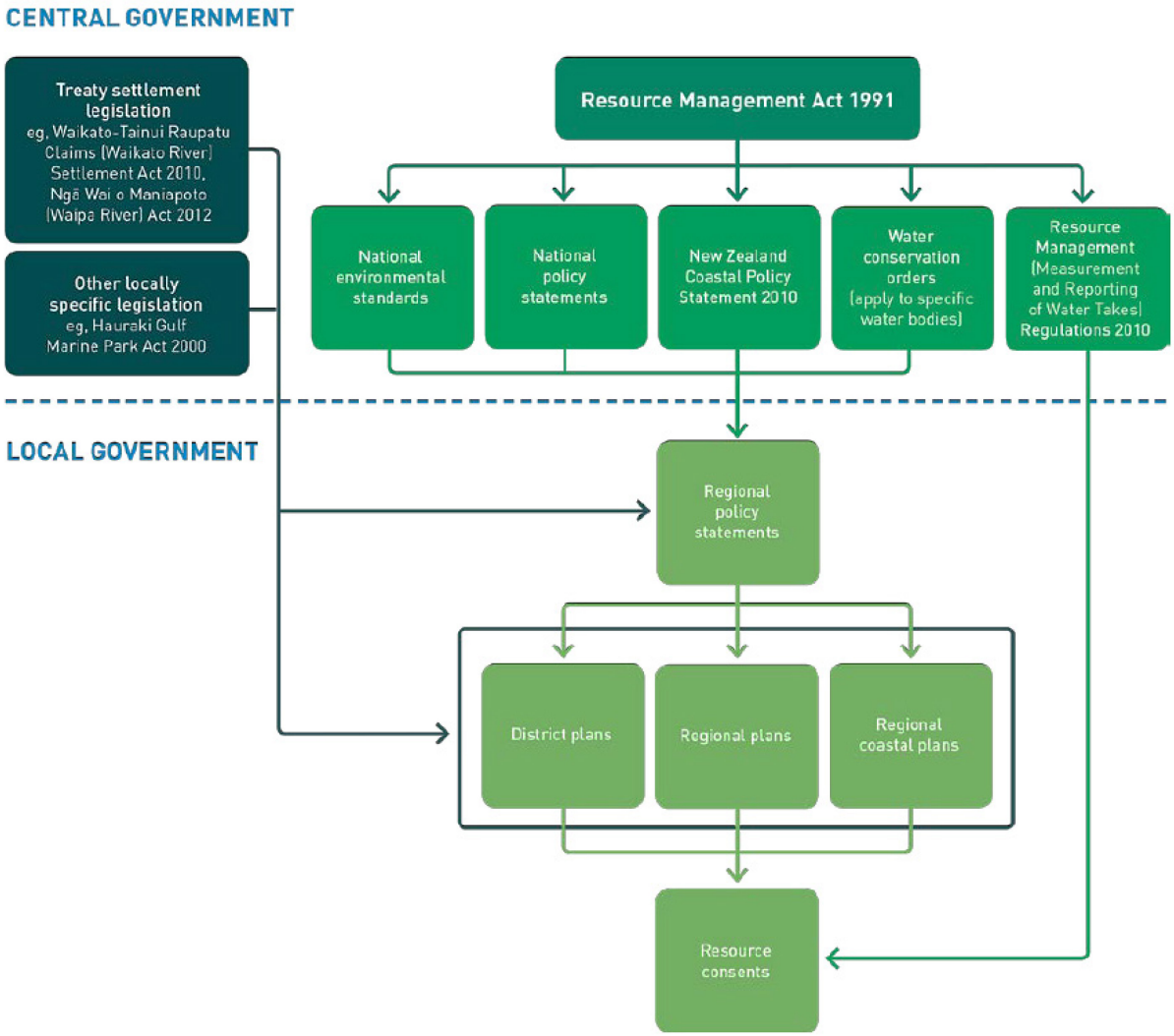

Figure 3.1 Legislative and regulatory instruments that influence the management of freshwater (Ministry for the Environment 2017a).

3.1.1.1 The Resource Management Act

The main responsibility for allocating water under the Resource Management Act 1991 (RMA; Resource Management Act 1991) is exercised by regional councils and unitary authorities. Councils specify environmental baselines and rules pertaining to how water will be shared between users under a resource consent process in regional policy statements and plans (Figure 3.1). The granting of water allocations or water permits relies on the 'first in, first served' principle and aims to avoid, remedy or mitigate adverse effects on the environment and existing

permit holders. Water permits do not constitute ownership or a property right, nor do they guarantee that the water will be available, they only confer rights to take, use, dam and/or divert water subject to the water availability (Ministry for the Environment 2004).

Abstraction can be limited by water conservation orders in certain circumstances for water bodies considered to be of national significance and that hold 'outstanding values' (see Section 3.1.2.2).

3.1.1.2 New Directions for Resource Management in New Zealand

In July 2020, the Government released the most comprehensive review of New Zealand's resource management system since the RMA was passed in 1991. The review report, New Directions for Resource Management in New Zealand (Resource Management Review Panel 2020), was commissioned by Minister for the Environment David Parker and prepared by an independent review panel, led by retired Court of Appeal Judge Tony Randerson QC, after extensive consultation (Parker 2020). One of its recommendations consists of replacing the existing RMA with two separate pieces of legislation, a Natural and Built Environments Act (NBEA) and a Strategic Planning Act. According to the review panel:

- the NBEA would take "a substantially different approach from the RMA" and "would focus on enhancing the quality of the environment, housing and achieving positive outcomes to support the wellbeing of present and future generations"; and
- the proposed Strategic Planning Act would embed integrated spatial planning across all regions of New Zealand. It would set long-term strategic goals and help integrate legislative functions across the resource management system, including the proposed NBEA, the Local Government Act, the Land Transport Management Act and the Climate Change Response Act. This will allow a broad range of matters to be reconciled to ensure better future planning, including for infrastructure and housing (Parker 2020).

The Resource Management Review Panel (2020) also recommends that "the NBEA should retain the current allocative functions for resources in the RMA" and makes the following proposition in the matter of allocation:

> *"To enable sustainable, efficient and equitable allocation of resources, the Natural and Built Environments Act should adopt a more balanced approach to the prioritisation of existing users in resource consent processes. This includes:*
>
> *(i) encouraging shorter permit durations, with flexibility to provide longer-term permits for major infrastructure*
>
> *(ii) providing stronger powers to review and change consent conditions*
>
> *(iii) providing for a wider range of matters to be considered in consent renewal processes*
>
> *(iv) providing powers to direct common expiry of permit terms."*

3.1.2 National Policies and Standards

3.1.2.1 The National Policy Statement for Freshwater Management

Background

National Policy Statements (NPS) are issued by central government to provide direction to local government about how to carry out their responsibilities under the RMA. The NPS for Freshwater Management (NPS-FM) applies to the management of freshwater through a framework that recognises Te Mana o te Wai as an integral part of freshwater management and directs the content that regional councils, in consultation with their communities, should include in their regional plans (Ministry for the Environment 2020a).

The first NPS-FM came into effect on 1 August 2014, which was amended in August 2017 (taking effect on 7 September 2017). In August 2020, the NPS-FM 2014 (amended 2017) was replaced by the NPS-FM 2020 (taking effect on 3 September 2020).

The NPS-FM 2020 furthers some of the requirements of the NPS-FM 2014 (amended 2017) (Table 3.1). For example, the NPS-FM 2020 introduces a hierarchy of obligations for the management of the freshwater bodies: (1) the health and wellbeing of water bodies; (2) the health needs of people; and (3) the ability of people and communities to provide for their social, economic and cultural wellbeing.

Requirements of the NPS-FM 2020 in Regard to Water Quantity Allocation

Introduction

The NPS-FM 2020 (Ministry for the Environment 2020b) consists of four main parts: Part 1 provides some 'Preliminary provisions', Part 2 introduces the 'Objective and policies', Part 3 provides guidance for 'Implementation' and Part 4 details 'Timing and transitional'.

Regarding water quantity allocation, the main requirements of the NPS-FM 2020 are to:

- Avoid over-allocation by setting up:
  - objectives, minimum flows/levels and allocation limits; and
  - targets to reduce over-allocation (if needed).
- Provide for efficient use and allocation.

Preliminary Provisions

The 'Fundamental concept – Te Mana o te Wai' and its encompassed six principles (Figure 3.2) are defined, as well as a hierarchy of obligations (see above) and frequently used terms (see Glossary).

Of interest to this study, the NPS-FM 2020 provides more guidance on how "to use the best information available at the time", e.g. to use:

> *(a) 'if practicable, complete and scientifically robust data';*
>
> *(b) 'In the absence of complete and scientifically robust data, the best information may include information obtained from modelling, as well as partial data, local knowledge, and information obtained from other sources …'*

For (b), preference is given to the “greatest level of certainty”, yet:

> *“a person who is required to use the best information available at the time must not delay making decisions solely because of uncertainty about the quality or quantity of the information available'; and (b) if the information is uncertain, must interpret it in the way that will best give effect to this National Policy Statement.”*

Policies

Policy 11 of the NPS-FM 2020 directly applies to the allocation of water quantity:

> *“Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided”.*

Other policies provide more general guidance but are also relevant to water allocation and limit setting, e.g. Policy 1 (Te Mana o te Wai framework), Policy 2 (tangata whenua involvement and Māori values integration), Policy 3 (integrated management), Policy 4 (integrated response to climate change), Policies 6 and 7 (prevention of loss of wetland and river extents, respectively), Policy 14 (monitoring and reporting) and Policy 15 (community social, economic and cultural wellbeing coherent with NPS-FM).

Implementation

Three subparts of Part 3: Implementation provide guidance to give effect to the objectives and policies of the NPS-FM 2020: Subpart 1 guides the implementation to give effect to Te Mana o te Wai; Subpart 2 sets out the National Objective Framework for Freshwater Management (NOF) and Subpart 3 sets out additional requirements.

Subpart 1, ‘Approaches to implementing the National Policy Statement’, sets out how to give effect to Te Mana o te Wai (e.g. by applying “diverse systems of values and knowledge, such as mātauranga Māori, to the management of freshwater”) and requires regional councils to develop long-term visions for freshwater (expressing “what communities and tangata whenua want the FMU, part of the FMU, or catchment to be like in the future” with “ambitious but reasonable” goals and achievable timeframes). In addition, local authorities must work with tangata whenua (e.g. in identifying Māori freshwater values in the NOF process) to avoid inconsistent decisions with any relevant iwi participation legislation. Freshwater management approaches have to be integrated, ki uta ki tai, to recognise the interconnectedness of the whole environment (from the mountain to the sea) and interactions “between freshwater, land, water bodies, ecosystems, and receiving environments”. Decision-making about mechanisms to involve tangata whenua in freshwater management and in preparing action plans should be transparent (e.g. regional councils record the matters considered for the decisions reached and promptly publish them).

The NOF, as described by the NPS-FM 2020 (Ministry for the Environment 2020b), includes ‘water quantity’ (defined as “the extent and variability in the level or flow of water”) as one of the five biophysical components considered to contribute to the freshwater ecosystem health and also considered as compulsory values (Appendix 1A). Of particular relevance to this study, the NOF process (Figure 3.3) recommends setting environmental flows and levels (Section 3.16) and identifying take limits (Section 3.17).

"3.17 Identifying take limits

…..

(4) Take limits must be identified that:

(a) provide for flow or level variability that meets the needs of the relevant water body and connected water bodies, and their associated ecosystems; and

(b) safeguard ecosystem health from the effects of the take limit on the frequency and duration of lowered flows or levels; and

(c) provide for the life cycle needs of aquatic life; and

(d) take into account the environmental outcomes applying to relevant water bodies and any connected water bodies (such as aquifers and downstream surface water bodies), whether in the same or another region."

Water allocation is described in Subpart 3 (specific requirement), with a strong focus on efficiency allocation and water use:

"3.28 Water allocation

(1) Every regional council must make or change its regional plan(s) to include criteria for:

(a) deciding applications to approve transfers of water take permits; and

(b) deciding how to improve and maximise the efficient allocation of water (which includes economic, technical, and dynamic efficiency).

(2) Every regional council must include methods in its regional plan(s) to encourage the efficient use of water."

The NPS-FM 2020 also directs regional councils to operate and maintain a 'freshwater quantity accounting system' in its implementation section. The level of maintenance should be based on the significance of the FMU quantity issue and information made available in a 'suitable form' to the public.

"3.29 Freshwater accounting systems

(1) Every regional council must operate and maintain, for every FMU:

…

(b) a freshwater quantity accounting system.

…

(2) The purpose of the accounting systems is to provide the baseline information required:

(a) for setting target attribute states, environmental flows and levels, and limits; and

(b) to assess whether an FMU is, or is expected to be, over-allocated; and

(c) to track over time the cumulative effects of activities (such as increases in discharges and changes in land use).

(3) The accounting systems must be maintained at a level of detail commensurate with the significance of the water quality or quantity issues applicable to each FMU or part of an FMU.

(4) Every regional council must publish information from those systems regularly and in a suitable form.

…

(6) The freshwater quantity accounting system must record, aggregate, and regularly update, for each FMU, information on the measured, modelled, or estimated:

(a) amount of freshwater take; and

(b) the proportion of freshwater taken by each major category of use; and

(c) where a take limit has been set, the proportion of the take limit that has been allocated.

(7) In this clause, freshwater take refers to all takes and forms of water consumption, whether metered or not, whether subject to a consent or not, and whether authorised or not."

Annual reporting on monitoring data and associated uncertainty and a five-year review (looking at the achievement of the long-term vision, NPS-FM implementation, current state of attributes in regard to targets, achievement of outcomes, ecosystem health scores, etc.) are also required by the NPS-FM 2020 (Section 3.30, 'Assessing and reporting').

Timing and Transitional

Local authorities are required to give effect to the NPS-FM 2020 by changing/amending regional policy statements and/or regional/district plans "as soon as reasonably practicable" and to publicly notify these changes.[2]

2 Section 80A of the Resource Management Act 1991 requires regional councils to notify freshwater planning instruments by 31 December 2024 if their purpose is to give effect to the NPS-FM 2020.

Table 3.1 Key requirements of the National Policy Statement for Freshwater Management, adapted from Ministry for the Environment (2020a).

Theme	NPS-FM 2014 (Amended 2017)	NPS-FM 2020
Te Mana o te Wai	• Consider and recognise Te Mana o te Wai in freshwater management. • Identify and reflect tangata whenua values and interests in the management of freshwater and in decision-making around freshwater planning.	• Manage freshwater in a way that 'gives effect' to Te Mana o te Wai through: - involving tangata whenua; - working with tangata whenua and communities to set out long-term visions in the regional policy statement; and - prioritising the health and wellbeing of water bodies, then the essential needs of people, followed by other uses.
Water quality	• Maintain or improve the overall quality of freshwater within an FMU but improve it where people recreate so that it is suitable for primary contact more often. • Operate and maintain a freshwater quality accounting system.	• Improve degraded water bodies and maintain or improve all others using bottom lines defined in the NPS. • Operate and maintain a freshwater quality accounting system.
Water quantity and allocation	• Safeguard the life-supporting capacity, ecosystem processes and indigenous species in sustainably managing the taking, using, damming or diverting of freshwater. • Improve and maximise the efficient allocation and use of water. • Avoid further over-allocation and phase-out existing over-allocation. • Enable communities to provide for their economic wellbeing, including being productive in sustainably managing freshwater quantity, within limits. • Operate and maintain a freshwater quantity accounting system.	• Allocate and use freshwater efficiently (including economic, technical and dynamic efficiency). • Phase-out existing over-allocation and avoid future over-allocation. • Identify limits on resource use (take limits) and include these limits in regional plan(s) to achieve environmental flows and levels for each FMU. • Operate and maintain a freshwater quantity accounting system.
National Objective Framework (NOF)	• The NOF is a specific process for: - identifying the values that tangata whenua and communities have for water. - using a specified set of water quality measures (called attributes) to set freshwater objectives to achieve those values.	• Expanded NOF: - Two additional values (threatened species and mahinga kai) join ecosystem health and human health for recreation as compulsory values. - Councils must develop plan objectives that describe the environmental outcome sought for all values (including an objective for each of the five individual components of ecosystem health).

Theme	NPS-FM 2014 (Amended 2017)	NPS-FM 2020
	- setting water quality and quantity limits on resource use (e.g. how much water can be taken or how much of a contaminant can be discharged) to meet the freshwater objectives over time and ensure that they continue to be met.	- New attributes, aimed specifically at providing for ecosystem health, include fish index of biotic integrity (IBI), sediment, macroinvertebrates (MCI and QMCI), dissolved oxygen, ecosystem metabolism and submerged plants in lakes; councils will have to develop action plans and/or set limits on resource use to achieve these attributes. - Tougher national bottom lines for the ammonia and nitrate toxicity attributes to protect 95% of species from toxic effects (up from 80%). - No national bottom lines for dissolved inorganic nitrogen (DIN) or dissolved reactive phosphorus (DRP; as consulted on), but there is a requirement to manage these attributes as they relate to periphyton and other ecosystem health attributes and to provide for the health of downstream ecosystems.
Wetlands and streams protection	• Protect the significant values of wetlands and outstanding freshwater bodies.	• Avoid any further loss or degradation of wetlands and streams, map existing wetlands and encourage their restoration.
Approach	• Take an integrated approach to managing land use, freshwater and coastal water.	• Adopting an integrated approach, ki uta ki tai, that recognises the interconnectedness of the whole environment, from the mountains and lakes, down the rivers to hāpua (lagoons), wahapū (estuaries) and to the sea and interactions between freshwater, land, water bodies, ecosystems and receiving environments.
Freshwater life safeguard	• Safeguard freshwater's life-supporting capacity, ecosystem processes and indigenous species.	• Identify and work toward target outcomes for fish abundance, diversity and passage and address in-stream barriers to fish passage over time. • Set an aquatic life objective for fish and address in-stream barriers to fish passage over time.
Monitoring and reporting	• Practical and affordable monitoring at representative sites. • If an implementation programme is adopted by a regional council: delivery of an annual report on implementation and a five-year review report on freshwater improvement.	• Monitor and report annually on freshwater (including the data used); publish a synthesis report every five years containing a single ecosystem health score and respond to any deterioration.

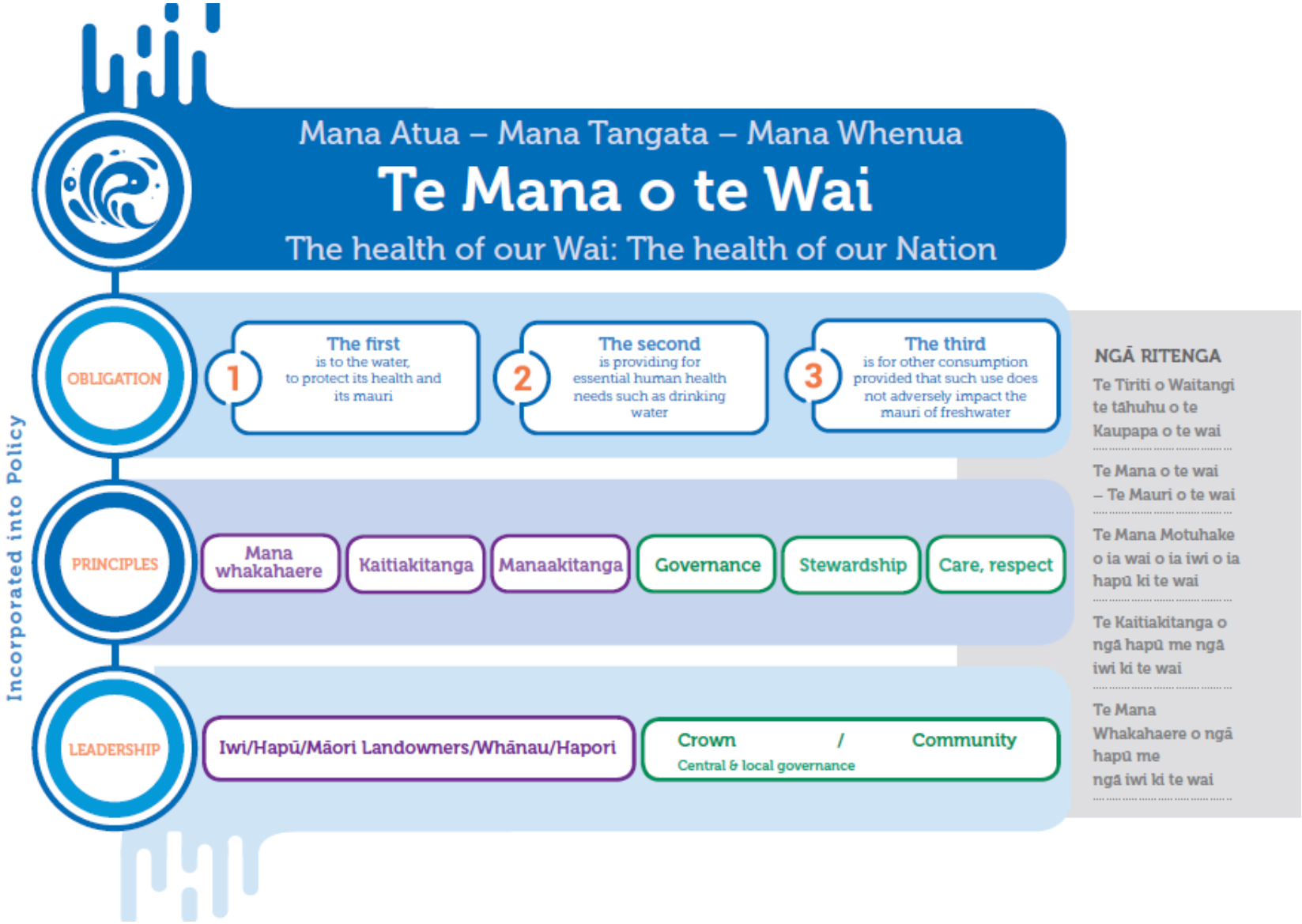

Figure 3.2 Kāhui Wai Māori overview of Te Mana o te Wai (Kāhui Wai Māori 2019).

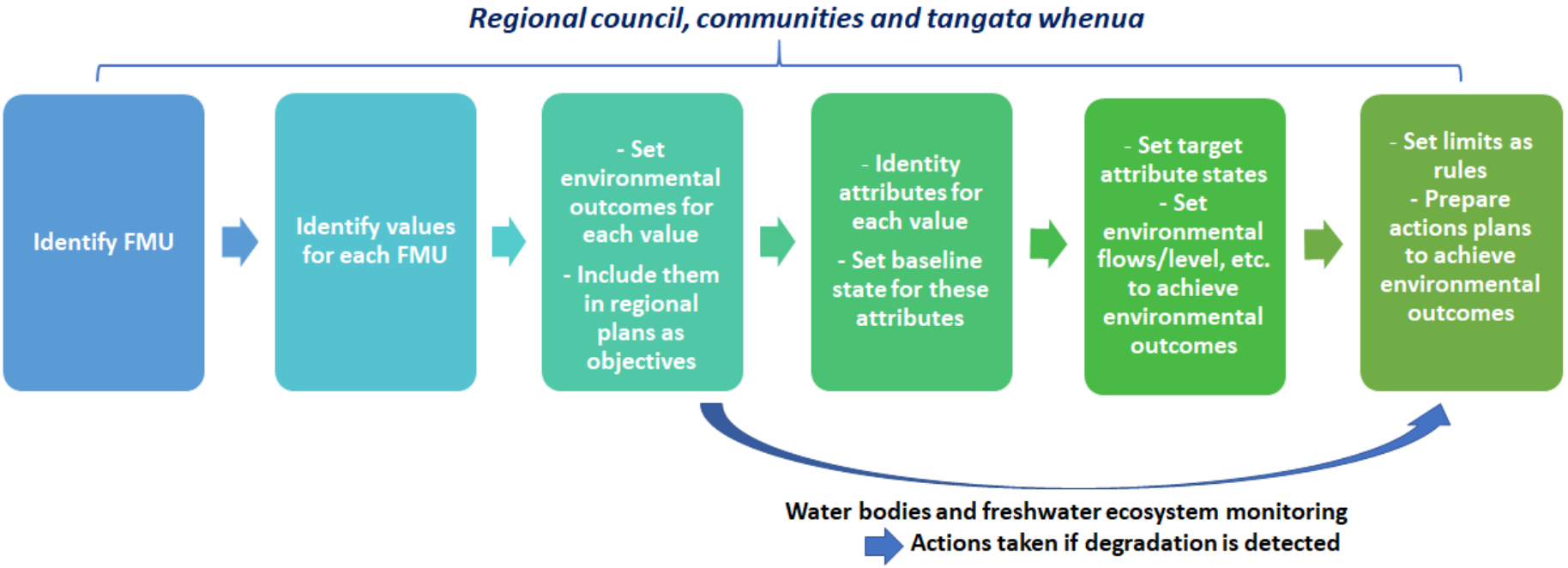

Figure 3.3 National Objectives Framework process, after Ministry for the Environment (2020b).

3.1.2.2 Water Conservation Orders

Water conservation orders aim “to provide recognition of the outstanding amenity or intrinsic values of water bodies” (Ministry for the Environment 2018b). They can be applied over rivers, lakes, streams, ponds, wetlands or aquifers and over freshwater or geothermal water. They intend to protect water body’s natural state or specific characteristics. These characteristics allow for particular values, including ecological, scenic, recreational, historical, spiritual and cultural values (some characteristics considered to be of outstanding significance, in accordance with tikanga Māori).

Water conservation orders can prohibit or restrict the issuing of new permits (e.g. take and discharge) but cannot affect existing permits. Local regulation (e.g. RPS, regional and district plans) has to be coherent to water orders provisions.

3.1.2.3 The Resource Management (Measurement and Reporting of Water Takes) Regulations 2010

The Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 (operative since November 2010) aim to improve water management by upgrading the way in which water takes were measured. These regulations introduced minimum requirements for the installation and operation of water metering/recording devices and for the transfer of data to regional councils.

Recent amendments (taking effect on 3 September 2020) introduce stricter regular measuring and reporting requirements, as, in many cases, a lack of accurate metering and irregular and poor-quality data were observed, limiting the usefulness of the data. The Regulations (amended 2020) provide a staged timeline for consent holders taking 5–20 L/s to measure their water use with a 15-minute interval, store their records and then electronically submit their records to their council daily (Ministry for the Environment 2020d).

Better water-take measurements aim to improve water-use efficiency and to gain a better understanding of how the resources respond to current abstraction.

3.1.2.4 The Proposed National Environmental Standard on Ecological Flows and Water Levels

National environmental standards (NES) are regulations (issued under the RMA by central government) that prescribe technical standards, methods or requirements for environmental matters.

The overall objective of the Proposed National Environmental Standard on Ecological Flows and Water Levels 2008 (Ministry for the Environment 2008) was to promote national consistency in assessing whether the variability and quantity of water flowing in rivers, aquifers, lakes and wetlands is sufficient. The purpose was also to set interim limits on the alteration to flows / water levels where limits were not yet imposed and to provide a process for selecting the appropriate method for evaluating the ecological component of environmental flows and water levels.

In the matter of groundwater, the proposed interim limits were:

- For shallow coastal aquifers, the greater of:
  - 15% of the annual average recharge as calculated by the regional council; or
  - the total allocation from the groundwater resource on the date that the standard comes into force less any resource consents surrendered, lapsed, cancelled or not replaced.
- For all other aquifers, the greater of:
  - 35% of the annual average recharge as calculated by the regional council; or
  - the total allocation from the groundwater resource on the date that the standard comes into force less any resource consents surrendered, lapsed, cancelled or not replaced.

Additionally, where groundwater is connected to surface water, it was recommended to apply the environmental flow / water level set for the surface water body to the management of groundwater takes.

A new direction for setting environmental flows and levels has been introduced by the NPS-FM 2020, and the Ministry for the Environment is currently "working with regional councils to determine the future of this proposed NES" (Ministry for the Environment 2020c).

3.2 Allocation Frameworks Used by New Zealand Regional Councils

Most of the regional councils have either developed regional water plans or are in the process of doing so, with a trend for the second-generation plans to merge individual regional plans (e.g. water, land, coastal) into an integrated document (e.g. the operative Canterbury Land and Water Regional Plan, the Proposed Southland Water and Land Plan). These plans present a variety of approaches in regard to water quantity allocation and related management considerations, e.g. consideration of groundwater connectivity, FMU/water/GMZ delineation, limit-setting or provisions to encourage water use and management efficiency and to limit/ avoid over-allocation. The availability of online water quantity allocation maps has also been investigated (summary in Table 3.6).

3.2.1 Freshwater Management Units Delineation

The process of delineating FMUs is underway, if not finalised, in many New Zealand regions. As no specific method is required by the NPS-FM, regional councils have adopted different approaches to allow the delineation of management units to be tailored to the local context.

For example, Northland Regional Council (NRC) has established water quantity FMUs based on water bodies' values and the sensitivity of these values to changes in levels and/or flows, while also considering an appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting purposes (Northland Regional Council 2020). NRC has identified:

- three groundwater management units: coastal aquifers, the Aupōuri aquifer and other aquifers;
- four river water quantity management units: outstanding rivers, coastal rivers, small rivers and large rivers; and
- lake/wetland management units: deep lakes (depth >10 m), shallow lakes (depth ≤10 m) and natural wetlands.

Greater Wellington Regional Council (GWRC) has delineated FMUs within five large-scale management units/catchments, referred to as 'whaitua'. A first mapping was based on a biophysical classification to delineate preliminary FMUs for rivers and streams within these whaitua. Then the 'whaitua planning process', through community consultation, allows the refinement of these boundaries by including additional factors such as human factors, e.g. cultural, social and economic (Ministry for the Environment 2016).

3.2.2 Groundwater Quantity Allocation Zones Delineation

For resource management purposes, Groundwater Management units or Zones have been delineated in most of the New Zealand regions. Delineation seems to be mainly guided by grouping hydrogeological units due to (i) their properties or physical characteristics and/or (ii) their usage or management objective(s).

Generally, the GMZs delineated by New Zealand regional councils for groundwater quantity are sub-units of larger-scale FMUs or surface water catchments. For example, in Northland, a broad water quantity FMU has been introduced for groundwater. Within this groundwater FMU, for example, the Aupōuri aquifer system is subdivided into 12 sub-aquifer units for managing water quantity (Northland Regional Council 2020). More frequently, FMUs are associated with catchments, and GMZs correspond to aquifers located within catchments, e.g. the Lower Waitaki Plains Aquifer, the North Otago Volcanics Aquifer, the Kakanui-Kauru Aquifer and the Shag Alluvium Aquifer within the North Otago FMU (Otago Regional Council 2019).

Kōmanawa Solutions (2020) recently compiled a summary of the methods used by regional council to delineate GMZs (Table 3.2). Various degrees of complexity are utilised in this process, depending on the resource and scientific knowledge available for the exercise. Most of the time, the utilisation of geological data to identify water-bearing formations (method D2) and consideration of the degree of connectivity to the surface water bodies (method D4) are utilised. Thus, Environment Southland (ES) has mapped its GMZs (Appendix A2.1) based on the areas with similar properties (method D2) and hydraulic connections (method D4).

Table 3.2 Allocation zone delineation methods, description and assessment requirements (after Kōmanawa Solutions 2020).

Delineation Method	Delineation Method Based on:	Method Description	Technical Assessment Requirements
D1	Surface water / topographic catchments	Groundwater management units aligned with surface water catchments.	Topographic contour or LiDAR-based mapping.
D2	Geological data (maps, well logs) used to define the lateral extent of transmissive material	Allocation zones aligned with spatial extent (lateral and vertical) of water-yielding geological units.	Well log, geological map. May also include aquifer test data analysis and 3D geological modelling.
D3	Groundwater flow lines	Subdivision of aquifers into smaller management units based on groundwater flow lines. These smaller units are sometimes defined to encapsulate the recharge area for one or more groundwater-dependent surface water bodies.	Groundwater contour interpolation from piezometric surveys.
D4	Degree of connectivity with surface water bodies	Several methods have been used to define allocation zones in accordance with effects on surface waters. These include delineation of alluvial aquifers immediately adjacent and closely connected to surface watercourses and delineation using stream depletion time-based criteria (e.g. area of aquifer within which stream depletion rates exceed 60% of the abstraction rate within a given period).	Collection and analysis of aquifer property data; stream depletion modelling with varying degrees of complexity (analytical modelling, deterministic numerical modelling, stochastic numerical modelling).
D5	Administrative boundaries	Defining or clipping groundwater allocation zones to align with administrative boundaries, e.g. Regional Council boundaries.	None.
D6	A combination of the above	Example: Development of a conceptual model of an aquifer system and defining allocation zone limits through consideration of geological, hydrogeological and surface water connectivity data, giving due consideration to the planning mechanisms that will be used to manage groundwater.	Combination of the above, sometimes in conjunction with expert judgement.

These methods can also be implemented with different levels of complexity. For example, the geological analysis (method D2) can be limited to the geological maps and bore logs that are available or can be furthered with the development of 3D geological models, e.g. White and Close (2016).

Often, regional councils combine the different methods listed (method D6), e.g. Auckland Council (AC) uses, in order of priority: (1) geology, (2) surface water catchments, (3) aquifer piezometric contours and (4) administrative boundaries, e.g. the boundary with NRC (Kōmanawa Solutions 2020).

In addition to the methods listed in Table 3.2, the 'baseflow protection method' was used by Bay of Plenty Regional Council (BoP) for their 'Plan Change 9' groundwater allocations[3] (White et al. 2018). Characterisation of the groundwater system used sub-regional 3D geological models to assess the distribution of aquifers, identify likely groundwater flow directions and inform the definition of groundwater catchment boundaries and allocation zones (Figures 3.4 and 3.6). Other methods to delineate GMZs use water/groundwater budget calculations (Figure 3.5), including the following components (White et al. 2013):

- P: precipitation;
- Q^{SW}_{IN}: quick flow and base flow;
- Q^{GW}_{IN}: groundwater inflow;
- ET: evapotranspiration;
- Q^{SW}_{QF}: surface water quick flow from the area (i.e. interflow and runoff);
- Q^{SW}_{BF}: surface water base flow from the area (i.e. discharge to surface water from the saturated portion of the groundwater system);
- U^{SW}: consumptive surface water use; and
- Q^{GW}_{OUT}: groundwater outflow, including consumptive groundwater use (U^{GW}) and groundwater discharge across groundwater catchment boundaries, in particular, across the coastal boundary (Q^{GW}_{COUT}).

Other methods include water/groundwater budgets with digital terrain models, e.g. the Lake Rotorua groundwater catchment (White et al. 2014), and groundwater flow models, e.g. groundwater catchments in the greater Lake Tarawera catchment (Toews et al. 2015).

3 PC9 has been withdrawn.

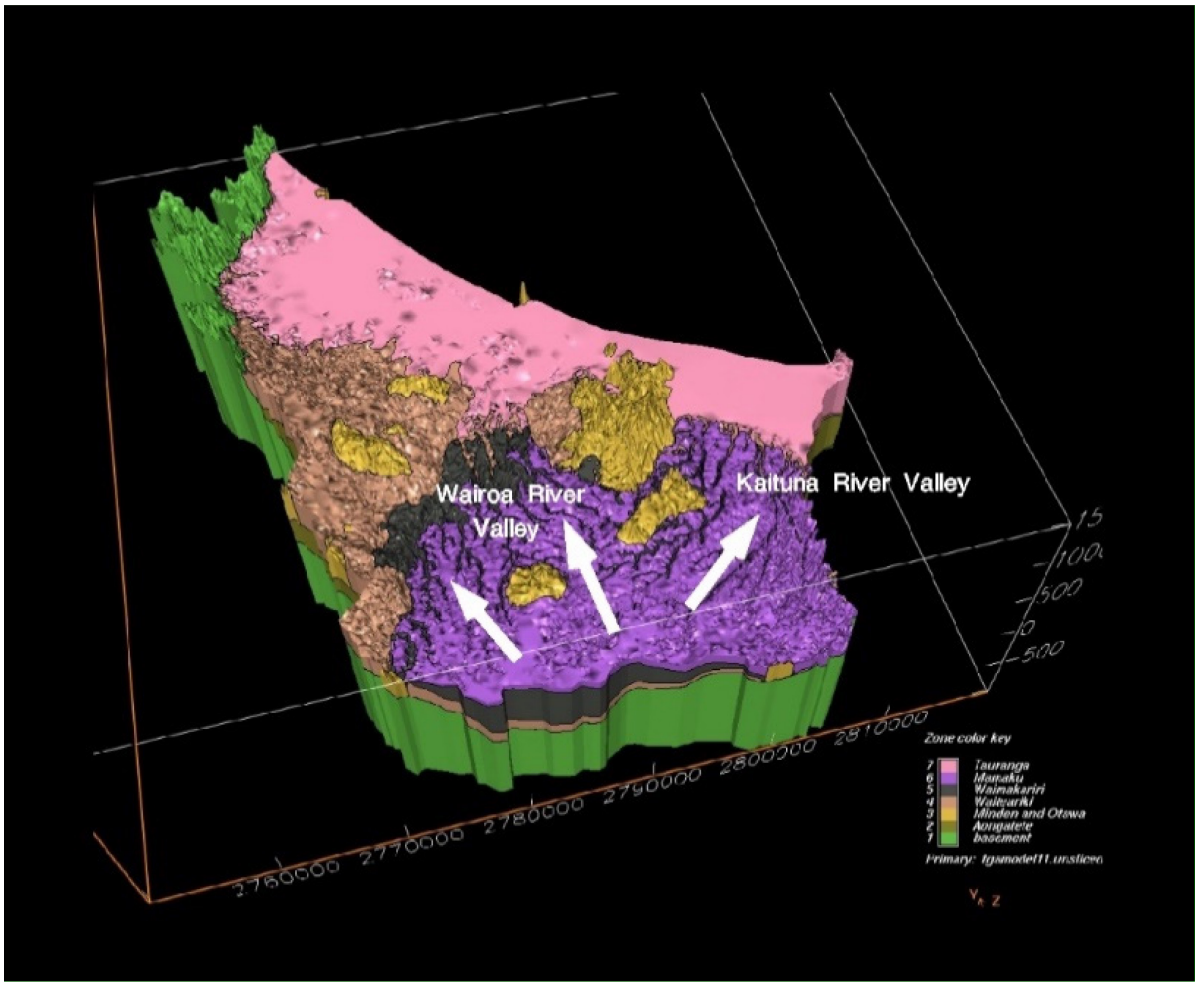

Figure 3.4 Example of 3D Geological Model developed for the Bay of Plenty region (White et al. 2009).

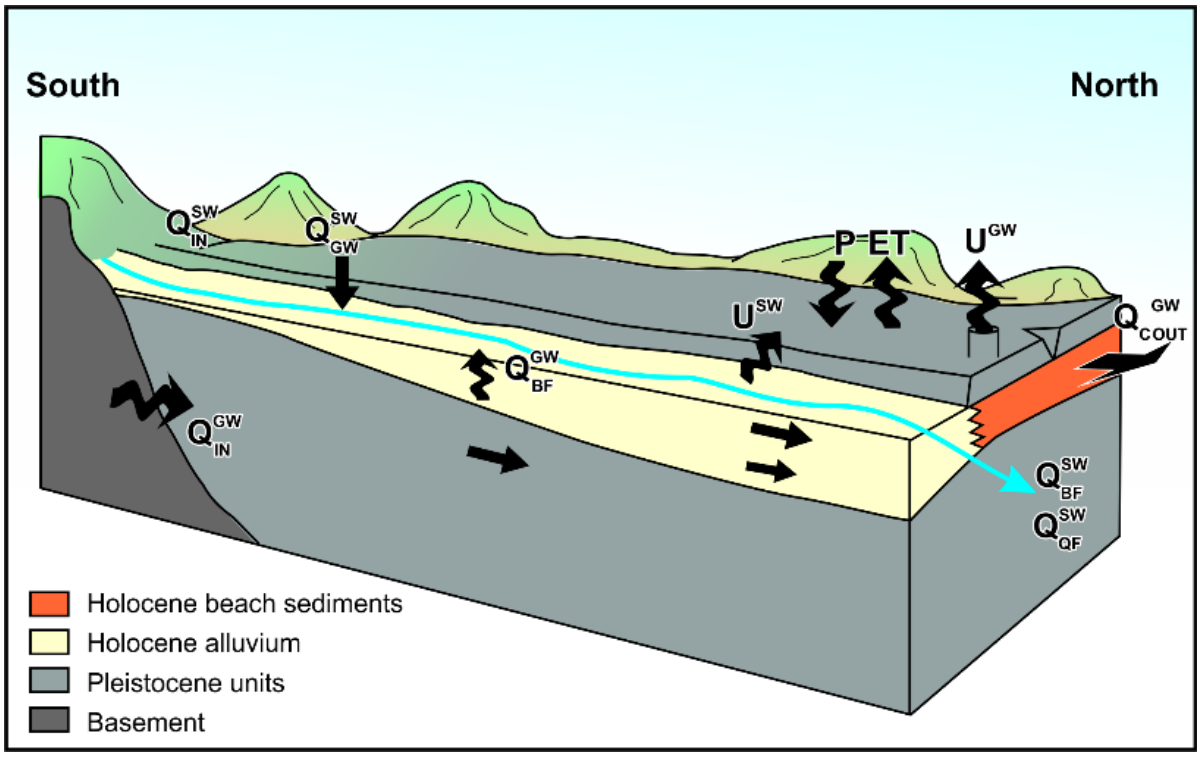

Figure 3.5 Example of water budget developed for the Bay of Plenty region (White et al. 2013).

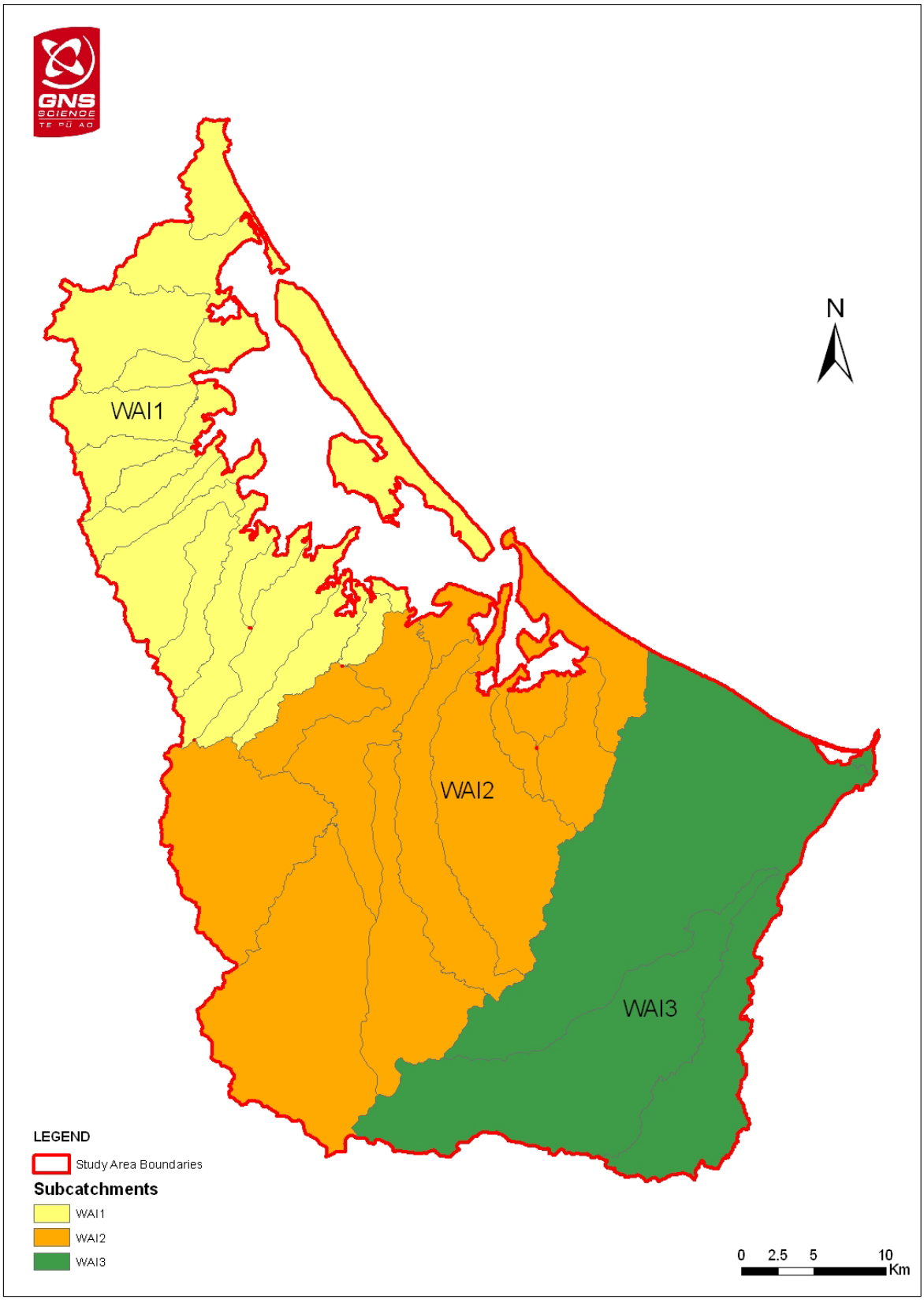

Figure 3.6 Groundwater catchments and groundwater allocation zones for the Waiteariki Ignimbrite, Aongatete Ignimbrite and Coromandel Volcanics in the Western Bay of Plenty area (White et al. 2009).

GWRC has delineated GMZs (Appendix A2.2) for the significant groundwater resources of the region by using a conceptualisation phase followed by numerical modelling work, with groundwater zones categorised based to their degree of hydraulic connection to surface water (Table 3.6 and Section 3.2.4).

3.2.3 Setting of Environmental Flows and Limits

3.2.3.1 Surface Water

A review of the methods utilised by New Zealand regional councils to set up environmental flows and limits for surface water is out of the scope of this study; however, a brief summary of the methods utilised by ten regional councils is provided in the regional templates (Appendix 1). For several regional councils, these provisions are relevant and apply to groundwater takes where there is a direct or high hydraulic connection to surface water (see Section 3.2.4). Additionally, groundwater quantity management regimes should consider the surface water and freshwater values and objectives set for the relevant FMU if aquifers are connected to surface water bodies, which is most generally the case in New Zealand (see Section 3.2.4).

3.2.3.2 Groundwater

Rainfall Recharge and Groundwater Recharge

Rainfall recharge to groundwater (Figure 3.7) is the amount of rainfall (precipitation) that vertically drains from the soil to replenish the groundwater, which depends on several factors such as climate (characteristics of rainfall, evapotranspiration) and soil/geological properties (e.g. infiltration capacity, permeability).

Groundwater recharge includes recharge from rainfall as well as from other potential sources (e.g. recharge from streams, irrigation surplus).

Several methods exist to assess rainfall recharge. For example, it can be measured with lysimeters and modelled on a sub-regional basis (White et al. 2003) or assessed from remote-sensing imagery and modelled from national to local scale (Mourot et al. 2019).

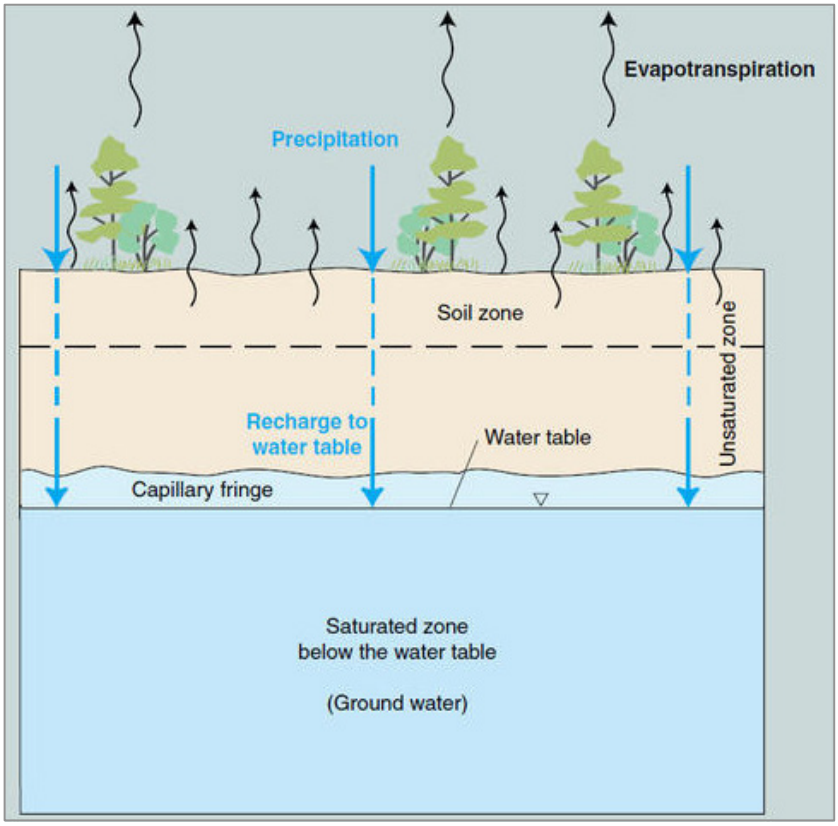

Figure 3.7 Rainfall recharge to groundwater (Alley et al. 1999).

Methods

Almost all New Zealand regional councils have introduced allocation limits for groundwater quantity at the time of the review, using a variety of methods. Most of the them (Table 3.3) have been recently summarised by Kōmanawa Solutions (2020).

Table 3.3 Allocation limit determination methods, description and assessment requirements, after Kōmanawa Solutions (2020).

Allocation Limit Method	Limit Based on:	Method Description	Technical Assessment Requirements
L1	Fixed percentage of annual average rainfall or groundwater recharge	Allocation limits defined as a fixed percentage of annual average rainfall (e.g. 5%) or estimated groundwater recharge (e.g. 10%, 50%).	Varies from rainfall data analysis to detailed recharge evaluation using soil water budget models, lysimeter data, satellite remote-sensing data, water table fluctuation and environmental tracer analysis.
L2	Existing consented use rates	Groundwater allocation is sometimes capped at current consented rates or current rates ± a given percentage, depending on whether current abstraction exceeds acceptable environmental effects thresholds.	Information on consented annual volumes and usage rates. Current state and trend analysis and evaluation of whether effects of current abstraction and/or potential future abstraction (e.g. within existing consent limits) are acceptable.

Allocation Limit Method	Limit Based on:	Method Description	Technical Assessment Requirements
L3	Maximum permissible stream depletion	Definition of allocation limits based on assessment of stream depletion rates and determination of the maximum acceptable rate of stream depletion.	Stream depletion analysis: Collection and analysis of aquifer property data, stream depletion modelling with varying degrees of complexity (analytical modelling, deterministic numerical modelling, stochastic numerical modelling). Stream depletion limit determination: approaches include a fixed percentage of mean annual low flow (MALF), structured expert judgement and stream-specific ecological effects-based thresholds.
L4	Prevention of seawater intrusion	Maintenance of positive coastal gradients and sufficiently high flux rates to prevent both active and passive seawater intrusion.	Examples include modelling maximum abstraction rates for maintenance of 2 m above sea level head in coastal sentinel wells and salinity monitoring-based approaches (e.g. England).
L5	Value judgement based on scenario modelling	Simulation of multiple allocation scenarios and associated impacts on stream flows and/or groundwater levels coupled with cost/benefit analysis (economic and environmental) of higher/lower rates of abstraction.	As per L3 above, as well as groundwater level modelling (ranging from spreadsheet calculations to numerical modelling), economic benefit (increased abstraction) and/or cost (reduced abstraction) assessment, stream health impact analysis and science communication with stakeholders involved in value judgement process.
L6	Adaptive management	Floating allocation set each year (typically in September) based on groundwater levels. Consent holders can access between 0 and 100% of their allocation.	Data analysis or modelling to determine relationship between groundwater levels and environmental effects. Level of complexity depends on local context.

* This method is used in England to assess the ‘quantitative status’, as per requirement of the Water Framework Directive (WFD).

These limits are either site-specific ‘tailored limits’, assessed through detailed investigations to characterise the resource of the GMZs, or region-wide ‘interim limits’ based on assumed and (usually conservative) parameters of the GMZs. The aim of setting these generic ‘interim limits’ is to ‘cap’ the abstraction while more scientific knowledge is acquired. Some regions have based their interim allocation limits on recommendations of the Ministry for the Environment Proposed National Environmental Standard on Ecological Flows and Water Levels 2008 (pNES 2008; see Section 3.1.2.4).

NRC, for example, uses (i) references to the pNES 2008 recommended allocation limits, expressed as percentages of rainfall recharge (method L1), as well as (ii) the current total consented amount when setting up new allocation limits (method L2), choosing the greatest of (i) or (ii) (see Appendix A1.7).

The definition of allocation limits on the current total consented amount of groundwater takes (method L2) is frequently used for areas where no limits were previously in place and for which the level of abstraction is already higher than the proposed limits. This method is utilised to avoid further over-allocation (see Section 3.2.5.2).

As part of their allocation framework, some regional councils utilise a threshold over which they take stream depletion into consideration. For example, ORC allocates a groundwater take as 'groundwater and part surface water if the take is 100 m or more from any connected perennial surface water body and depletes that water body most affected by at least 5 L/s, as determined by Schedule 5A (Otago Regional Council 2004). Therefore, where surface water is over-allocated, this will condition the volume of groundwater that can be abstracted from a bore.

In addition to the methods listed in Table 3.3, the BoP 'baseflow protection method' was developed as part of 'Plan Change 9' groundwater allocations (White et al. 2018). After delineation of groundwater catchment boundaries (Section 3.2.2), steady-state water budgets were used to characterise groundwater flows, including groundwater outflow to surface water. These budgets assessed all relevant flow components and were assembled for all BoP catchments (groundwater and surface water). Groundwater Available for Allocation (GAA), i.e. a flow rate from which aquifer allocation is determined (see Appendix A1.2), was also calculated with 3D geological models and water budgets. GAA was a science-derived estimate of maximum aquifer use that preserved groundwater outflow to surface water bodies such as rivers and streams (Figure 3.8).

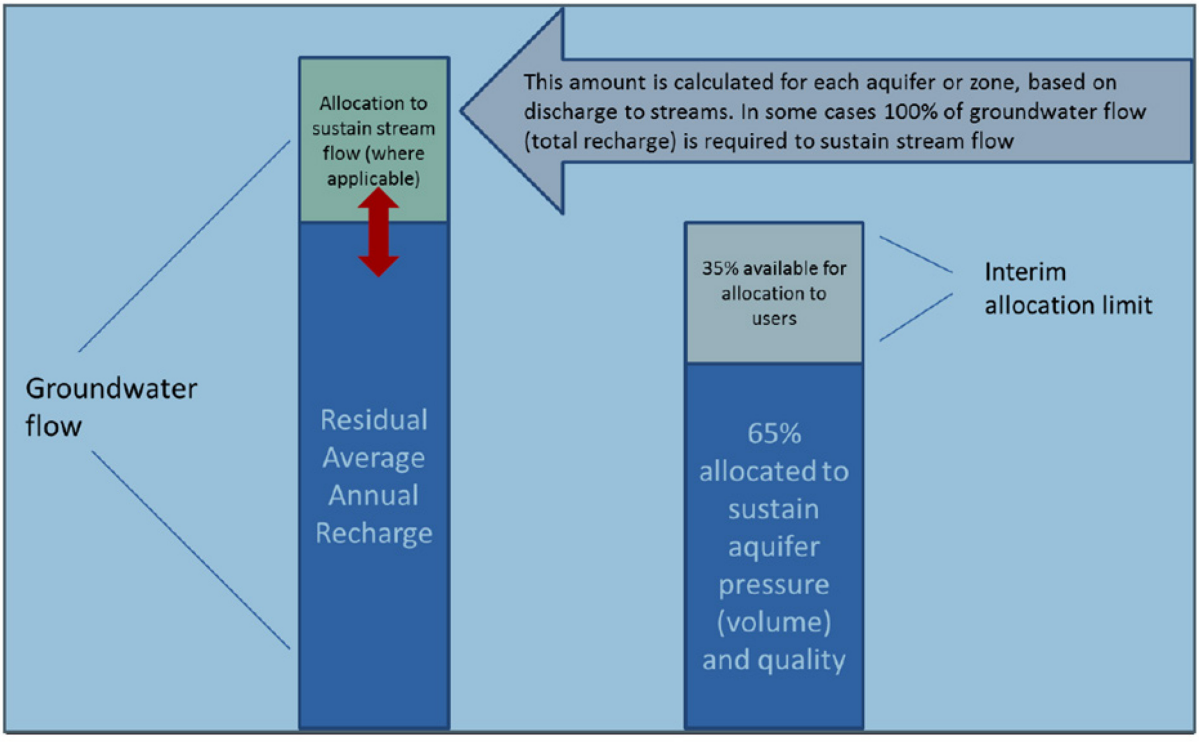

Figure 3.8 Groundwater available for allocation proposed as part of Plan Change 9 for the Bay of Plenty region (Bay of Plenty Regional Council 2016).

Water dating and spring flow measurements can be used to estimate the volume of groundwater in a groundwater catchment (Morgenstern et al. 2015).

To complement the groundwater allocation limits, some councils have introduced minimum groundwater levels to further ensure the sustainable management of the resources; this is similar to the 'adaptive management' method (L6) mentioned in Table 3.3.

For instance, Otago Regional Council (ORC) regulates the abstraction from four aquifers using restriction bores in addition to allocation limits (Table 3.4). For these aquifers (e.g. Lower Taieri West and East aquifers), a series of groundwater levels have been defined for the restriction bores that can trigger 25%, 50% and 100% restriction levels for the water takes (Schedule 4B of the Regional Plan: Water for Otago; Otago Regional Council 2004) and a protocol implemented by a water allocation committee.

Table 3.4 Restrictions for groundwater takes in Schedule 4B of the Regional Plan: Water for Otago (Otago Regional Council 2004).

Aquifer	Aquifer Reference Bore	Aquifer Maximum Height (Metres above Datum)	Restriction Levels (Metres above Datum)		
			25% Restriction or Response in Terms of Council Recognised Rationing Regime	50% Restriction	100% Restriction
North Otago Volcanic	Websters Well	130.8	126.0	125.5	125.0
Lower Taieri – West	Momona Bore	101.24	100	99.5	99
Lower Taieri – East	Harleys Well, Piczo. 2	112.5	110.5	110.0	109.5
Ettrick Basin	Cemetery Bore	172.29	170.29	169.79	169.29
Roxburgh Basin (Coal Creek Terrace)	White-Hall Bore	189.5	188	187.8	187.5

ES has a similar process to manage abstraction with monitoring bores and associated initial water-level triggers and minimum level cut-offs. In addition, for some aquifers (e.g. North Range Aquifer), seasonal recovery triggers have been introduced to adjust groundwater abstraction seasonally (Environment Southland Regional Council 2018a).

The last two examples can be related to an adaptive management approach (method L6, as per Table 3.3).

AC has also introduced 'interim aquifer groundwater levels' to protect groundwater from saline intrusion (similar to method L4 of Table 3.3) and/or geothermal resources from over-extraction (Auckland Council c2016).

The approach per whaitua committee of GWRC relates to the 'judgement approach' (method L5 of Table 3.3), where different modelling scenarios have been developed to consider 'human' (e.g. economic) parameters in addition to the physical parameters.

3.2.4 Consideration of Groundwater Connectivity

The NPS-FM 2020 prescribes adopting an integrated approach, ki uta ki tai, for the management of freshwater to consider interconnections and interactions within the environment (Section 3.1.2.1); this includes groundwater and surface water bodies; groundwater and geothermal systems; and groundwater and sea water.

3.2.4.1 Connectivity to Surface Water

Groundwater is commonly connected to surface water bodies in New Zealand. Rivers, lakes and wetlands can provide recharge to groundwater and, respectively, groundwater can feed surface water bodies through springs, seeps and subterranean flows (Rosen and White 2001).

Most of the regional councils have introduced provisions in their regional plans to manage these resources sustainably by adopting integrated approaches. For example, Environment Canterbury Regional Council (ECan) introduced ‘combined groundwater and surface water allocation regimes’ for the Selwyn Te Waihora sub-region to manage surface water and groundwater allocation jointly; elsewhere, the amount of water to allocate as ‘surface water’ versus ‘groundwater’ (Table 3.5) is assessed based on ‘stream depletion effect’ or ‘induced infiltration of stream flow’ (Figure 3.9).

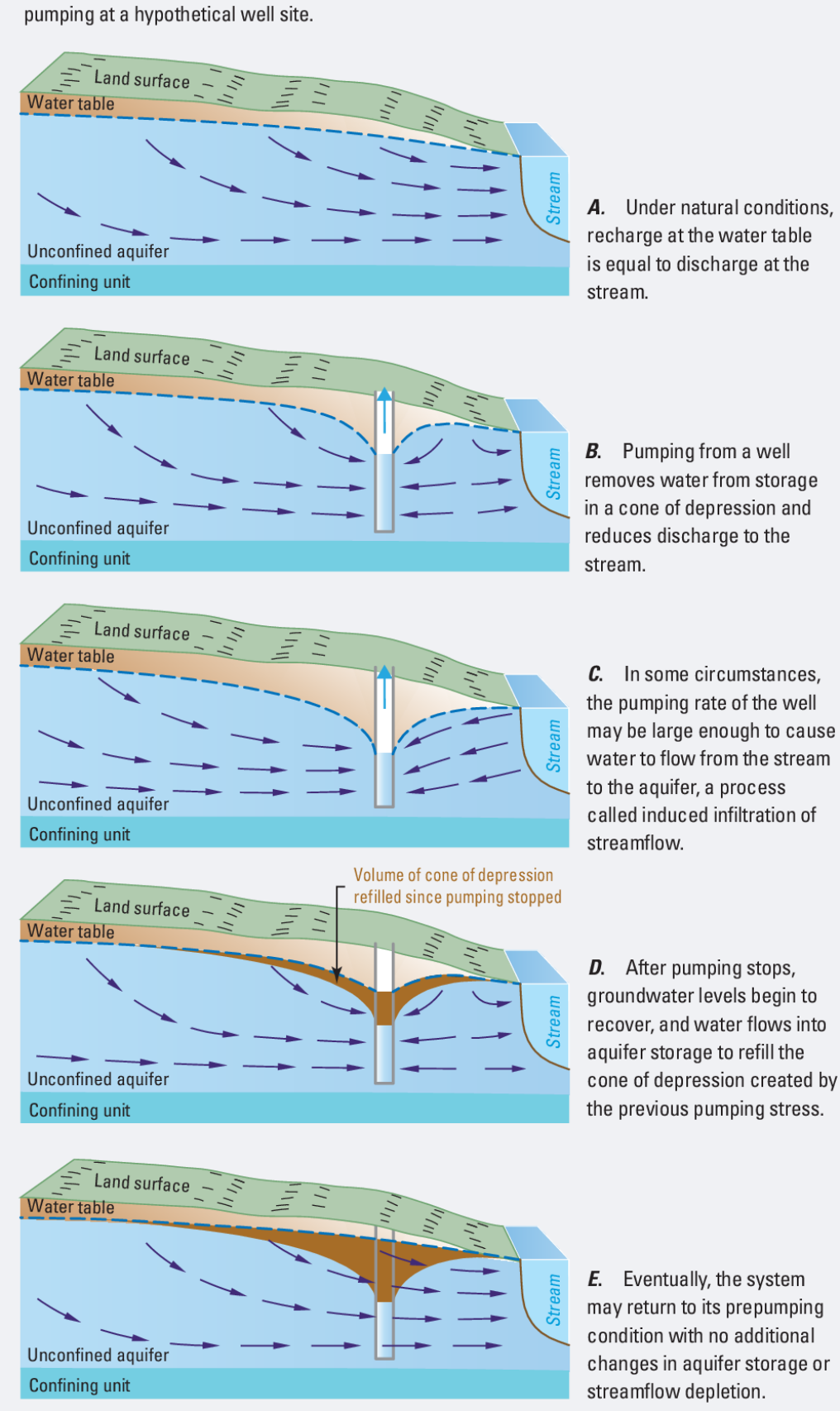

Figure 3.9 Progressive changes to groundwater flow and streamflow before, during and after pumping at a hypothetical well site (Leake and Barlow 2013).

Table 3.5 ECan Land and Water Regional Plan, Schedule 9, Table S9.1: Stream depletion effect to be included in the surface and groundwater allocations (Environment Canterbury Regional Council 2019).

Stream Depletion Effect	Amount to be Included in the Surface Water Allocation Limit	Amount Allocated from the Groundwater Zone	Pumping Schedule	Subject to Surface Water Minimum Flow Restrictions
Direct	Maximum daily rate of take[1] (the rate at which water can be continuously taken to abstract the maximum daily volume that is to be taken); 100% of the annual volume	None	Not applicable	Yes
High	The stream depletion effect[1] estimated using the pumping schedule; 75% of the annual volume	25% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	Yes, if above stream depletion effect cut-off
Moderate	The stream depletion effect[2] estimated using the pumping schedule; 50% of the annual volume	50% of the annual volume	150 days continuous steady pumping required to deliver the annual volume	No
Low	None	100% of the annual volume	Not applicable	No

1 This effect will be included in the surface water allocation, irrespective of the rate of take.

2 This effect will be included in the surface water allocation if the stream depletion effect exceeds the stream depletion effect cut-off provided in Sections 6 to 15, or where none has been set in Sections 6 to 15, 5 L/s.

Often the challenge relies in assessing the degree of interconnectivity. For this purpose, ECan developed some tools to assess the stream depletion according to pumping characteristics, separation distance between well and stream, and stream bed and aquifer properties, which are readably available on their website (Environment Canterbury Regional Council 2003).

GWRC classifies groundwater bodies into categories according to their connection to surface water (A: high connection, B: moderate connection and C: limited connection) and provides different management approaches accordingly (Greater Wellington Regional Council 2019). For instance, category A groundwater takes are allocated from surface water allocation amounts for the relevant catchment (sub)unit.

3.2.4.2 Connectivity to the Ocean

Approximately one-third of the hydrogeological systems of New Zealand, as per area, have been classified as coastal systems (Moreau et al. 2019). Coastal hydrogeological systems present an interface between fresh groundwater and saline groundwater due to the occurrence of sea water within the strata that occur underneath and adjacent to the sea (Pattle Delamore Partners 2011). Under natural conditions, a hydraulic gradient exists towards the coast, which leads the excess freshwater to flow to the sea. However, increased demand and abstraction from coastal aquifers can result in the lowering of the water tables and cause saltwater intrusion (Figure 3.10). This process is largely responsible for groundwater quality degradation and poses a major challenge for the management of the coastal aquifers (Abd-Elaty et al. 2019).

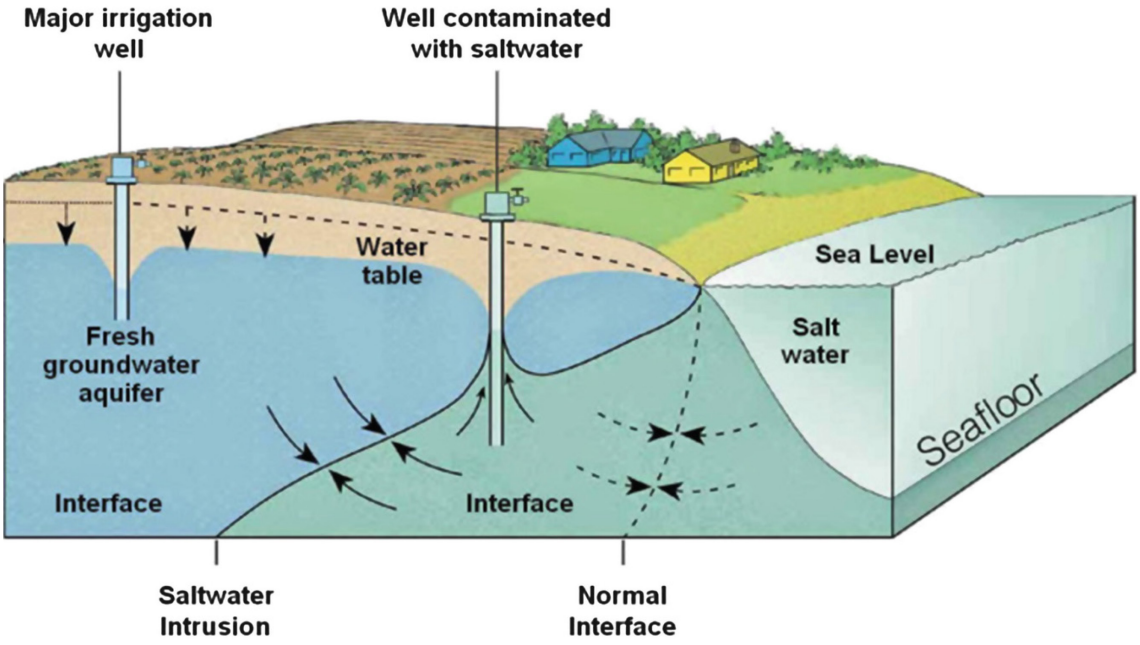

Figure 3.10 Saltwater intrusion interface (Abd-Elaty et al. 2019).

New Zealand regional councils utilise a wide variety of management practices, with some approaches based on the generic intention to avoid the problem (e.g. Case 1) and others more prescriptive (e.g. Cases 2 and 3):

- Case 1: The Draft Freshwater and Land Management Plan for Taranaki (Taranaki Regional Council 2015) recommends in its 'Policy 8.1: Taking or use of groundwater (ii)' to avoid, remedy or mitigate the "… contamination of groundwater including through saltwater intrusion …".
- Case 2: The One Plan 'Policy 16-7: Saltwater intrusion' (Horizons Regional Council 2014) provides specific requirements for the groundwater takes located within 5 km of the coastal mean water springs line. Consent applicants must provide a hydrogeological assessment of the level of drawdown at the coast to assess the likelihood of inducing saltwater intrusion – the application can then be declined, or the requested amount reduced, and the consent should include monitoring conditions (electrical conductivity measurements) with some restriction/suspension of the abstraction determined by electrical conductivity thresholds.
- Case 3: The Unitary Plan 'Table 2 of Appendix 3: Aquifer water availabilities and levels' (Auckland Council c2016) provides 'interim aquifer groundwater levels' that should be maintained during groundwater abstraction and to avoid saltwater intrusion (e.g. an interim level of 3.25 m above mean sea level has to be maintained for the Omaha Waitemata aquifer at Bore 25, Points Wells Road).

3.2.4.3 Connectivity to Geothermal Systems

Geothermal resources are present in some regions of New Zealand, with, for example, more than ten geothermal areas in the Bay of Plenty region (Figure 3.11). Under the RMA, the regional councils are responsible for managing these resources sustainably and protecting surface features. For instance, BoP uses the Regional Policy Statement and the Rotorua Geothermal Regional Plan as guidance for resource consent to manage the Rotorua geothermal system. Current provisions require re-injection to limit net loss of water to the system and to control the taking of heat and water near Pohutu Geyser (Bay of Plenty Regional Council c2020a).

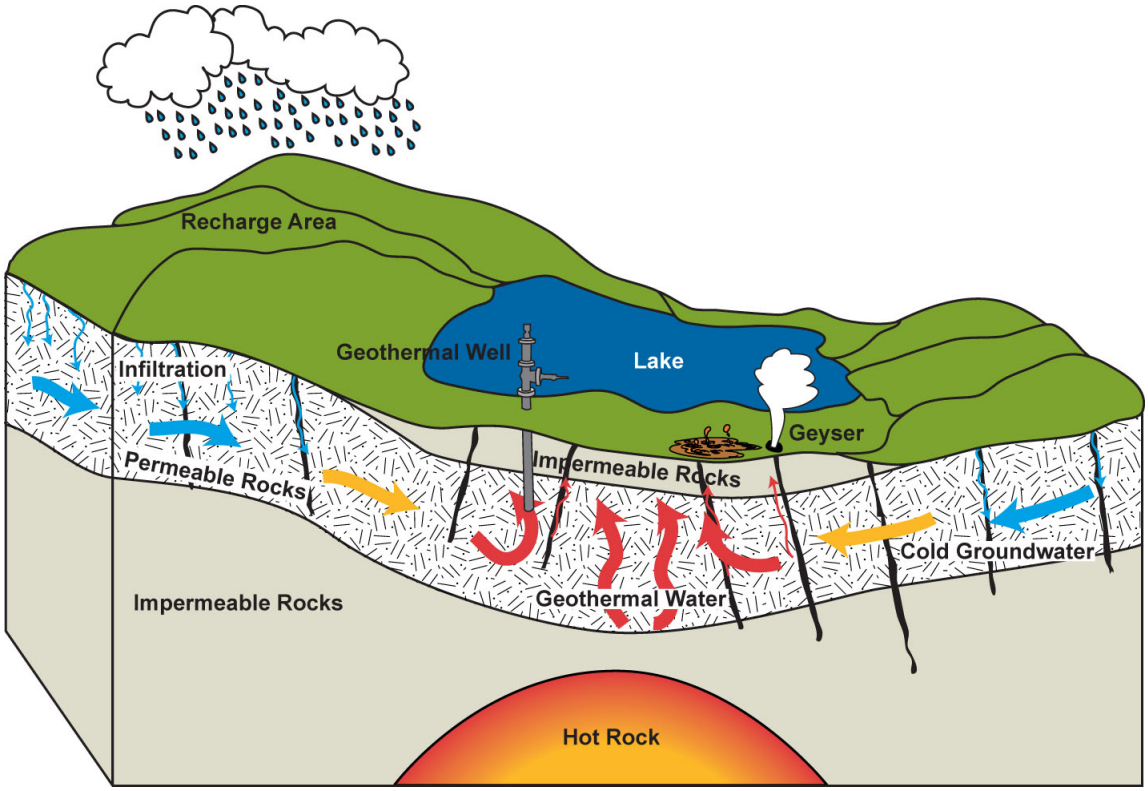

Figure 3.11 Geothermal systems and connectivity to groundwater systems (Bay of Plenty Regional Council c2020a).

The Waikato Regional Plan (Policy 4.m) requires "the avoidance of a reduction in recharge groundwater flows to Geothermal Systems" while establishing, setting and reviewing sustainable yield from groundwater resources that are used to assess consent applications (Waikato Regional Council 2007).

The Unitary Plan 'Table 2 of Appendix 3: Aquifer water availabilities and levels' (Auckland Council c2016) and its 'interim aquifer groundwater levels', mentioned in the previous section, are also utilised to avoid depletion of geothermal systems (e.g. an interim level of 2.5 m above mean sea level [averaged over any 12 consecutive months] has to be maintained for the Parakai Geothermal aquifer at AC Deep Bore No. 86).

3.2.5 Other Important Management Considerations

3.2.5.1 Water Efficiency and Water Metering

Water Efficiency

Water efficiency is an aim of national and regional water-management legislation, such as the NPS-FM 2020 (Ministry for the Environment 2020b) and regional plans, e.g. Tasman Resource Management Plan (TRMP; Tasman District Council 2014) and the Horizons Regional Council One Plan (Horizons Regional Council 2014). For example, water-allocation efficiency and water-use efficiency are aims/requirements of the former NPS-FM 2014 (Objective B3), the new NPS-FM 2020 (Policy 11), the TRMP (Policy 30.1.3.22) and the One Plan, with, for example:

- 'Policy 5-12: Reasonable and justifiable need for water' providing references for resource consent assessment of 'reasonable use daily rates' for irrigation, public water supply, animal drinking water, dairy shed washdown and industrial use.

- ‘Policy 5-13: Efficient use of water’ commending the following measures: establishing water audits and budgets to check for leakages and water use efficiency; requiring the progressive upgrade of infrastructure for water distribution, minimising the loss of water; restricting the usage to determined amounts; enabling the transfer of water permits; promoting water storage; raising awareness about water efficiency issues and techniques and requiring the monitoring of water takes (metering and telemetry).

Efficiency measures include economic, technical and dynamic. However, the use of efficiency measures by water managers is in its infancy in New Zealand (White 2018). These measures can identify significant trends in water use. For example, economic efficiency (annual revenue from production divided by annual groundwater use) increased significantly in the Lower Confined Aquifer (LCA), Waimea Plains, from 4.8 $/m^3 to 16.8 $/m^3 in the period 2004/05 to 2007/08 (White 2018). This was because of the conversion of most dairy land to high-revenue land uses (i.e. horticulture-other and market gardening).

Water Metering

National regulations aim to improve the understanding of water use in New Zealand. The Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 aimed to improve measurements of water use. These regulations generally apply to consumptive water users with a rate of take that is greater than, or equal to, 5 L/s. Measurement of water use in the Canterbury Plains demonstrated a response to these regulations. For example, 6655 Canterbury Plains water takes were recorded in 2013/14 and, of these, 4344 (approximately 65%) were ‘measured takes’, i.e. equipped with flow-measuring devices (Glubb and Durney 2014).

The value of a long record of water use is demonstrated by measurements of water use (mainly from groundwater) by agricultural and commercial takes from the Waimea Plains (Nelson Catchment and Regional Water Board 1981). This record has enabled monitoring of groundwater takes in regard to water allocation provisions of the Waimea Plains Water Management Plan, including protection against over-extraction of water against set limits and maintenance of minimum flows on interconnected surface water bodies by restricting water use when triggers are reached during drought conditions.

Groundwater use records are also valuable for research (White and Close 2016). For example, economic drivers of land uses were a critical control on groundwater use in the LCA zone of the Waimea Plains (White 2011). Here, groundwater use in the LCA zone by the main farming activities (dairy, apples, horticulture-other and market gardening) largely followed trends in irrigated land area over the period from 2003/04 to 2007/08 (coefficient of variation, R^2 = 0.91).

3.2.5.2 Measures to Avoid and Limit Over-Allocation

A number of regions are considered as having fully allocated and over-allocated water resources, e.g. in 2010, ten of the 29 Canterbury allocation zones were fully allocated and six were above 80% of the allocation limits (Kaye-Blake et al. 2014). In parallel to the NPS-FM 2014 (amended 2017), the Ministry for the Environment (2018a) provided guidance in regard to the process to implement the restriction of resource use to specified limits (Figure 3.12). Avoidance and phasing-out over-allocations is also one of the key requirements of the NPS-FM 2020.

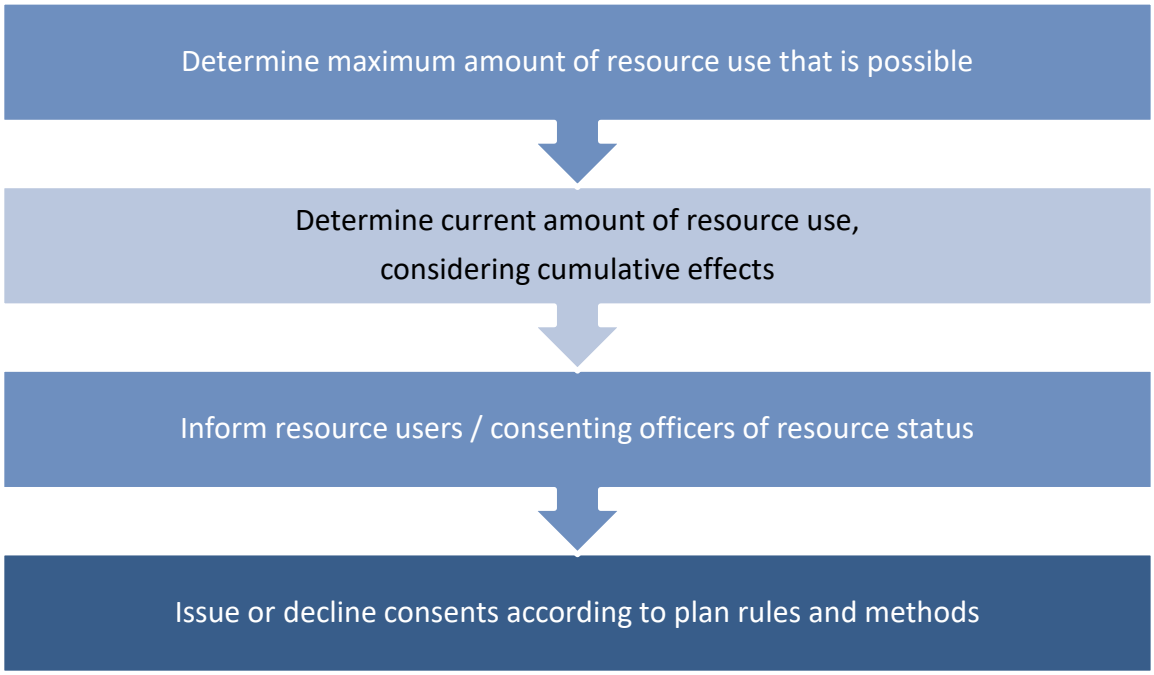

Figure 3.12 Recommended process to restrict resource use to specified limits under the NPS-FM, after Ministry for the Environment (2018a).

Determination of over- and/or full allocation of the resources is not straightforward (Lincoln Environmental 2000). Booker (2016) outlines the practical difficulties in defining water resource use limits and subsequently calculating over-allocation due to, for example, spatial and temporal variations of over-allocation for the same resource, the lack of understanding of hydrological effects of permitted activity takes, the variability in consent conditions and total allocation calculation methods of the potential effects of restriction periods.

Issues linked to over-allocation are complex, e.g. rolling-back over-allocation is very contentious and can be very expensive (e.g. the Murray-Darling Basin, Australia). Most of the New Zealand regional councils have current specifications in their regional plans to avoid over-allocation at the outset. For instance, the sub-regional sections of the Canterbury Land and Water Regional have specific methods and timeframes to manage over-allocation (Environment Canterbury Regional Council 2019). For example, during the replacement of consents, no additional rates are granted, applicants are encouraged to shift from surface water hydraulically connected groundwater to deep groundwater blocks (e.g. sub-regional section 13.4.4 for Ashburton). Priority to scheme water over river and groundwater resource can also be encouraged (e.g. sub-regional section 14.4.4 for Orari-Opihi-Pareora).

3.2.5.3 Community Consultation and Public Data Access

Community Consultation Process

Communities can be at the centre of water management (White, forthcoming 2020). Waimea Plains water zone committees are an early example of involvement of groundwater user groups (Nelson Catchment and Regional Water Board 1981). These committees continue to operate today and are particularly relevant at times of environmental stress, such as very low flow in the Waimea River, when Tasman District Council operate an allocation-reduction regime on groundwater consents in the Waimea Plains (Tasman District Council 2014; Rule 31.1.2.2).

Water zone committees are the interface for water management by ECan, Jenkins (2018), Eppel (2015) and White (forthcoming 2020). Committee members are sourced from the community (appointed by the three Canterbury Water Management Strategy partners – regional and local councils and rūnanga), rūnanga (members appointed by their rūnanga) and councils (elected officials from ECan, city councils and district councils) (White, forthcoming 2020).

Community groups are also an important part of sustainable management of water resources:

> *"The Canterbury-based Water Rights Trust was formed in 2002 and has aimed to encourage restoration, maintenance, protection, and enhancement of rivers, wetlands, and aquifers. The trust, using voluntary labour, has tried to effect these aims by affiliation with other like-minded entities and communicating with government, politicians and the public. Similarly, Taupo's Lakes and Waterways Action Group is based around volunteers who have given much of their time to the Lake Taupo Protection Project (Environment Court 2011). LWAG has led more than 220 community meetings, typically at monthly intervals from the mid-1990s to the current day, informing the community on water science and land management related to the LTPP."* (White, forthcoming 2020).

Engaging with Iwi and Hapū

Increasingly, Māori are engaging with water management (White 2012). Te Mana o te Wai values "must inform the setting of freshwater objectives and limits" (NPS-FM Objective AA1; Ministry for the Environment 2017a). The new NPS-FM 2020 also provides greater direction to give effect to Te Mana o te Wai through involving and working with tangata whenua. Integration of Māori approaches to water resources with western science are being developed that provide new approaches to water resource management, e.g. the 'Kaitiaki Flow', to limit setting in spring-fed streams (White et al., forthcoming 2020).

Broadly, regional councils engage with iwi and hapū to identify communities' values and to set up objectives for freshwater. For example, in Southland, the 'Regional Forum' (created under the 'People, Water and Land Programme – Te Mana o te Tangata, te Wai, te Whenua') advises ES and Te Ao Marama board members on the methods to meet selected freshwater values and objectives (Environment Southland Regional Council 2018b). Freshwater planning in the Greater Wellington region is organised around catchment areas or 'whaitua'. Whaitua committees (made up of local community members, iwi representatives, local authority representatives and GWRC representatives) are tasked to develop Whaitua Implementation Programmes that make recommendations in the matter of freshwater management for the catchment.

3.2.5.4 Online Allocation Maps

Regional councils are active in making their groundwater data and information available to the public (White 2020; BoP and ORC links in Appendix A1.2 and A1.8, respectively). Recent moves of central government point to the increasing importance of public information on water, generally, and groundwater science and management, particularly, e.g. the NPS-FM directs all councils to transparently report on the freshwater allocation and availability.

Public information systems are serving multiple purposes within, and outside, resource management organisations. For example, the BoP 'Indicative groundwater availability and consented allocation' web interface (Figure 3.13) provides useful resources to internal staff,

consultants, communities and individual landowners. This interface indicates the allocation status of the water management area by showing the ‘groundwater flow’ (see Section 3.2.3.2) total ‘available allocation’, amount of ‘allocated groundwater’ and ‘remaining allocation’ potentially available in the area.

The role of public information systems will continue to expand as councils develop new tools that meet new opportunities, for example:

- new tools to represent a multitude of data and information types
- modern web-based data collection systems that are providing increasing volumes of data, and
- information services to support local communities and freshwater management zones.

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Table 3.6 Regional Plans and provisions in regard to freshwater management and groundwater quantity allocation.

Item	Regional Council									
	AC	**BoP**	**ECan**	**ES**	**GWRC**	**Horizons**	**NRC**	**ORC**	**TRC**	**WRC**
Reference Regional Plan	Auckland Unitary Plan	Regional Natural Resources Plan	Canterbury Land and Water Regional Plan	Proposed Southland Water and Land Plan	Proposed Natural Resources Plan	One Plan	Proposed Regional Plan for Northland	Regional Plan: Water for Otago	Draft Freshwater and Land Management Plan for Taranaki	Waikato Regional Plan
Status	Operative in part	Operative	Operative	Proposed	Proposed	Operative	Proposed	Operative, but under review	Proposed	Operative
FMUs and/or water management zones	10 FMUs, based on common marine receiving environments	9 water management areas, which may contain a number of FMUs (delineation to be finalised)	10 zones to manage freshwater; 5 FMUs delineated	Water management zones and subzones; 6 FMUs	5 catchment areas ('whaitua'); some FMUs delineated within these whaitua	Water management zones and subzones; 6 FMUs	Water quantity FMUs with three categories of management units and sub-units (groundwater, rivers, lake/wetlands)	5 FMUs	4 FMUs	8 water-quality FMUs in the Waikato and Waipa river catchments
GMZs	121 aquifer management areas	110 groundwater allocation zones	30 groundwater allocation zones	32 GMZs	Three categories of groundwater bodies in relation to the degree of hydraulic connection to surface water: cat. A: high connection, cat. B: moderate connection and cat. C: limited connection	10 GMZs	2 broad aquifer management units (coastal /other aquifers) and Aupōuri Aquifer system (with 12 sub-aquifers)	Aquifer management zones	Each of the FMUs is subdivided into groundwater zones associated with groundwater systems[2]	29 'assessed aquifers' delineated for allocation management
Groundwater allocation limits	Interim and specific	Interim and specific	Specific	Specific	Specific	Specific	Interim and specific	Interim and specific	Under development[2]	Specific
Interim limit as a percentage of LT mean annual recharge (MAR)	• 15% of MAR: for shallow coastal aquifers • 35% of MAR: for aquifers connected to surface water • 65% of MAR: for other aquifers (not connected to surface water)	No current provisions, but withdrawn PC9 proposed to set this allocation threshold at 35% of long-term residual groundwater recharge[1]	Tailored allocation limits are provided in the regional chapters of the Plan.	5% of MAR for each GMZ	Allocation amounts provided in the 'whaitua' chapters of the Regional Plan[3]	5% of MAR for each GMZ	• 10% of MAR: for coastal aquifers[4] • 35% of MAR: for other aquifers[4] • Tailored for Aupōuri aquifer management units	• 50% of MAR: for aquifers not connected to surface water • When connected to surface water; groundwater take managed as surface water	Sustainable yield estimates have been set at 15% of MAR[2]	• Sustainable yields for 'assessed aquifers'[3] • Recommendation to use a water balance with conservative basis to determine sustainable yields for other aquifers
Minimum groundwater levels	Interim groundwater levels provided to avoid saltwater intrusion and/or manage geothermal systems	-	Minimum groundwater levels at which abstraction ceases are specified in regional chapter (as relevant)	Monitoring bores in place, with an initial groundwater level trigger and a minimum groundwater level cut-off	-	-	Minimum groundwater levels are required along coastal margins to prevent saline intrusion, as a general provision but without specific values provided	Restriction bores in place to adjust abstraction with groundwater level thresholds established	-	-

Item	Regional Council									
	AC	**BoP**	**ECan**	**ES**	**GWRC**	**Horizons**	**NRC**	**ORC**	**TRC**	**WRC**
Groundwater and surface water interactions	Provision to manage groundwater connected to surface water bodies	Provision to manage groundwater connected to surface water bodies (e.g. some exclusion zones have no groundwater available for allocation, based on the premise that in that location groundwater sustains surface water base flow)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if these is direct hydraulic connection)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)	Under development[2]	Water allocation regime implemented based on degree of hydraulic connection (e.g. groundwater takes managed as surface water takes if there is direct hydraulic connection)
Water Allocation maps	Not yet	Online; updated in relation to consent application process	Online maps with allocation limits, but current allocation not available yet	Online maps indicating the allocation status	Not yet	Not yet	Online, but not available at the time of this study	Online; updated in relation to consent application process	Not yet	Not yet

[1] Residual groundwater recharge = groundwater recharge – base flow.

[2] Not in the plan yet.

[3] No reference to a certain percentage of MAR in the plan.

[4] Or the quantities currently consented, if greater.

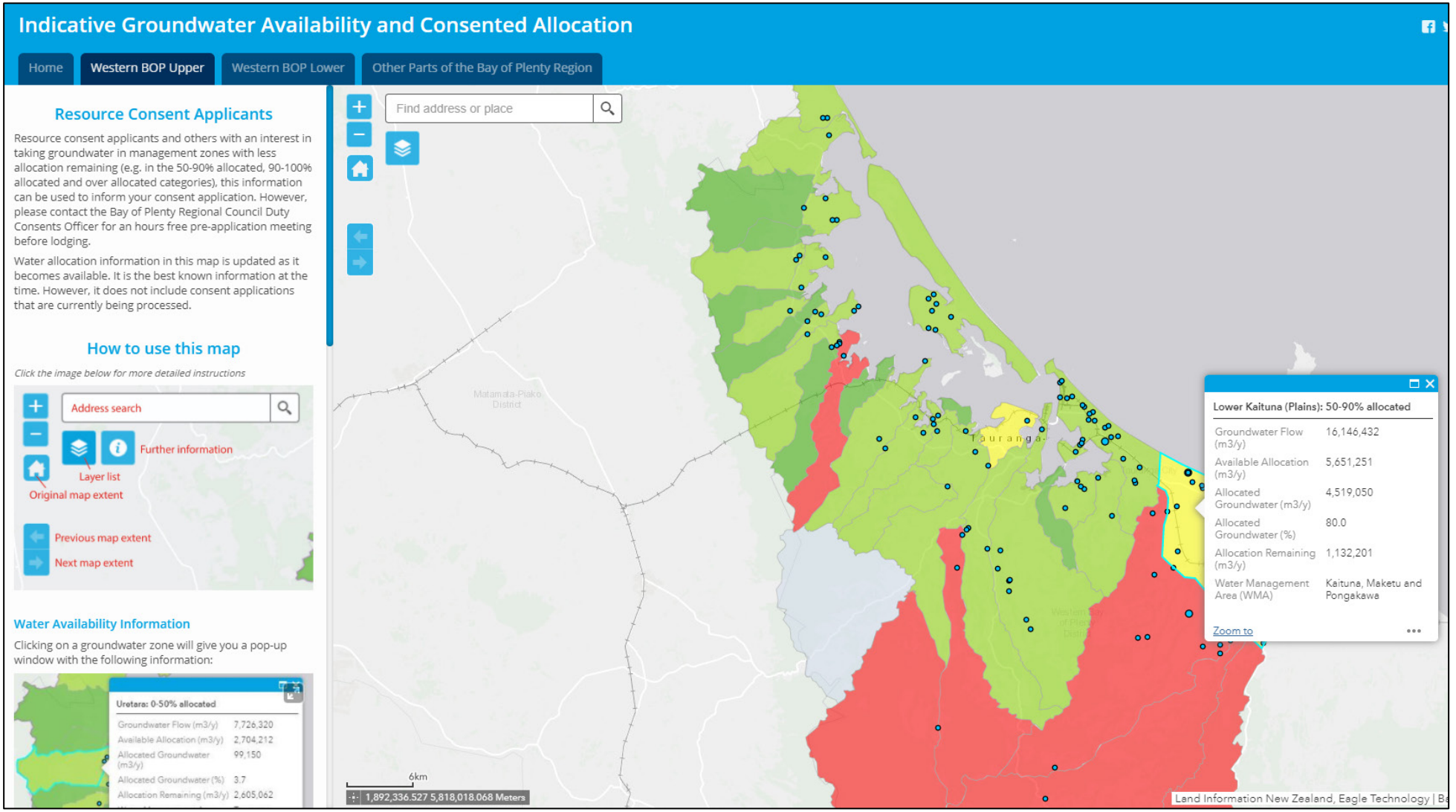


Figure 3.13 Bay of Plenty Regional Council 'Indicative groundwater availability and consented allocation' web interface (Bay of Plenty Regional Council c2020b).

4.0 ROADMAP FOR INTRODUCING A GROUNDWATER QUANTITY ALLOCATION FRAMEWORK

The roadmap to a groundwater quantity allocation framework aims to assist WCRC with future groundwater management in the West Coast region (Figure 4.1). The recommended approach includes two major objectives: enhancement of the scientific understanding of groundwater with its associated resources (Section 4.1); and development of new policies, with transitional processes to implement these (Section 4.2).

4.1 Scientific Knowledge Development

The roadmap recommends the use of scientific information to delineate GMZs, consider groundwater connectivity and assess relevant management targets. Scientific understanding of potential connections between groundwater and other water bodies (e.g. rivers, lakes and the ocean) is also relevant to new policies.

4.1.1 Delineation of Groundwater Management Zones

West Coast groundwater studies have typically focused on groundwater quality but have also included groundwater-level trend analyses, e.g. Moreau (2019), Raiber and Daughney (2009). At present, the geometry (extent and depth), the properties and the connectivity of the groundwater systems have not been well characterised, and no GMZs or aquifers have been delineated yet.

Scientific information relevant to the delineation of GMZs includes the national-scale GIS map of hydrogeological units. The 'Hydrogeological-unit map (HUM) for New Zealand' (White et al. 2019) provides a classification of geological units in terms of their importance for groundwater flow and storage in an ArcGIS seamless digital map. This map represents hydrogeological units as 'stacked polygons', which correspond to hydrogeological units occurring within the same area (e.g. Figures 4.2a and 4.3). The HUM polygons also include hydrogeological attributes, e.g. system type (aquifer,[4] aquitard,[5] aquiclude[6] or basement), age, lithology (Figure 4.2b). Other relevant data includes bore logs, aquifer tests, groundwater level measurements, water quality, isotope data, topography (i.e. LiDAR) and surface water catchments boundaries will also help to refine the GMZ delineation process in a 'combined approach' (Table 3.2), as well as any conceptual models or water budgets developed as part of the definition of management targets (Section 3.2.2).

4 A formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

5 A saturated but poorly permeable stratum that impedes groundwater movement and does not yield water freely to wells that may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important groundwater storage zone.

6 A saturated but relatively impermeable material that does not yield appreciable quantities of water to wells.

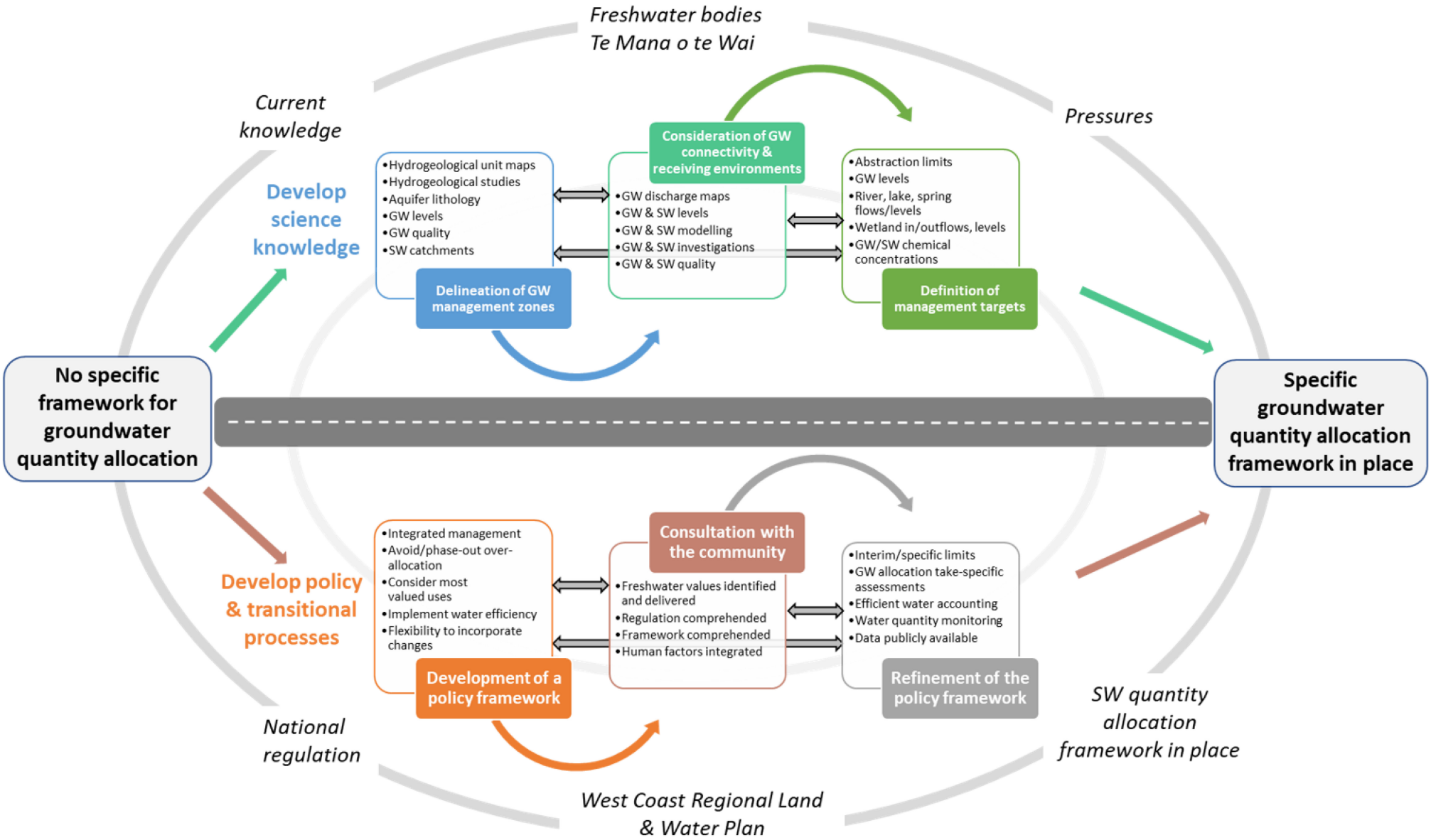


Figure 4.1 Schematic of the proposed roadmap to groundwater quantity allocation for the West Coast region. GW: groundwater, SW: surface water.

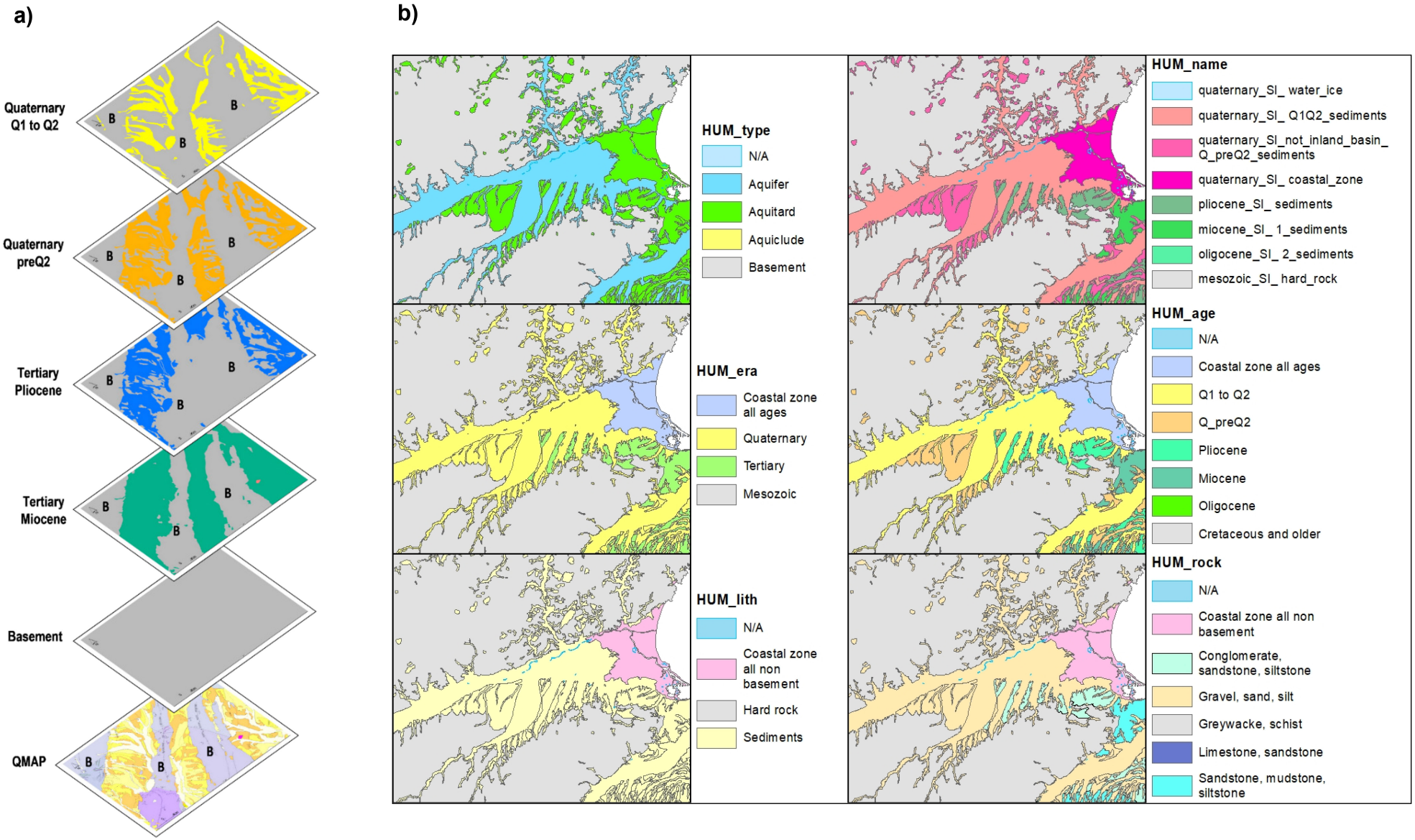


Figure 4.2 Hydrogeological-Unit Maps of New Zealand; (a) 'stacked' polygons concept and (b) polygon attributes; example for the Wairau Plains, Marlborough (White et al. 2019).

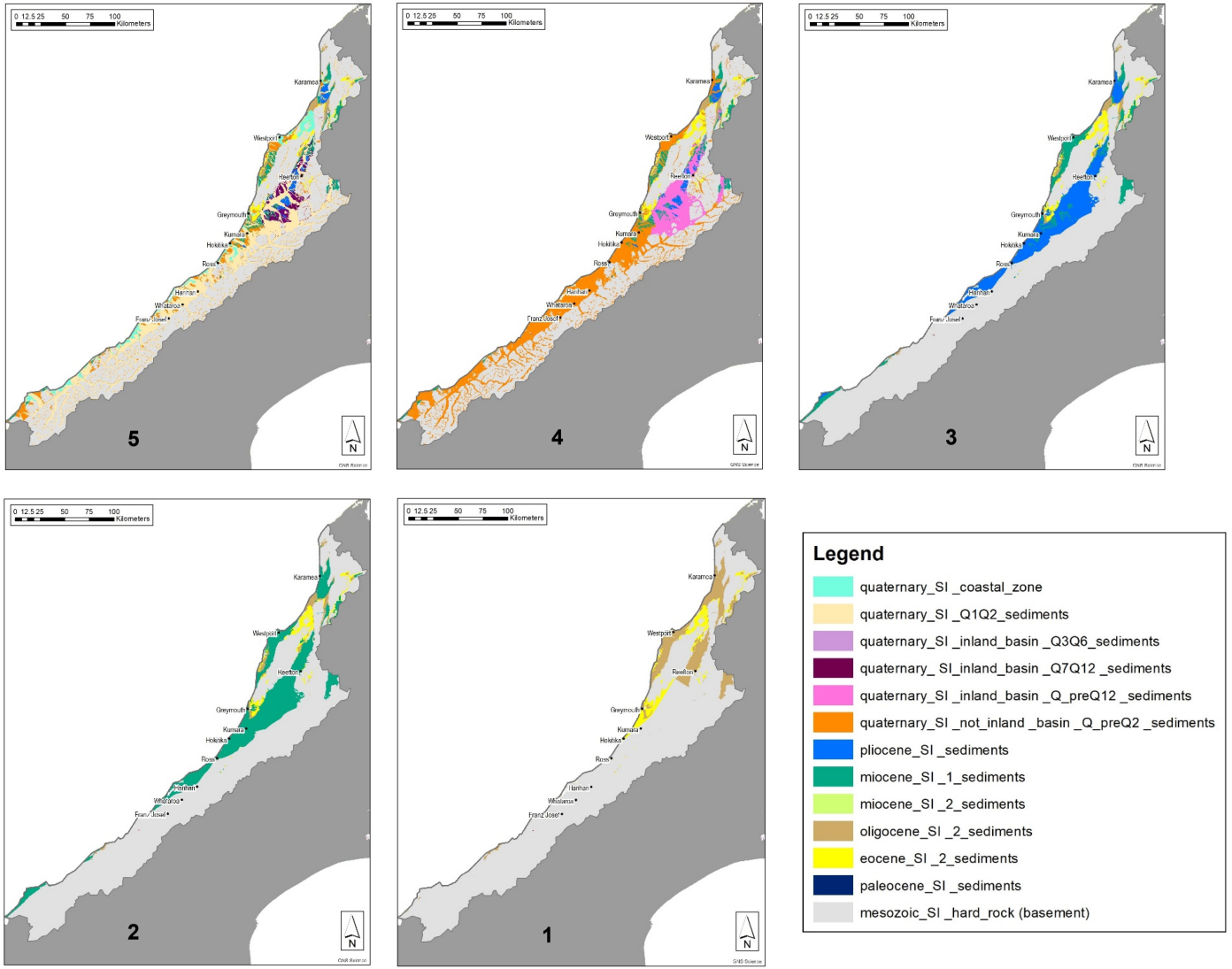


Figure 4.3 Hydrogeological-Unit Maps of New Zealand; example for the West Coast, oldest (1) to most recent deposits (5) (White et al. 2019).

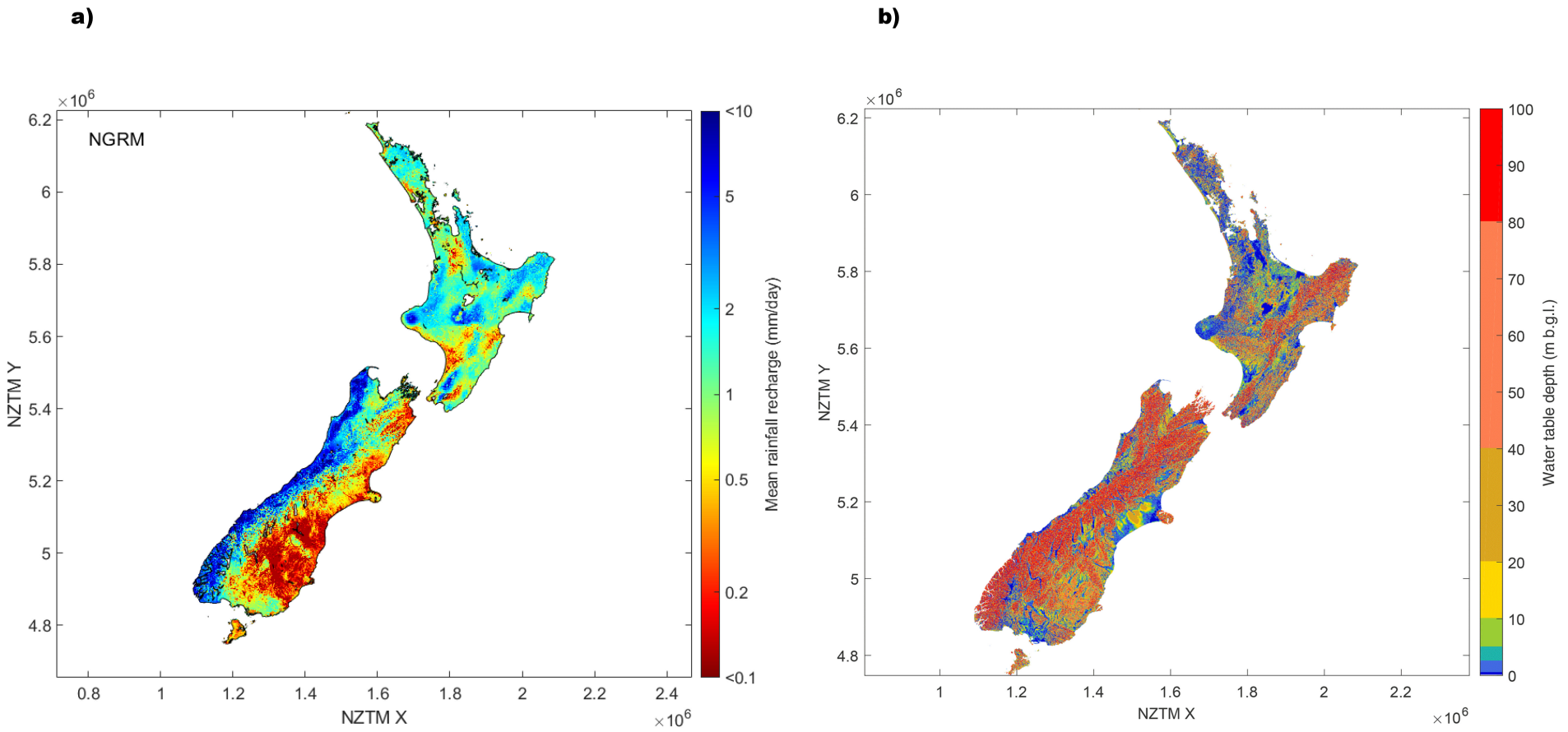


Figure 4.4 Mean 2000–2015 recharge from the National Groundwater Recharge Model estimates (a) (Westerhoff et al. 2018a) and national water table depth from National Water Table model (b) (Westerhoff et al. 2018b).

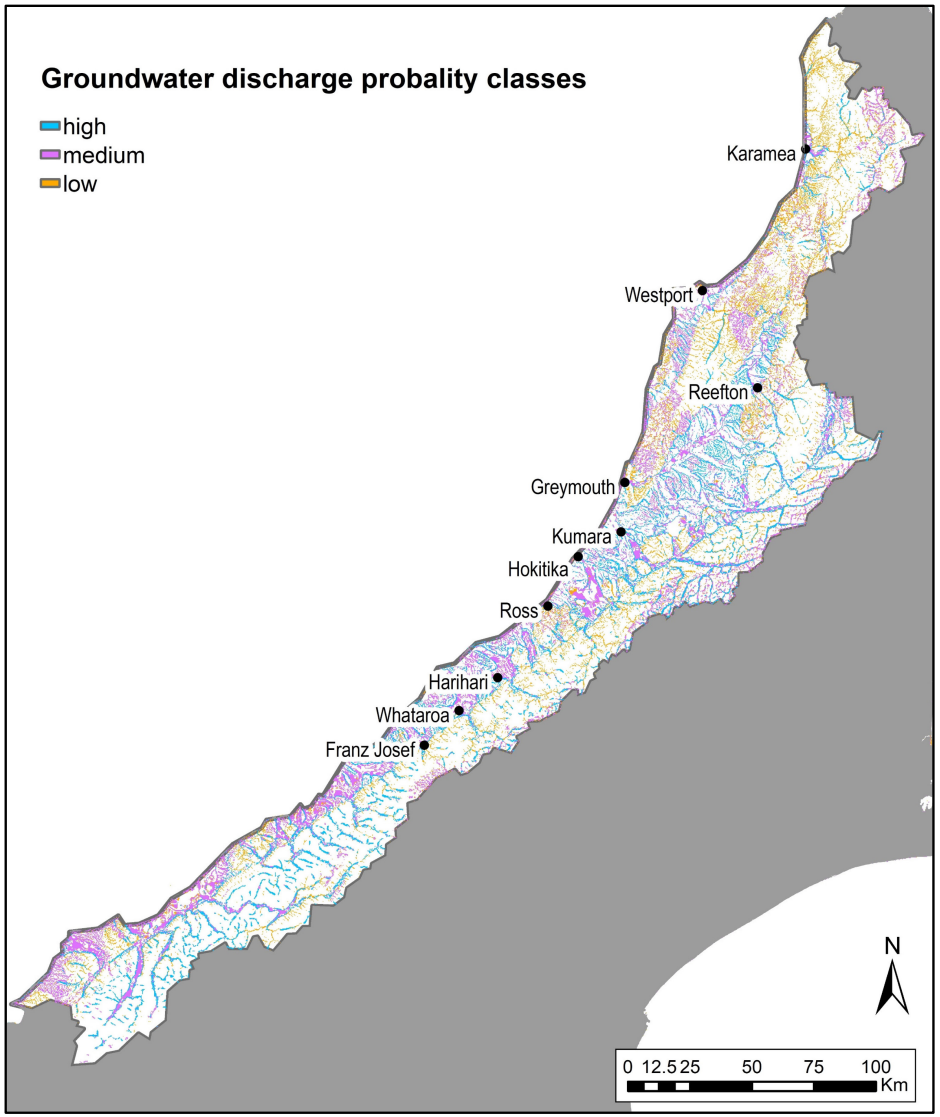
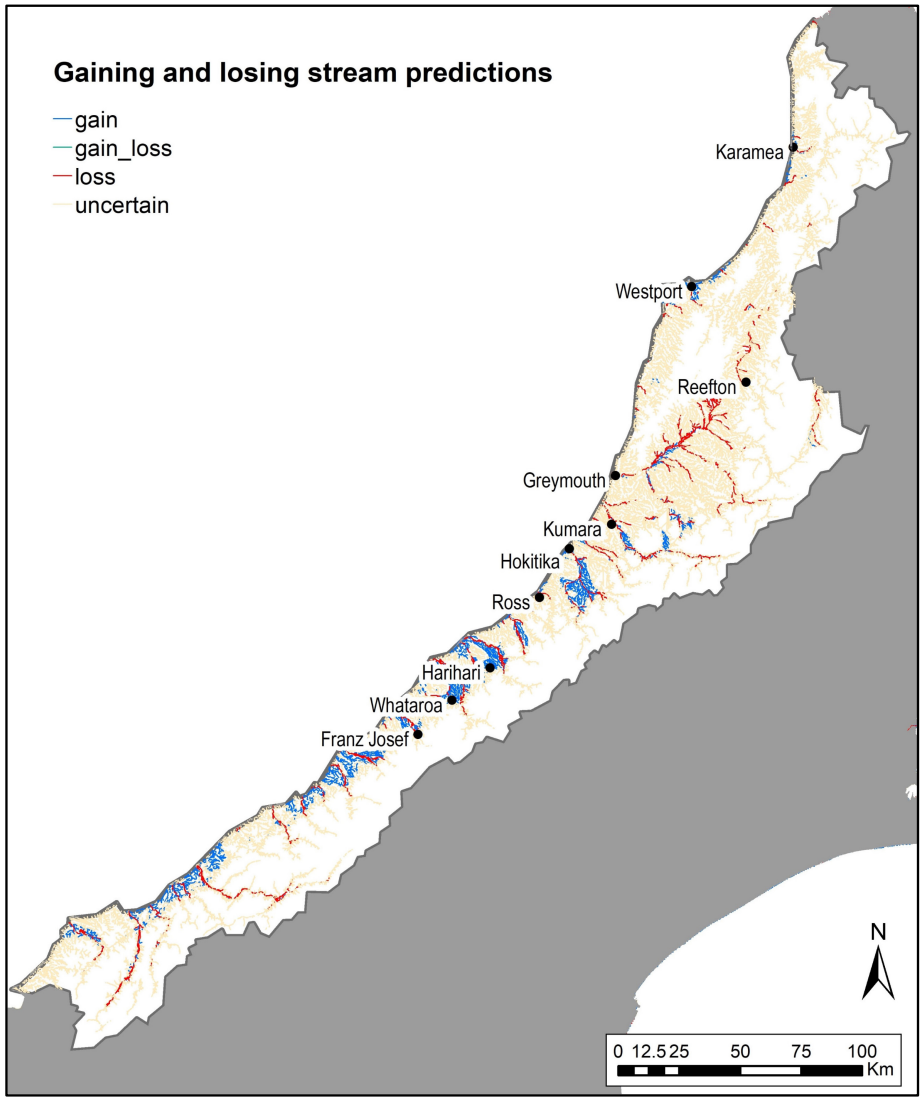


Figure 4.5 Groundwater discharge probability classes, after Westerhoff et al. (2019).

Groundwater Discharge Class	Description
None	The NWT model never encountered groundwater discharge
Low	A low probability of groundwater discharge; the NWT model has encountered discharge a few times (lower than the 25th percentile)
Medium	A medium probability of groundwater discharge; the NWT model has encountered discharge relatively often (in between 25th and 75th percentile)
High	A high probability of groundwater discharge; the model has encountered discharge very often (higher than 75th percentile)



Classes of gaining and losing reach prediction	Description
Losing	The reach is always losing (i.e. surface water is infiltrating to groundwater)
Gaining	The reach is always gaining (i.e. groundwater is discharging to surface water)
Gain_loss	The reach is both gaining and losing
Uncertain	Gaining and/or losing in the reach is unknown

Figure 4.6 National Classification of gaining and losing stream predictions; example for the West Coast region, after Yang et al. (2019).

4.1.2 Consideration of Groundwater Connectivity and Receiving Environments

4.1.2.1 Surface Water

Characterisation of groundwater connectivity to surface water, sea and geothermal systems (Section 3.2.4) is limited in the West Coast region.

As part of different research studies, a series of national datasets that are relevant to the characterisation of groundwater connectivity have been developed, including maps of:

- groundwater recharge (Figure 4.4a; Westerhoff et al. 2018a)
- hydraulic head and water table depths (Figure 4.4b; Westerhoff et al. 2018b)
- groundwater discharge probability (Figure 4.5; Westerhoff et al. 2019), and
- gaining and losing streams (Figure 4.6; Yang et al. 2019).

Additionally, relevant local data, including river flow/gauging data, groundwater levels, water quality data, aquifer testing, distributed temperature sensing and radon sampling, and hydrological models will assist in the understanding of groundwater–surface water interaction.

4.1.2.2 Ocean

Pattle Delamore Partners (2011) reported "no known incidences of sea water intrusion on the West Coast to date". They noted that restrictions on groundwater takes were not needed to prevent sea water intrusion to groundwater at the time of the review because most wells in the West Coast region were not near the coast.

4.1.3 Definition of Management Targets

In May 2018, the West Coast Regional Council National Policy Statement for Freshwater Management – Regional Implementation Strategy was released. This document set out the Council's strategy for implementing the NPS-FM, including full implementation of the NPS-FM by 2030[7] (Beaumont et al. 2018). Since 2018, three FMU management groups have been established (Kawatiri, Grey and Hokitika), and a fourth should become active in December 2020 (South Westland; West Coast Regional Council 2020). FMU groups include representatives from across the community (e.g. local iwi, regional and district council representatives). FMU groups aim to:

> *"identify the values and issues of the community in the catchment around freshwater quality and quantity, and to look at what future plan provisions and work programmes may be needed to manage land and water resources in the area"* (Hokitika FMU Group 2020).

A diversity of management targets can be utilised in relation to water groundwater quantity, which includes abstraction limits, minimum groundwater levels / groundwater heads, minimum rivers flows/levels, minimum lake levels, minimum spring volumes, minimum wetland inflows and water quality bottom lines (Sections 3.1.2 and 3.2.3).

7 The NPS-FM 2020 requires implementation by 31 December 2024.

The definition of management targets for the GMZs would therefore benefit from the work developed by the FMU groups to understand the issues and values identified by the community. This will particularly apply where groundwater sustains surface water bodies, as surface water attributes will be conditioned by groundwater inputs.

In addition to considering the community values/issues and regulation requirements, a conceptual understanding of the aquifer(s) located in the GMZs will help to identify relevant management target types (e.g. abstraction limits). In a second stage, the development of water budget calculations will allow assessment of discharge and recharge components and estimation of sustainable allocation limits to satisfy local values.

4.2 Policy and Transitional Processes Development

4.2.1 Development of a Policy Framework

The current West Coast Regional Land and Water Plan (LWP) does not contain groundwater quantity allocation policies. The recommended science component of this roadmap will provide information to develop a groundwater quantity allocation framework (Sections 3.1.2 and 3.2.3). As explained previously, we recommend the joint management of surface water and groundwater. In addition, the proposed framework should contain provisions to avoid allocating water when the management targets are reached and solutions to phase-out potential over-allocation where the current abstraction does not allow the delivery of management targets.

“Promoting the efficient use of water” has been listed as one of the objectives of the LWP (West Coast Regional Council 2014). We recommend introducing specific provisions in relation to efficient water use (e.g. by providing guidelines of reasonable use) and to also consider water management efficiency (e.g. by improving accounting systems, by allocating water to higher economical returns).

Currently, the ‘first in, first served’ approach is widely used in New Zealand. The introduction of provisions prioritising the most valued uses in the LWP could inform water allocation, e.g. in consideration of higher environmental or economic standards (Makgill 2010).

The proposed framework should also have the flexibility to adapt to important changes in a catchment (e.g. large-scale afforestation, climate change). For example, WRC introduced a policy to review the allocation limits in its Waikato Regional Plan, e.g. in case climate change would affect surface water flows and groundwater sustainable yields (Policy 3.3.4.9; Waikato Regional Council 2007).

We suggest introducing region-wide interim limits to protect the freshwater resources of the region. These limits could be based on the Proposed National Environmental Standard on Ecological Flows and Water Levels 2008 recommendations (Section 3.1.2.4). Specific or tailored limits could then replace interim limits once they become available.

In addition, we recommend introducing specific policies in the LWP to prevent saltwater intrusion. For example, a policy could require an assessment of potential drawdown for groundwater takes located within a certain margin from the coast. Specific monitoring conditions could also be requested to ensure that no saltwater intrusion is induced (e.g. groundwater levels and conductivity).

4.2.2 Consultation with the Community

The proposed framework could be presented for discussion and refinement to the community (Sections 3.1.2 and 3.2.5). A first objective would then be to explain the regulation requirements and the proposed provisions and their rationale in order for the community to understand and become familiar with the allocation framework.

A second objective would be to ensure that the issues and values of the community have been integrated by the proposed framework and, if not, to acquire a better understanding of the values is associated with the local groundwater resources.

Overall, testing this framework with the community seems to align with the work started by the FMU groups and should allow the delivery of a more meaningful and appropriate framework.

4.2.3 Refinement of the Policy Framework

Following consultation with the community, the proposed framework should be adjusted as necessary to integrate the comments from the community while still meeting the regulation requirements (Sections 3.1.2 and 3.2.5).[8]

The proposed management targets and tailored limits could also be translated into GMZ-specific chapters of the LWP (e.g. as per for the Greater Wellington or Canterbury regions).

In relation to the consenting process, the introduction of requirements in the matter of aquifer testing, assessment of stream depletion, drawdown at the coast and interference effect on surrounding wells would be beneficial to ensure that the effects of new groundwater takes are properly assessed. It would also be relevant to introduce a general provision to take into account the potential cumulative effect of these individual takes.

To be able to assess the efficiency of the allocation framework, we recommend implementing efficient water accounting systems, including accurate metering near the bore head, efficient data transfer (e.g. telemetry) and data quality checks. This will provide useful insights to resource managers to quantify the actual quantity of groundwater abstracted, as it is often different from the consented amount. Metering requirements can be added as consent conditions.

Additionally, installing WCRC groundwater level monitoring bores will also be important. A drilling programme should be established and implemented over a multiple-year time frame, with priority given to aquifers under the greatest pressures or with the greatest sensitivity. Ideally, these monitoring bores should be established on ‘public land’ to assure long-term continued access for council. Groundwater level monitoring data (and especially long-term data) are valuable indicators of the sustainability of abstraction.[9] For example, declining groundwater level trends for the deep Makauri Aquifer (Gisborne) suggested an unsustainable regime with the need to reduce abstraction (or to increase recharge; White et al. 2012).

8 Refinement of the framework will also be possible through the notification phase of the plan.

9 In rare cases, for example, for coastal aquifers, water level trends can be misleading, as saline intrusion may induce stable levels despite depleting freshwater volumes.

5.0 CONCLUSION

5.1 Summary

This study analysed the current regulation requirements for freshwater quantity allocation, with particular attention to the newly released NPS-FM. The NPS-FM 2020 (now operative since 3 September 2020) requires efficient water use and management to avoid and phase out over-allocation, the operation and maintenance of water accounting systems and directs all councils to transparently report on the freshwater allocation and availability.

This report completed a technical review of the allocation frameworks currently utilised by ten regional councils. A strong focus on the NPS-FM 2020 requirements directed this review, with background information (e.g. an explanation of stream depletion) and regional provision examples (e.g. ECan policies) provided.

A roadmap to introduce a groundwater quantity allocation framework for the West Coast region was developed. This roadmap included two main components: (i) the use of scientific information to map GMZs, consider groundwater connectivity and identify management targets; and (ii) the development of new policies, with transitional processes to implement these policies. These policies include the introduction of sustainable allocation limits linked to the identified management targets. The provided methodology aimed to be consistent, transparent and reproductible across the West Coast region.

The proposed groundwater quantity framework should integrate groundwater and surface water, promote water use and water management efficiency, avoid over-allocation and have the flexibility to update limits in case of significant changes in the catchments. Consultation with the community and iwi would allow them to be more familiar with the framework and identify appropriate and achievable values. The monitoring of water use and groundwater levels is crucial to assess the effectiveness of the allocation framework and inform potential adjustments. Finally, it was recommended to make allocation data publicly available for transparency and outreach purposes and for facilitating access to this information for water managers, iwi, communities and consultants.

5.2 Next Steps

As part of a second Envirolink grant for the WCRC, GNS was commissioned to test the implementation of this roadmap in a case study. WCRC staff expressed their interest in the upper Grey River FMU. The next steps include delineation of GMZs, assessment of groundwater connectivity and identification of draft managements targets for this area.

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APPENDICES

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APPENDIX 1 SUMMARY OF THE REGIONAL WATER QUANTITY ALLOCATION FRAMEWORKS

These templates provide high-level summaries of regional plans and provisions in relation to themes; however, they do not capture details/exceptions – please refer to the original plans and policies for a complete/accurate description.

Despite the authors making their best effort to provide accurate information in this appendix, and regional council staff reviewing our content, there may be inaccuracies due to the complexity of regional plans, our summary of them and the limited council time available for review.

A1.1 Auckland Council

Item	Description	Reference
Regional Plan	Auckland Unitary Plan (AUP).	https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/unitary-plan/Pages/what-is-the-auckland-unitary-plan.aspx
Plan status and development	Operative in part.	-
Freshwater Management Units (FMU)	10 FMUs have been defined. They have been determined based on common marine receiving environments. This approach reflects the small size of Auckland's streams and the focus of stakeholders on marine water outcomes. For groundwater, AC has 121 aquifer management areas, which could be argued to function as FMUs for groundwater.	https://www.aucklandcouncil.govt.nz/environment/looking-after-aucklands-water/looking-after-our-waterways/Pages/wai-ora-healthy-waterways.aspx
Community involvement	The Wai Ora Partnerships team within the Wai Ora – Healthy Waterways Programme lead the engagement related to the NPS-FM implementation, with a focus on collaborating with key stakeholders, council-controlled organisations and mana whenua.	-
Plan reference to water allocation	Chapter E2: Water quantity, allocation and use. Policy E2.3 (5): Water allocation and availability guidelines.	https://unitaryplan.aucklandcouncil.govt.nz/Images/Auckland%20Unitary%20Plan%20Operative/Chapter%20E%20Auckland-wide/1.%20Natural%20Resources/E2%20Water%20quantity%20allocation%20and%20use.pdf

Item	Description	Reference
Environmental minimum flows and levels	Water availability, flows and levels are included in: • Appendix 2: River and stream minimum flow and availability; and • Appendix 3: Aquifer water availabilities and levels to guide the assessment of resource consent applications to take and use surface water from lakes, rivers, streams, springs or wetlands, and take and use groundwater from aquifers. These guidelines will be reviewed and updated to meet the requirement of the NPS-FM where applicable. The NPS-FM also requires the inclusion of interim policies in the Plan to guide freshwater allocation. This is until such time as the Plan's provisions give full effect to the NPS-FM.	Appendix 2 Appendix 3
Limits – Groundwater	Table 1: Aquifer water availabilities and Table 2: Interim aquifer groundwater levels (in Appendix 3: Aquifer water availabilities and levels) are not exceeded, with: • Water availability in m^3/year: - Specified values for aquifers as listed in Appendix 3. - For other aquifers: ▪ 15% of average annual recharge (as determined by AC) for shallow, coastal aquifers; ▪ 35% of average annual recharge (as determined by AC) for all other aquifers with connection to a surface water body; and ▪ 65% of average annual recharge (as determined by AC) for all other aquifers not separately listed without a connection to a surface water body. • Interim groundwater levels (in metres above mean sea level) for a list of specific bores.	Policy E2.3 (5)(b) https://unitaryplan.aucklandcouncil.govt.nz/Images/Auckland%20Unitary%20Plan%20Operative/Chapter%20M%20Appendices/Appendix%203%20Aquifer%20water%20availabilities%20and%20levels.pdf

Item	Description	Reference
Limits – Surface Water	Table 1: River and stream minimum flow and availability (in Appendix 2: River and stream minimum flow and availability) are not exceeded, with: • Minimum flow: - Specific values for river, as listed in Appendix 2. - 85% of MALF for other rivers/streams. • Surface water available: - Specific values for river, as listed in Appendix 2. - 30% of MALF for other rivers/streams.	Policy E2.3 (5)(a) https://unitaryplan.aucklandcouncil.govt.nz/Images/Auckland%20Unitary%20Plan%20Operative/Chapter%20M%20Appendices/Appendix%202%20River%20and%20stream%20minimum%20flow%20and%20availability.pdf
Groundwater and surface water interactions	Generic requirements.	Policy E2.3(7)
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the AUP.	Policy E2.3 (10)
Water shortage conditions	Specifications in the AUP.	Policy E2.3 (12)
Water use metering	Specifications in the AUP.	Policy E2.3 (9)
Information and data (allocation maps)	No interface introduced yet.	-
Efficient allocation and use	Specifications in the AUP.	Policy E2.3 (4)
Priority of use	Specifications in the AUP.	Policy E2.3 (1), (2) and (3)

A1.2 Bay of Plenty Regional Council

Item	Description	Reference
Regional Plan	Regional Natural Resources Plan (RNRP).	https://atlas.boprc.govt.nz/api/v1/edms/document/A3490282/content
Plan status and development	The RNRP was introduced in September 2017 and will eventually incorporate all of the following stand-alone plans: • On-site Effluent Treatment Regional Plan • Regional Air Plan • Regional River Gravel Management Plan • Regional Water and Land Plan • Rotorua Geothermal Regional Plan • Tarawera River Catchment Plan. No rules, objectives or policies in the RWLP have been changed. A series of plan changes (PC) are currently underway (e.g. Proposed PC10: Lake Rotorua Nutrient Management, Proposed PC13: Air Quality, Draft PC14: On-Site Effluent Treatment- OSET and Proposed PC17: Awatarariki Fanhead). PC9 (notified in October 2016), the first step in a two-stage approach to improving the rules for water quality and quantity management in the Bay of Plenty, was withdrawn in February 2020.	https://www.boprc.govt.nz/your-council/plans-and-policies/plans/regional-plans/regional-natural-resources-plan
Freshwater Management Units	FMU delineation has not been finalised yet. BoP has currently delineated nine Water Management Areas (WMAs) for managing freshwater, based on a range of factors (e.g. physical surface catchments, iwi cultural boundaries, Treaty settlements, major project areas and where people live). Specific objectives, limits and rules for each WMA will override the regional defaults.	https://www.boprc.govt.nz/your-council/plans-and-policies/plans/regional-plans/regional-natural-resources-plan/national-policy-statement-for-freshwater-management-implementation

Item	Description	Reference
	WMAs are: Tauranga Harbour, Kaituna Maketū and Pongakawa Waitahanui, Tarawera, Rotorua Lakes, Rangitaiki, Whakatāne and Tauranga, Ohiwa Harbour and Waiotahe, Waioeka and Otara, and East Coast. The WMAs may contain a number of different FMUs.	
Community involvement	At regional scale: Engagement with stakeholders in relation to issues to implement the NPS-FM through a regional water advisory panel, including representatives from major primary industry sectors, environmental groups, energy producers and other interest groups. At sub-regional scale: approach tailored for each WMA. Community groups have been set up in water management areas in Rangitāiki, Kaituna/Maketū and Pongakawa/Waitahanui catchments to support decision-making. BoP intends to roll out similar engagement in other WMAs.	https://www.boprc.govt.nz/environment/fresh-water/co-governance-and-advisory-groups Example for Rangitaiki: https://www.boprc.govt.nz/our-projects/rangitaiki-freshwater-community-group
Plan reference to water allocation	Resource consents allow for groundwater or surface water to be allocated amongst different users. Water take consents can be issued for any purpose (unless it is a prohibited activity) but will only be granted if the water use is efficient and will not have a significant environmental or cultural impact.	Chapter 7: Water quantity and allocation https://atlas.boprc.govt.nz/api/v1/edms/document/A3416920/content https://www.boprc.govt.nz/environment/fresh-water/water-use
Environmental minimum flows and levels	The RNRP sets regional defaults for minimum flow and allocation levels, as well as region-wide parameters (e.g. water metering and reporting requirements, permitted activity thresholds and requirements, policy for dealing with over allocation, existing unauthorised takes, transfers, etc.).	Surface water: Policies 64 to 69 Groundwater: Policies 70 to 75 Explanations for community, iwi and hapū engagement: Setting Environmental Flows in Water Management Areas: https://cdn.boprc.govt.nz/media/737219/2018-03-15-wma-env-flow-setting_info-sheet-for-all-wma-engagement.pdf

Item	Description	Reference
		Introduction to Groundwater Environmental Level Setting (updated February 2019) https://www.boprc.govt.nz/media/796400/2018-03-28-rangitaiki-groundwater-limits_info-sheet.pdf Kaituna and Pongakawa-Waitahanui Kaituna WMA, based on a 3D groundwater modelling approach: https://atlas.boprc.govt.nz/api/v1/edms/document/A3470701/content Report on the approach to iwi engagement (Komiti Māori): https://atlas.boprc.govt.nz/api/v1/edms/document/A3560937/content See report 7.2 (Te Hononga: Maori Relationship and Engagement Plan for the National Policy Statement for Freshwater Managament 2020, p. 33) and Appendix 1 (Te Hononga: Draft Regional Maori Engagement Plan for Implementing the NPS-FM 2020, p. 41)
Limits – Groundwater	Interim region-wide allocation threshold for aquifers, expressed in term of groundwater recharge.* Specific allocation limit for hydrogeological units underlying the WMAs. ** Withdrawn PC9 proposed to set this allocation threshold at 35% of long-term residual groundwater recharge.* *Residual groundwater recharge = groundwater recharge – base flow.* *Groundwater recharge = rainfall – evapotranspiration.* *The proposed National Environmental Standard on Ecological Flows and Water Levels, Discussion Document, suggested 15% and 35% of recharge depending on the type of aquifer.*	Methods 183 and 184 Maps with current limits: https://boprc.maps.arcgis.com/apps/MapSeries/index.html?appid=7a2ff1e0b0454bdb89498f0e019a23dd Introduction to Groundwater Environmental Level Setting (updated February 2019) https://www.boprc.govt.nz/media/796400/2018-03-28-rangitaiki-groundwater-limits_info-sheet.pdf

Item	Description	Reference
Limits – Surface Water	The RNRP recommends using the following interim allocation limits until permanent limits are set through regional and/or sub-regional plans within each WMA: 1. Primary instream minimum flows: 90% of Q5 seven-day low flow* for each river or stream. 2. Primary allocation limit for surface water: 10% of Q5 seven-day low flow for each river or stream. 3. Secondary in-stream minimum flow for rivers or streams with a mean flow ≥5 m^3/s: 100% of Q5 seven-day low flow for each river or stream. 4. Secondary allocation limit for rivers or streams with a mean flow >5 m^3/s of 40% of the Q5 seven-day low flow, providing that the combined total of primary and secondary allocation does not exceed 50% of the Q5 seven-day low flow. ** Q5 seven-day flow: the five-year seven-day MALF, which is the seven-day low flow value that has a 20% probability of occurring in any one year.*	Policy 66 Table 13: Water allocation methodology Table 14: Water allocation on surface water bodies with hydroelectric power schemes Method 177 and 179 Table 16: Instream minimum flow requirement methodology Figure 6: Instream minimum flow requirements process Setting Environmental Flows in Water Management Areas https://cdn.boprc.govt.nz/media/737219/2018-03-15-wma-env-flow-setting_info-sheet-for-all-wma-engagement.pdf
Groundwater and surface water interactions	Specifications in the RNRP. 'Baseflow protection approach'.	Policies 74 and 75 Method 165 and 184 Rule 43
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the RNRP.	Policies 64, 66, 67, 68, 69, 70, 71, 72, 74, 76 and 79
Water shortage conditions	Specifications in the RNRP.	Policy 80 Method 172 Table 15: Water management during drought and low flow events

Item	Description	Reference
Water use metering	Specifications in the RNRP.	Rule 41A Method 164
Information and data (allocation maps)	Indicative groundwater allocation map tool available online (regularly updated based on consent application process). Report on surface water allocation as per October 2016.	https://boprc.maps.arcgis.com/apps/MapSeries/index.html?appid=7a2ff1e0b0454bdb89498f0e019a23dd https://www.boprc.govt.nz/media/2866/assessment-of-water-availablity-report-rev-12.pdf
Efficient allocation and use	Specifications in the RNRP.	Policy 73 Method 168
Priority of use	Specifications in the RNRP.	Policy 71 Method 166

PC9: Schedule 15 – Method for Estimating Surface Water and Groundwater Allocation Status (Withdrawn, see Figure 3.8)

1. Residual Average Annual Recharge (RAAR) is calculated as follows:
2. Calculate average annual flows into the relevant aquifer or zone.
3. Subtract from this flow an allocation to sustain stream flow where it is determined that there is connection between groundwater and surface water (note that this is not necessary for the deeper groundwater zones, where there is unlikely to be connection to surface water).
4. The groundwater remaining is referred to as the 'Residual Average Annual Recharge'.
5. The allocation limit is set at 35% of RAAR, as shown in Figure 3.8.

Total current authorised allocations are calculated by summing the net annual volume (m^3/year) allocated to every water permit to take water from that aquifer or zone, with the following modifications where the consent does not specify a period of use:

- Annual use is assessed as daily use x 155 days for irrigation (includes crop and pasture).
- Annual use is assessed as daily use x 30 days for frost protection.
- Otherwise, annual use is calculated on the basis of 365 days continuous use (this includes municipal and commercial).

Total current authorised allocations will be compared with 35% of RAAR to determine whether the aquifer or zone is under, fully or over-allocated in relation to the limits in WQ P5 (Water Quantity Policy 5).

A1.3 Environment Canterbury Regional Council

Item	Description	Reference
Regional Plan	The Canterbury Land and Water Regional Plan (LWRP).	https://eplan.ecan.govt.nz/eplan/#Rules/0/55/1/25081
Plan status and development	The LWRP was made operative in late 2016 and established provisions for land and water management at the regional scale. The LWRP is structured to give effect to the Canterbury Water Management Strategy (CWMS) process, with 10 sub-regional chapters that relate to individual CWMS zones. Alongside these, the LWRP also specifies region-wide objectives, policies and rules that apply where location-specific provisions have not been established in the various sub-regional chapters. Several Plan Changes (PC) have been undertaken since: PC 1: Selwyn Waihora, PC 2: Hinds, PC 3: South Coastal Canterbury, PC 4: Omnibus, PC 5; Nutrient Management and Waitaki and PC 6: Wairewa / Lake Forsyth are now operative. PC 7 is at the hearings stage.	https://www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan/
Freshwater Management Units	Ten zones to manage freshwater (not explicitly identified as FMUs), as well as: • four FMUs covering the Upper Waitaki zone (PC 5), and • one FMU for the Wairewa / Lake Forsyth catchment.	https://opendata.canterburymaps.govt.nz/datasets/fd5453687d7a4be0a7ae75fd8f82b4c7_2
Community involvement	Engagement with the Canterbury region community is based on the use of the collaborative zone committees.	https://ecan.govt.nz/your-region/your-environment/water/whats-happening-in-my-water-zone/about-the-water-zone-committees/ https://www.ecan.govt.nz/your-region/your-environment/water/canterburys-approach-to-water-management/collaborative-planning
Plan reference to water allocation and	The LWRP specifies environmental flows and allocation limits for surface waterways in the Canterbury region either via catchment (or sub-catchment) specific limits established in sub-regional chapters or the region-wide (default) allocation limits specified in Chapter 5.	(Sub)Catchment-specific: • Policies and rules in Chapters 6 to 15 • Schedule 13: Requirements for implementation of water allocation regimes Region-wide: • Policies in Chapter 4 and rules in Chapter 5.

Item	Description	Reference
Environmental minimum flows and levels	-	-
Limits – Groundwater	The LWRP specifies volumetric allocation limits for a significant number (>40) of groundwater allocation zones. In its sub-regional chapters, groundwater allocation is managed in terms of Policies and Rules (Chapters 4 and 5), including limit on abstraction of groundwater as a permitted activity outside of the defined zones.	-
Limits – Surface Water	The LWRP specifies environmental flows and allocation limits for surface waterways in the Canterbury region either: 1. via catchment (or sub-catchment) specific limits established in sub-regional chapters, or 2. via region-wide (default) allocation limits specified in Chapter 5. Method (1) above comprises minimum flows and allocation blocks (for specific environmental monitoring or administrative points). Method (2) determines minimum flow and allocation regime on a percentage of the seven-day MALF set at a threshold to achieve CWMS targets related to supply reliability and ecosystem health. Other methods specified in the LWRP to manage the abstraction of surface water include controls on stream-depleting groundwater takes, partial restrictions on abstraction, restrictions on transfers within or between allocation zones and provision for water user groups.	(Sub)Catchment-specific: • Allocation limits chapters and tables of the sub-regional chapters (Sections 6 to 15), e.g. 6.6: Allocation Limits, Table 2: Kaikoura Streams Environmental Flow and Allocation Limits and Table 3: Kaikoura Groundwater Limits Region-wide: • Chapters 4 and 5: Policies and Rules • Rules 5.128 to 5.132: Take and Use Groundwater
Groundwater and surface water interactions	Combined groundwater and surface water allocation regimes; hydraulically connected groundwater is also considered to be part of surface water allocation blocks.	Schedule 13: Requirements for implementation of water allocation regimes Schedule 9: Assessment of Stream Depletion Effect

Item	Description	Reference
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the LWRP.	Sub-regional sections have specific methods and timeframes to manage over-allocation
Water shortage conditions	Specifications in the LWRP.	Policy 4.72: Sharing water in times of restriction
Water use metering	Requirements in the LWRP.	Policy 4.54: Abstraction of Water
Information and data (allocation maps)	'Canterbury maps' web-interface. At present, accurate maps of allocation zones from all plans and associated allocation limits are available. Current allocation data will be added in the future.	https://opendata.canterburymaps.govt.nz/datasets/lwrp-groundwater-allocation-zones https://opendata.canterburymaps.govt.nz/datasets/lwrp-surface-water-allocation-zones?geometry=161.263%2C-45.445%2C-177.830%2C-42.682 https://opendata.canterburymaps.govt.nz/datasets/lwrp-combined-surface-groundwater-allocation-zones?geometry=166.962%2C-44.119%2C177.415%2C-42.723&selectedAttribute=Zone_Status
Efficient allocation and use	Specifications in the LWRP.	Policies 4.65, 4.66, 4.67, 4.68, 4.69: Efficient Use of Water
Priority of use	Specifications in the LWRP.	Policy 4.5: Strategic Policies

A1.4 Environment Southland Regional Council

Item	Description	Reference
Regional Plan	Proposed Southland Water and Land Plan (pSWLP).	Part A (text, decision version 4/04/2018): https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan/documents/Proposed%20Southland%20Water%20and%20Land%20Plan%20-%20Part%20A%20-%20Decisions%20Version%20%284%20April%202018%29%20PDF.pdf Part B (maps, decision version 4/04/2018): https://www.es.govt.nz/repository/libraries/id:26gi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan/documents/Proposed%20Southland%20Water%20and%20Land%20Plan%20-%20Part%20B%20-%20Decisions%20Version%20%284%20April%202018%29%20PDF.pdf
Plan status and development	The formal Environment Court appeals process is currently underway.	https://www.es.govt.nz/about-us/plans-and-strategies/regional-plans/proposed-southland-water-and-land-plan
Freshwater Management Units	Five FMUs in Southland: Fiordland and Islands, Aparima, Mataura, Oreti, and Waiau. To manage groundwater, groundwater management zones that have similar hydrogeological characteristics have been delineated, currently including: • 30 GMZs for unconfined aquifers; • 2 GMZs for confined aquifers with significant levels of abstraction in the Mossburn/Lumsden area.	Policy 46 Map Series 6: Freshwater Management Units Map Series 3: Groundwater Management Zones https://maps.es.govt.nz/index.aspx?app=groundwater&ext=1126883,4821543,1373775,4939103

Item	Description	Reference
Community involvement	As part of the 'People, Water and Land Programme – Te Mana o te Tangata, te Wai, te Whenua'*, the 'Regional Forum' has been set up to advise ES's council and Te Ao Marama board members (Governance) on the methods to achieve the communities' values and objectives for freshwater. ** This programme is a partnership between ES and Te Ao Marama aiming to inspire change to improve Southland's water and land.*	https://waterandland.es.govt.nz/about/regional-forum
Plan reference to water allocation and	The pSWLP contains region-wide and FMU specifications. The primary allocation thresholds in this Plan are intended to be precautionary, with fixed allocation limits to be developed and implemented within the FMU sections of this Plan over time.	Policy 21: Allocation of water Policy 47: FMU process Policy 22: Management of the effects of groundwater and surface water use Policy 42: Consideration of water permit applications Rule 49: Abstraction diversion and use of water Rule 54: Abstraction and use of ground water
Environmental minimum flows and levels	As part of the FMU limit-setting process, FMU-specific objectives, policies and rules will replace the region-wide provisions. ES intends to have its FMU chapters operative by December 2025.	Policy 22: Management of the effects of groundwater and surface water use Policy 42: Consideration of water permit applications Policy 47: FMU process Rule 49: Abstraction diversion and use of water Rule 54: Abstraction and use of ground water
Limits – Groundwater	For the GMZ defined in Map Series 3: • For unconfined aquifers: primary allocation limits are specified in Table L.4. • For the Lumsden Aquifer: primary allocation and minimum groundwater level cut-offs are specified in Table L.5. • For the North Range Aquifer: primary allocation and minimum groundwater level cut-offs are specified in Table L.7, and pro-rata reduction in seasonal allocation is based on the seasonal recovery triggers specified in Table L.8.	Map Series 3: Groundwater Management Zones Appendix L.4: Calculation of seasonal surface water and groundwater allocation Appendix L.5: Groundwater Allocation Table L.4: Primary groundwater allocation limits Table L.5: Lumsden Aquifer allocation and minimum groundwater level cut-offs for the Lumsden Aquifer Table L.7: North Range Aquifer minimum groundwater level cut-off Table L.8: North Range Aquifer seasonal recovery triggers

Item	Description	Reference
	• For all other confined aquifers: allocation volumes, minimum water level cut-offs and seasonal recovery triggers are to be established following the methodology outlined in Appendix L.6. For the aquifers located outside the GMZ, primary allocation is established as 35% of the rainfall recharge occurring over the relevant land area where the water is to be taken.	Appendix L.6: Establishing allocation volumes for confined aquifers Appendix L.7: Establishing allocation volumes for takes outside of groundwater management zones
Limits – Surface Water	Minimum flow: 1. For takes from the primary allocation, the minimum flow will be Q95. 2. For takes from the secondary allocation, the minimum flow will be the natural median flow during the period from 1 April to 30 November each year and the natural mean flow during the period from 1 December to 31 March each year. 3. For takes outside of the primary or secondary allocation, the minimum flow will be derived on a case-by-case basis using the guidance contained in Method 2 of Appendix K. Primary allocation is available when*: 1. the total surface water allocation < 30 percent of the natural pre-allocation Q95 as determined by ES following the methodology established in Appendix K, at any downstream point in the catchment; and 2. the flow at that location ≥ natural Q95. Secondary allocation is available when*: 1. the total surface water allocation <10% of the relevant seasonal flow cut-off flow in the lakes, rivers, artificial watercourses, modified watercourses or natural wetlands at the time of take; and	Appendix K: Surface Water Appendix

Item	Description	Reference
	2. the flow at that location ≥ the natural median flow during the period from 1 April to 30 November each year and the natural mean flow during the period from 1 December to 31 March each year. ** For any lakes, rivers, artificial watercourses, modified watercourses or natural wetlands outside the Waiau catchment and not subject to a Water Conservation Order.*	
Groundwater and surface water interactions	Management approach adjusted according the degree of hydraulic connection (riparian, direct, high, moderate and low types).	Policy 23: Stream depletion effects Appendix L.2: Stream depletion effects
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the pSWLP.	Policy 21.2: Allocation of water Policy 47.3
Water shortage conditions	Specifications in the pSWLP.	Policy 24: Water abstraction for community water supply Policy 25: Priority takes Policy 42(5): Consideration of water permit applications
Water use metering	Specifications in the pSWLP.	Policy 42.3: Consideration of water permit applications
Information and data (allocation maps)	GMZs with factsheets available online and provide an indication of the allocation level. Details about the allocation limits and current use is not provided yet.	https://maps.es.govt.nz/index.aspx?app=groundwater&ext=1126883,4821543,1373775,4939103
Efficient allocation and use	Specifications in the pSWLP.	Appendix O: Reasonable and Efficient Use of Water

A1.5 Greater Wellington Regional Council

Item	Description	Reference
Regional Plan	Proposed Natural Resources Plan (pNRP).	Part 1: http://pnrp.gw.govt.nz/assets/Uploads/Proposed-Natural-Resources-Plan-Part-1.pdf Part 2: http://pnrp.gw.govt.nz/assets/Uploads/Proposed-Natural-Resources-Plan-Part-2.pdf Maps part 1: http://pnrp.gw.govt.nz/assets/Uploads/Chapter-13-Maps-Part-1.pdf Maps part 2: http://pnrp.gw.govt.nz/assets/Uploads/Chapter-13-Maps-Part-2.pdf
Plan status and development	The integrated pNRP replaces five regional plans for managing the coast, soil, discharges to land, freshwater and air. Decisions on the pNRP were publicly notified on 31 July 2019, and, from the date of the public notice, the proposed Natural Resources Plan was amended in accordance with those decisions. Whaitua recommendations have not yet been incorporated in the plan changes and will be subject to cost/benefit and other planning tests; therefore, they might be adjusted.	https://www.gw.govt.nz/proposed-natural-resources-plan/
Freshwater Management Units	GWRC is basing water planning around five catchment areas or 'whaitua'. FMUs are established within these whaitua through whaitua committees who consult widely with the community of interest. FMU boundaries are being determined through consideration of the values for freshwater for each area of the whaitua (for example, see the Ruamāhanga Whaitua Implementation Programme [WIP] and related FMUs. The regulatory recommendations in the WIP have been included in a plan change process to become a chapter in the PNRP).	https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/guide-to-freshwater-management-units_0.pdf http://www.gw.govt.nz/assets/Ruamahanga-Whaitua/Final-Ruamhanga-WIP-August-2018-Pdf-version.pdf

Item	Description	Reference
Community involvement	The pNRP was created in 2009 and is an expression of the partnership relationship with mana whenua at a regional level. It provides the mana whenua voice in the area of resource management as it relates to their sites of significance. It emphasises regional council and mana whenua individual and shared roles in caring for the environment. It puts a great deal of importance on the mauri, or life-giving properties, of fresh and coastal waters. GWRC's primary avenue for community engagement is through the whaitua committees.	https://www.gw.govt.nz/the-proposed-natural-resources-plan/ http://www.gw.govt.nz/ruamahanga-whaitua/
Plan reference to water allocation and	The pNRP includes general policies and rules for water allocation, plus specific policies in the whaitua chapters. Groundwater shall be allocated from one of two sources according to connectivity to surface water. Minimum flows, minimum water levels and core allocation referred to in the Plan are interim to the extent that they will be reviewed by whaitua committees and may be amended by plan changes or variations following recommendations of whaitua committees.	Policy P108: Integrating management of groundwater and surface water Policy P113: Core allocation for rivers Policy P116: Reallocating water Policy P117: Supplementary allocation amounts at flows above the median flow Rules 5.6: Water allocation Table 4.1: Groundwater connectivity Policies in Chapters 7–11 (whaitua chapters) also apply to allocating water
Environmental minimum flows and levels	The Proposed Plan includes a set of interim environmental flows and levels that apply region-wide until over-written for each whaitua through the whaitua process.	Policy P111: Water takes at minimum flows and minimum water levels Policy P129: Minimum flows and minimum water levels Policy R.P1: Minimum flows and minimum water levels in the Ruamāhanga Whaitua Policy WH.P1: Minimum flows and minimum water levels in the Wellington Harbour and Hutt Valley Whaitua Policy P.P1: Minimum flows and minimum water levels in Te Awarua-oPorirua Whaitua Policy K.P1: Minimum flows and minimum water levels in the Kāpiti Coast Whaitua Policy WC.P1: Minimum flows and lake levels in the Wairarapa Coast Whaitua

Item	Description	Reference
Limits – Groundwater	There are three categories of groundwater bodies: High connection (Category A), Moderate connection (Category B) and Limited Connection (Category C). Groundwater or surface water limits apply according to categories, with specific limits provided in the whaitua individual chapters.	Table 4.1: Groundwater connectivity Policy R.P2: Core allocation in the Ruamāhanga Whaitua Policy WH.P2: Core allocation in the Wellington Harbour and Hutt Valley Whaitua Policy K.P2: Core allocation for rivers and groundwater in the Kāpiti Coast Whaitua The calculated amount of water available for allocation listed in: Tables 7.3–7.5, Tables 8.2 and 8.3 and Tables 10.2 and 10.3
Limits – Surface Water	**Core allocation**: The maximum amount of water available for allocation: 1. for the catchment management unit and catchment management sub-unit listed in the whaitua chapters shall not exceed whichever is the greater of: a. the total amount allocated by resource consents at the time the resource consent application is lodged; or b. the allocation amounts provided for in Tables 7.3–7.5, Tables 8.2 and 8.3 and Tables 10.2 and 10.3; or 2. for rivers (and their tributaries) and Category A groundwater and Category B groundwater (stream depletion) not covered by (1): a. 50% of the MALF for rivers with mean flows >5 m^3/sec, or b. 30% of the MALF for rivers with mean flow ≤5 m^3/sec.	Table 4.1: Groundwater connectivity Policy R.P2: Core allocation in the Ruamāhanga Whaitua Policy WH.P2: Core allocation in the Wellington Harbour and Hutt Valley Whaitua Policy K.P2: Core allocation for rivers and groundwater in the Kāpiti Coast Whaitua The calculated amount of water available for allocation listed in: Tables 7.3–7.5, Tables 8.2 and 8.3 and Tables 10.2 and 10.3

Item	Description	Reference
	Supplementary allocation: when the river is above the median flow: 1. for rivers (and their tributaries) listed in Table 1 of Schedule V, up to 50% of the portion of flow in the river above the median flow at the point of abstraction; or 2. for rivers (and their tributaries) listed in Table 2 of Schedule V, up to 10% of the total amount of flow in the river at the point of abstraction; or 3. for rivers and their tributaries not listed in either Table 1 or 2 of Schedule V, up to 10% of the total amount of flow in the river at the point of abstraction.	
Groundwater and surface water interactions	Policy P108: Integrating management of groundwater and surface water. Groundwater shall be allocated from one of two sources: • Category A groundwater and Category B (stream depletion) within the core allocation for surface water, or • Category B groundwater (excluding Category B [stream depletion]) and Category C groundwater within the core allocation for groundwater.	Table 4.1: Groundwater connectivity
Over-allocation and measures to avoid / phase out over-allocation	The pNRP includes methods to phase out over-allocation of water quantity. This includes allocation limits and rules in the Proposed Plan to manage reduction in abstractions over time, and improvement in the efficient use of abstractions.	Objective O52A
Water shortage conditions	Specifications in the pNRP.	Policy P112: Priorities in drought and serious water shortage
Water use metering	Consideration of 'water use records' in relation to reasonable and efficient use of water in the pNRP.	Policy P118: Reasonable and efficient use

Item	Description	Reference
Information and data (allocation maps)	GIS map gallery available with information related to pNRP; no direct allocation maps available.	https://mapping.gw.govt.nz/GW/GWpublicMap_Mobile/?webmap=df7b7def7721420ea75e7240706f0f61
Efficient allocation and use	Provisions in the pNRP that are directed at promoting and encouraging the efficient use of water.	Policy P118: Reasonable and efficient use
Priority of use	Specifications in the pNRP.	Policy P114: Priorities

A1.6 Horizons Regional Council

Item	Description	Reference
Regional Plan	The One Plan.	http://www.horizons.govt.nz/CMSPages/GetFile.aspx?guid=ad4efdf3-9447-45a3-93ca-951136c7f3b3
Plan status and development	Fully operative since December 2014, the One Plan is the 'one-stop shop' resource management planning document for the Horizons region. It combines the Regional Policy Statement, Regional Plan and Coastal Plan.	http://www.horizons.govt.nz/publications-feedback/one-plan
Freshwater Management Units	Water management zones and subzones in the One Plan cover the entire region but are not the same as the FMUs. Six FMUs have been delineated: Horowhenua, Manawatū, East Coast, Rangitīkei, Turakina-Whangaehu and Whanganui (each of these has boundaries that match the boundaries of a collection of the water management zones).	http://www.horizons.govt.nz/HRC/media/Media/Agenda-Reports/Strategy-Policy-Committee-2019-10-09/19139%20State%20of%20Environment%20%20Catchment%20Summaries.pdf
Community involvement	Horizons is also developing a catchment planning programme, 'Our Freshwater Future', working with local communities to develop broad-based action plans for continued improvements to freshwater quality in the region.	https://www.horizons.govt.nz/managing-natural-resources/our-freshwater-future
Plan reference to water allocation and	Section 5.4.3: Water Quantity and Allocation of the Part 1 of the One Plan. For the purposes of managing water quality, water quantity and activities in the beds of rivers and lakes, the catchments in the region have been divided into Water Management Zones and Water Management Sub-zones. Groundwater has been divided into GMZs.	http://www.horizons.govt.nz/publications-feedback/one-plan/part-1-regional-policy-statement/chapter-5/5-4-3-water-quantity-and-allocation **Surface water:** Policy 5-1: Water Management Zones and Values Policy 5.4.3.2: Policies for Surface Water Policy 5-14: Overall approach for surface water allocation Policy 5-15: Core allocations and minimum flows Policy 5-17: Supplementary water allocation Policy 5-18: Apportioning, restricting and suspending takes in times of minimum flow Policy 5-19: Surface water allocation – lakes

Item	Description	Reference
		Figure A:1 Schedule A http://www.horizons.govt.nz/CMSPages/GetFile.aspx?guid=4c2a879a-8f05-44a1-952b-e8f34078f8c8 **Groundwater** 5.4.3.3: Policies for Bores and Groundwater Policy 5-20: Overall approach for bore management and groundwater allocation Policy 5-21: Groundwater Management Zones Figure D:1 in Schedule D
Environmental minimum flows and levels	The regional council has set minimum environmental flows and defined core allocation volumes for Water Management Sub-zones under pressure from surface takes. These are used to manage and allocate water. GMZs have also been established and respective allocable volumes identified.	Policy 5-16: Approach to setting minimum flows and core allocations
Limits – Groundwater	Annual allocable volumes (m^3/year) are provided for each GMZ in Table D.1: Allocation limits by Groundwater Management Zone. These volumes are based on 5% of the average annual rainfall for each GWMZ.	Schedule D: Groundwater quantity http://www.horizons.govt.nz/CMSPages/GetFile.aspx?guid=99ea476c-2875-4c17-8ca1-62c4395264d3
Limits – Surface Water	The surface water allocation framework is based on the concepts of: • an environmental flow maintained by a minimum flow • a core allocation limit, and • a management flow that sets the upper limit of the core allocation. Any further or 'supplementary' allocation is available only at high flows (e.g. >median) to encourage water storage for later use (water harvesting).	Schedule C: Surface Water Quantity http://www.horizons.govt.nz/CMSPages/GetFile.aspx?guid=b519e6d9-c8b1-45a6-a5ab-89cce244d9b4

Item	Description	Reference
Groundwater and surface water interactions	Groundwater takes that are hydrologically connected to rivers are managed within the minimum flow and allocation regimes established for rivers.	Objective 5-3 (b) ii Policy 16-6: Effects of groundwater takes on surface water bodies
Over-allocation and measures to avoid / phase out over-allocation	The demand on surface water and groundwater resources is one of the most critical issues addressed in the One Plan. The water allocation framework of the One Plan is implemented during the consenting process to avoid over-allocation of water.	Scope 5.1.3 Policy 5-20 (c): Overall approach for bore management and groundwater allocation
Water shortage conditions	Specifications in the One Plan.	Policy 5-18: Apportioning, restricting and suspending takes in times of minimum flow
Water use metering	Requirements in the One Plan.	Policy 16-8: Monitoring requirements of consent holders
Information and data (allocation maps)	Map with water allocation status for catchments as per October 2019. No online updated maps.	Surface water catchments (October 2019): http://www.horizons.govt.nz/HRC/media/Media/Water/Water-Allocation-Status_All-catchments_102019.pdf?ext=.pdf
Efficient allocation and use	Specifications in the One Plan.	Policy 5-12: Reasonable and justifiable need for water Policy 5-13: Efficient use of water
Priority of use	Some specifications in the One Plan.	Policy 5-18: Apportioning, restricting and suspending takes in times of minimum flow

A1.7 Northland Regional Council

Item	Description	Reference
Regional Plan	(Regional Water and Soil Plan for Northland 2004). Proposed Regional Plan for Northland (Appeals Version 2020) (pRP).	https://www.nrc.govt.nz/media/nqckqnfr/proposed-regional-plan-updated-appeals-version-june-2020.pdf
Plan status and development	The council has now produced an Appeals Version of the Proposed Regional Plan for Northland (June 2020). It will not be fully operative until all appeals are resolved. Where a rule in the Proposed Regional Plan has not been appealed, in accordance with Section 86F of the Resource Management Act, it must be treated as operative (and any previous rule as inoperative).	https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/
Freshwater Management Units	In regard to water quantity, FMUs have been established based on the water body's values and the sensitivity of these values to changes in levels/flows. NRC has identified: • three groundwater management units: coastal aquifers, Aupōuri aquifer and other aquifers for the purposes of setting default allocation limits; • four river water quantity management units: outstanding rivers, coastal rivers, small rivers and large rivers; and • lake/wetland management units: deep lakes (depth >10 m), shallow lakes (depth ≤10 m) and natural wetlands.	Maps / water quality and quantity management units' section of the Proposed Regional Plan for Northland (June 2020).
Community involvement	Workshops with stakeholders and consultation with tangata whenua have been organised as part of the regional plans review process. Five collaborative stakeholder groups were established in priority catchments: Mangere, Whangarei Harbour, Waitangi, Doubtless Bay and Pouto. The initial draft allocation policy was discussed with these groups and, as a result of the collaborative stakeholder process, amendments to the allocation policy were made for some of these catchments.	https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/10-year-review-of-the-regional-plans/
Plan reference to water allocation and	Rules in Section C.5.1: Taking and use of water. Policy H.4.3: Allocation limits for rivers. Policy H.4.4: Allocation limits for aquifers.	-

Item	Description	Reference
Environmental minimum flows and levels	**Table 24: Minimum flows for rivers** provides minimum flow values (L/s) for the different river water quantity management units: • 100% of MALF for outstanding rivers • 90% of MALF for coastal rivers • 80% of MALF for small and large rivers. **Table 25: Minimum levels for lakes and natural wetlands** provides minimum level values for the different lake/wetland management units: • Median lake levels are not changed by more than 0.5 m, there is less than a 10% change in mean annual lake level fluctuation and patterns of lake level seasonality (relative summer versus winter levels) remain unchanged from the natural state for deep lakes. • Median lake levels are not changed by more than 10%, there is less than a 10% change in mean annual lake level fluctuation and patterns of lake level seasonality (relative summer versus winter) remain unchanged from the natural state for shallow lakes. • There is no change in seasonal or annual range in water levels for natural wetlands.	Policy H.4.1: Minimum flows for rivers Policy H.4.2: Minimum levels for lakes and natural wetlands
Limits – Groundwater	Aupōuri Aquifer: limits of Table 27 (Allocation limits for the Aupōuri aquifer management unit) and minimum groundwater levels along coastal margin to prevent saline intrusion. • Coastal aquifer: whichever is the greater from: a. 10% average annual recharge of the aquifer, or b. the quantities authorised to be taken by: i. resource consents at the date of public notification date of this plan, less any resource consents subsequently surrendered, lapsed, cancelled or not replaced; and	Policy H.4.4: Allocation limits for aquifers

Item	Description	Reference
	ii. takes that existed at the notification date of this plan that are not authorised by resource consents under: Rule C.5.1.8 Replacement water permits for registered drinking water supplies – controlled activity; Rule C.5.1.9 Takes existing at the notification date of the plan – controlled activity; and Rule C.5.1.11 Takes existing at the notification date of this Plan – discretionary activity. • Other aquifers: whichever is the greater from: a. 35% average annual recharge of the aquifer, or b. the quantities authorised to be taken by (i) and (ii) above.	
Limits – Surface Water	1. The quantity of freshwater that can be taken from a river at flows <median; flow must not exceed whichever is the greater of the following limits: a. Relevant limit in Table 26: Allocation limits for rivers, i.e.: ▪ 10% of MALF for outstanding rivers ▪ 30% of MALF for coastal rivers ▪ 40% of MALF for small rivers ▪ 50% of MALF for large rivers, or b. The quantity authorised to be taken by: i. resource consents existing at the date of public notification of this Plan, less, with the exception of water permits for takes from rivers in the Mangere Catchment, any resource consents subsequently surrendered, lapsed, cancelled or not replaced; and ii. takes that existed at the notification date of this Plan that are subsequently authorised by resource consents under: Rule C.5.1.8 Replacement water permits for registered drinking water supplies – controlled activity; Rule C.5.1.9 Takes existing at the notification date of the plan – controlled activity; and Rule C.5.1.11 Takes existing at the notification date of this Plan – discretionary activity.	Policy H.4.3: Allocation limits for rivers

Item	Description	Reference
	2. The allocation limits specified in Clause (1) include volumes allowed to be taken under Section 14(3)(b) of the RMA and permitted to be taken by rules in this Plan, and the estimated or measured volumes associated with such takes should be considered when making decisions on applications for water permits. 3. The allocation limits specified in Clause (1) apply to applications for water permits for the taking and use of freshwater from rivers but do not apply to non-consumptive components of takes.	
Groundwater and surface water interactions	Surface and groundwater resources are managed in an integrated way; see Table 28: Classifying and managing groundwater and surface water connectivity.	Appendix H.5: Managing groundwater and surface water connectivity
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the Proposed Regional Plan for Northland (Appeals Version 2020)	Policy D.4.10: Avoiding over-allocation
Water shortage conditions	No particular specification on the pRP.	Covered by the RMA (Section 329, covering Water Shortage Directions)
Water use metering	Specification for metering water takes.	Policy D.4.17: Conditions on water permits
Information and data (allocation maps)	Maps available to show current allocation level in comparison to the allocation limits in the proposed Regional Plan (maps were temporarily disabled at the time of the review).	https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/indicative-water-quantity-allocation-maps/
Efficient allocation and use	Specifications in the Proposed Regional Plan for Northland (Appeals Version 2020).	Policy D.4.13: Reasonable and efficient use of water – irrigation Policy D.4.14: Reasonable and efficient use of water – group or community water supplies Policy D.4.15: Reasonable and efficient use of water – other uses
Priority of use	No particular specification in the pRP.	Covered by the RMA

A1.8 Otago Regional Council

Item	Description	Reference
Regional Plan	Regional Plan: Water for Otago (RPW).	https://www.orc.govt.nz/plans-policies-reports/regional-plans-and-policies/water
Plan status and development	The RPW became operative on 1 January 2004 and is currently under review. The proposed new Land and Water Regional Plan (LWRP; intended to be notified by 31 December 2023) will give full effect to higher order planning documents, including the Resource Management Act 1991 (RMA), any relevant national policy statements and ORC's new proposed RPS (to be notified by November 2020), while also taking into account relevant iwi planning documents.	https://www.orc.govt.nz/plans-policies-reports/regional-plans-and-policies/water/review-of-the-regional-plan-water-for-otago
Freshwater Management Units	Five FMUs set for the Otago region (April 2019), including the Clutha/Mata-Au, Taieri, North Otago, Dunedin Coastal and Catlins units, as well as five sub-units, or 'rohe', for the Clutha/Mata-Au: Upper Lakes, Dunstan, Manuherekia, Roxburgh and Lower Clutha.	https://www.orc.govt.nz/plans-policies-reports/regional-plans-and-policies/water/freshwater-management-units
Community involvement	As part of the RPW review, ORC has agreed to do this in stages based on the development of FMUs and community value, objective and limit setting. Each FMU or rohe will essentially form a chapter of the new water plan, ensuring that water management is based on locally determined values, rather than on a 'one size fits all' region-wide approach. Some provisions may apply in more than one FMU.	-
Plan reference to water allocation and	The RPW uses two principal mechanisms for managing water takes: • minimum flows for rivers and connected groundwater, and • allocation limits for consented water takes. Residual flows and recovery flows are additional mechanisms that can be used in particular cases to achieve sustainable management of catchment water. Any takes not using the RPW limits can be considered on a case-by-case basis.	6.4: Policies applying to the management of the taking of water Policy 6.4.1–10: Surface water allocation system Policy 6.4.10A1: Groundwater allocation system

Item	Description	Reference
	Groundwater takes are managed by setting a maximum allocation limit and, where necessary, restriction levels on an aquifer. Any other groundwater take is considered on a case-by-case basis.	
Environmental minimum flows and levels	ORC began a programme of plan changes in 2004 to set minimum flows and levels for catchments throughout Otago. There are also a number of historic 'deemed permits' in Otago that provide rights to take water that have not yet been required to comply with take restrictions such as minimum flows. Under the RMA, these expire in 2021, and the process of replacing deemed permits with resource consents has begun. Plan changes for catchments with high numbers of deemed permits are now prioritised to ensure as much certainty as possible for those applicants replacing deemed permits.	**Surface water takes:** 6.4.2: Primary allocation 6.4.2A: When a primary allocation take will be no more than under an existing consent 6.4.2AA: When actual taking reflects supplementary allocation taking 6.4.3: Minimum flow for primary allocation, Schedule 2A 6.4.4: Minimum flow for primary allocation, outside Schedule 2A 6.4.5: Application of minimum flows 6.4.6: Exception to primary allocation minimum flow, Schedule 2A 6.4.7: Residual flows 6.4.8: Exception to primary allocation minimum flow, Schedule 1B 6.4.9: Supplementary allocation and supplementary minimum flow 6.4.10: Further supplementary allocation **Groundwater takes:** 6.4.10AB: Aquifer restrictions 15.8: Methods for calculating allocation and applying minimum flows Schedule 2: Schedule of specified restrictions on the exercise of permits to take surface water Schedule 4: Schedule of the allocation and restriction regime for groundwater
Limits – Groundwater	The maximum allocation limit for specified aquifers is set in Schedule 4A of the RPW. It sets a limit of the volume of water that can be taken annually from an aquifer by consents and is set to maintain long-term groundwater levels and avoid aquifer compaction.	https://www.orc.govt.nz/media/5810/schedule-4-schedule-of-the-allocation-and-restrictions-regime-for-groundwater.pdf

Item	Description	Reference
	When no limit is set in Schedule 4A, the maximum allocation limit is determined as 50% of the mean annual recharge (MAR) of the aquifer. The maximum allocation limit is expressed in million cubic metres per year (M m^3/yr).	
Limits – Surface Water	There are two types of allocation in the RPW for surface water, primary and supplementary: • **Primary[10] allocation** is the maximum amount of water that can be taken from the catchment by holders of a consent classed as 'primary' and has the lowest scheduled minimum flow. A primary allocation limit is set to provide for economic, social and cultural wellbeing, while also supporting reliable access to the water resource. Schedule 2A identifies primary allocation limits for specified catchments in Otago. Catchments that are not listed in Schedule 2A have a 'default' primary allocation limit, which is 50% of the seven-day MALF. • **Supplementary allocation**, which can be in blocks if appropriate, is available if primary allocation is fully or over-allocated. Supplementary allocation consents have a higher minimum flow and water is usually taken in winter and spring and stored for later use. When river flows drop, supplementary consent holders will be required to stop taking water before those with primary allocation consents. Supplementary allocation beyond this can be made at still higher minimum flows, including generous allocation called 'further supplementary' (Policy 6.4.10). Policy 6.4.9 provides for supplementary allocation, and Schedule 2B of the Water Plan identifies those catchments that have supplementary allocation blocks and specific minimum flows for those blocks.	https://www.orc.govt.nz/media/1246/schedules-2.pdf

10 'Secondary Allocation' only exists in Otago in one catchment (the Kakanui).

Item	Description	Reference
Groundwater and surface water interactions	If groundwater is considered to be 'connected' to a surface water body, then it is managed as surface water and would be subject to any relevant minimum flow and allocation limit. 'Connected' groundwater is defined in Policy 6.4.1A of the Water Plan and includes any aquifers identified in Schedule 2C and any groundwater that is within 100 m of a surface water body and has a hydrological connection to it (the taking of groundwater would deplete the surface water body). If groundwater takes are located more than 100 m from a connected surface water body and deplete the surface water body by at least 5 L/s, a dual water allocation regime applies.	Policy 6.4.1A: Groundwater connected to surface water
Over-allocation and measures to avoid / phase out over-allocation	Several Plan changes introducing minimum flows for catchments. Mining privileges / deemed permits will expire in 2021, specific re-consenting process is in place.	For example, Plan Change 1B, 3A, 3B, 3C, 5A Plan Change 1C emphasised a mechanism for reducing primary allocation in over-allocated catchments through Policy 6.4.2AA (changing status to supplementary, if that is how it is taken) Policy 6.4.10A3: Avoiding allocation of groundwater beyond limit
Water shortage conditions	Water rationing conditions. A restriction level restricts the taking of groundwater from an aquifer during extended periods of low recharge or assists with sustainably managing groundwater in localised areas of high demand. These protect the aquifer from over-depletion. Typically, the restriction will be of a percentage of a consented take. Schedule 4B.1 of the Water Plan identifies the aquifer restriction levels at which the taking of groundwater will be increasingly restricted and the nature of the restriction that applies at different restriction levels.	Policy 6.4.12B: Water rationing options Policy 6.4.12C: Consent condition for water rationing Policy 6.4.13: Restriction of takes by Council-approved rationing regime Policy 6.4.10AB: Aquifer restrictions https://www.orc.govt.nz/media/5810/schedule-4-schedule-of-the-allocation-and-restrictions-regime-for-groundwater.pdf
Water use metering	Requirements in the RPW.	Policy 6.4.16: Measurement of takes

Item	Description	Reference
Information and data (allocation maps)	Online maps available with catchment and aquifer allocation status and consented water takes location and volume.	https://maps.orc.govt.nz/OtagoViewer/?map=1c59ff71893d4613a169806198eedafd In layer menu: • Untick 'Bores and Well Locations' • Tick 'Water Allocation' and select options (surface water / groundwater current allocation and catchments/aquifer allocation status)

A1.9 Taranaki Regional Council

Item	Description	Reference
Regional Plan	Draft Freshwater and Land Management Plan for Taranaki (Draft FLMP).	https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/DraftPlan-April2015W.pdf Summary: https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/DraftPlanSummary-April2015.pdf
Plan status and development	The TRC's current Fresh Water and Soil Plans are being merged into a Regional Freshwater and Land Management Plan for Taranaki. TRC intends to combine its freshwater, soil and air quality plans into one 'Natural Resources Plan'. Following the release of the Action for Healthy Waterways package, the Council is required to notify the proposed plan by December 2024.	https://www.trc.govt.nz/council/plans-and-reports/strategy-policy-and-plans/regional-fresh-water-plan/water-and-soil-plan-review/
Freshwater Management Units	The Draft Freshwater and Land Plan proposes to divide the 286 main river catchments and 530 named rivers present in the region among four Freshwater Management Units, labelled A to D, with: • Unit A: outstanding freshwater bodies • Unit B: waterways on Mount Taranaki and the ring plain • Unit C: waterways on the northern and southern coastal terraces • Unit D: waterways in the eastern hill country. The units are based on shared values, land use and physical characteristics. Current FMUs are under review.	https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/DraftFLMP-1FMU.pdf FMU described in Schedule 1: Freshwater management units for Taranaki
Community involvement	TRC is meeting regularly with iwi and hapū representatives as part of the Wai Māori Working Group to ensure tangata whenua values and interests are properly incorporated into the new Plan. Workshops are being held with the communities to discuss the methods and choices in the matter of the levels of protection, minimum flow and allocation limit setting.	https://www.trc.govt.nz/council/plans-and-reports/strategy-policy-and-plans/regional-fresh-water-plan/water-and-soil-plan-review/

Item	Description	Reference
Plan reference to water allocation and	The draft FLMP refers to surface water allocation in Chapter 7 (Taking, use, damming and diversion of surface water) and Chapter 8 (Groundwater)	Policy 7.2 (e) Policy 7.7: Allocation limits Policy 7.9: Supplementary water takes Policy 8.1 (a): Potential updates available here: https://www.trc.govt.nz/environment/core-documents/regional-fresh-water-plan/water-and-soil-plan-review/
Environmental minimum flows and levels	The draft FLMP set revised minimum flows and allocation limits based on the 'Review of Minimum Flows and Water Allocation in Taranaki' report adopted by TRC in July 2018.	Policies 7.5 to 7.8 Recent guiding reports (currently under review): 1. Review of Minimum Flows and Water Allocation in Taranaki (2018) Factsheet: https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/AllocationFactsheetJun2018-web.pdf Full report: https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/WaterAllocationReport2018.pdf 2. Considerations of Stream Size in Determining Minimum Flows and Water Allocation Limits in Taranaki rivers (2020) Factsheet: https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/FactSheet-StreamSize-July2020.pdf Full report: https://www.trc.govt.nz/assets/Documents/Plans-policies/SoilWaterPlanReview/StreamSizeAndAllocation-Jowett-June2020.pdf
Limits	The Plan's limits either: • set out the maximum amount of the resource that can be allocated to those using freshwater in the catchment, or • control activities by: - permitting activities that TRC has determined can cumulatively occur while still ensuring that Plan objectives, including freshwater objectives, can be achieved.	Section 2.3: National Policy Statement for Freshwater Management Freshwater limits

Item	Description	Reference
	- requiring resource consents for activities where the Council has determined that a case-by-case assessment is required to assess whether Plan objectives, including freshwater objectives, will be achieved. - prohibiting activities that the Council has determined will not enable Plan objectives, including freshwater objectives, to be achieved.	
Limits – Groundwater	Within each of the four FMUs, groundwater systems are further subdivided by formation into groundwater zones. As FMU boundaries do not necessarily align with geological unit boundaries, many large aquifers span multiple FMUs. The taking or use of groundwater must not exceed the sustainable yield* of the aquifer or significantly impact on water levels and flows of surface water bodies. ** An estimate of sustainable yield has been calculated for each of the groundwater zones and conservatively set at 15% of the total average annual rainfall by TRC, but these percentage and specific values have not been introduced in the Draft FLMP yet.*	Policy 8.1 (a): Taking or use of groundwater Section 2.1: (Estimates of recharge and sustainable groundwater yields) of the following report: https://www.trc.govt.nz/assets/Documents/Environment/Monitoring-SOE/Groundwater/GroundWaterQuantity15-17Web.pdf
Limits – Surface Water	**Primary allocation:** The maximum instantaneous rates (authorised through resource consents) not otherwise provided for in Policy 7.5(b) must not exceed: a. 10% of MALF for rivers in FMU A at the site of the take b. 30% of MALF for rivers in FMU B at the site of the take, and c. for rivers in FMUs C and D: i. 30% of MALF for small rivers (≤5 m^3/s at the site of the take), or ii. 50% of MALF for large rivers (> 5 m^3/s at the site of the take).	Policy 7.7: Allocation limits Policy 7.8: Minimum flows and water levels Policy 7.9: Supplementary water takes (Policies under review)

Item	Description	Reference
	Consented takes must cease when the minimum flow / water level at the take site is: a. ≤100% of MALF for rivers in Freshwater Management Unit A; b. ≤90% of MALF in Freshwater Management Unit B; c. ≤80% of the MALF for rivers in Freshwater Management Unit C and D; and d. lowers the existing water levels for natural lakes, unless the activity is for a temporary take for the purposes of a pest fish eradication programme. **Supplementary allocation**: may be provided in circumstances: a. When the river is flowing above its median flow, and the total amount of water taken by way of a supplementary allocation does not exceed 10% of the actual flow in the river at the time of abstraction; and b. Where it can be shown that the supplementary allocation will not: i. increase the frequency or duration of low flows; ii. adversely affect flow variability leading to a significant departure from the natural flow regime, including the magnitude of the median flow and the frequency of flushing flows; and iii. limit the ability of anyone to lawfully take water as provided for under the Policies of this Plan.	
Groundwater and surface water interactions	For the purposes of freshwater allocation, accounting and management, Taranaki's surface and ground water are grouped according to shared values, physical and hydrological characteristics, adjacent land uses and management responses in FMUs.	No specific policies are in place yet, but some related work is under development.

Item	Description	Reference
Over-allocation and measures to avoid / phase out over-allocation	Specifications in the draft FLMP.	Policy 7.6: Fully allocated catchments
Water shortage conditions	Method of implementation referring to RMA provisions (Section 329).	Method 29
Water use metering	Specifications in the draft FLMP.	Policy 7.2 (i) Policy 8.1 (d)
Information and data (allocation maps)	Local maps interface, but FMUs and allocation data were not available at the time of the review.	https://maps.trc.govt.nz/LocalMapsGallery/
Efficient allocation and use	Specifications in the draft FLMP.	Objective 8: Freshwater quantity Policy 7.2 (f) and (i) Policy 8.1 (b) and (c)
Priority of use	Specifications in the draft FLMP.	Policy 7.2 (b) Method 29

A1.10 Waikato Regional Council

Item	Description	Reference
Regional Plan	Waikato Regional Plan (WRP).	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/
Plan status and development	The Waikato Regional Plan is operative in full. In 2017, an integrated review (Healthy Environments – He Taiao Mauriora) was launched, which also includes a review of the Regional Coastal Plan, and will give effect to the Regional Policy Statement and National Directions.	https://www.waikatoregion.govt.nz/council/policy-and-plans/healthy-environments/
Freshwater Management Units	Eight FMUs have been set in relation to water quality for the Waikato and Waipa river catchments (under Plan Change 1), based on their type: peat, dune, riverine or volcanic. Chapters 3.3 (Water Takes) and 3.4 (Efficient Use of Water) in the WRP covers the entire Waikato region. This plan was prepared prior to the NPS-FM requirement to set FMUs.	https://www.waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/HR/FAQS/Freshwater-management-units.pdf https://data-waikatolass.opendata.arcgis.com/datasets/waikatoregion::healthy-rivers-river-freshwater-management-units
Community involvement	These eight water quality FMUs have been set by the Collaborative Stakeholder Group and community and stakeholder feedback	-
Plan reference to water allocation and	Chapters 3.3 (Water Takes) and 3.4 (Efficient Use of Water) comprise of issues, objectives (Section 3.3.2), policies (Section 3.3.3) and implementation methods (Section 3.3.4) that set out the Regional Plan's approach to the protection, allocation and use of the region's surface and groundwater resources (excluding geothermal water, which is addressed elsewhere in the Plan).	Chapter 3.3: Water Takes https://www.waikatoregion.govt.nz/Council/Policy-and-plans/Rules-and-regulation/Regional-Plan/Waikato-Regional-Plan/3-Water-Module/33-Water-Takes/ Chapter 3.4: Efficient Use of Water https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/34-efficient-use-of-water/

Item	Description	Reference
Environmental minimum flows and levels	Section 3.3.4.6: Development of Minimum and Allocable Flows for Surface Water Bodies and Sustainable Yields for Aquifers (Method to implement Section 3.3.3 Policies 1, 2, 3 and 4). Section 3.3.4.8: Assessment of hydrological flow statistics for water allocation (Method to implement Section 3.3.3 Policy 1). Section 3.3.4.9: Review Allocable Flows / Sustainable Yields (Method to implement Section 3.3.3 Policy 1).	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/333-policies/ **Groundwater:** Policy 4: Establish Sustainable Yields from Groundwater Policy 5: Determining sustainable yields Policy 10: How Groundwater Takes will be Classified **Surface water:** Policy 1: Establish Allocable and Minimum Flows for Surface Water Policy 2: Determining the level of minimum flows, primary, secondary and water harvesting allocable flows Policy 3: Determining the combined level of surface water allocation within a catchment Policy 6: Certain Exceedances of Table 3-5 Allocable Flows not to Represent Over-allocation for the Purposes of the Freshwater NPS Policy 7: How Surface Water Takes Will Be Classified in Catchments Where Existing Takes Exceed the Table 3-5 Allocable Flows Policy 8: How Surface Water Takes Will Be Classified in Catchments that do not Exceed the Table 3-5 Allocable Flows Policy 9: How Surface Water Takes for Domestic or Municipal Supply Will Be Classified
Limits – Groundwater	Limits provided in Table 3-6: Sustainable Yields from Aquifers: • Management level (m^3/year) • Sustainable yield (m^3/day) • Reference to aquifer map number. In the absence of a sustainable yield being determined, a management level will be set on a conservative basis, using a water balance methodology that considers:	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/3-3-4/ https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/water-allocation-maps/ Policy 5: Determining sustainable yields

Item	Description	Reference
	• the average annual recharge over the aquifer • the area of land above the aquifer, and • the distribution of groundwater users. The management level represents a portion of an aquifer's likely recharge and will be used as a trigger point for the setting of a sustainable yield.	
Limits – Surface Water	Limits* are provided as a percentage of the one-in-five-year seven-day low flow (Q5) in Table 3-5: Allocable Flows for Surface Water, with: • Minimum flow - 90% of Q5 for stream with mean flow >5 m^3/s. - 95% of Q5 for stream with mean flow <5 m^3/s. - the remaining fraction of the Q5 flow (95%) for the catchment above Karapiro Dam. • Primary allocable: - If minimum flow <Q5: the allocable flow is the difference between these two flows. - If the minimum flow >Q5: the allocable flow is zero. • Secondary allocable: - Portion of the flow between the primary allocable flow and 30% of Q5, or - as specified in Table 3-5. • Harvesting: 10% of the river's flow when the flow >median flow immediately upstream of the point of the take (not for catchments upstream Karapiro Dam). ** Some catchments have a set of limits (see above) for both the Upland and Lowland catchments; others have the same limits for the whole catchment.*	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/3-3-4/ https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/water-allocation-maps/ Policy 2: Determining the level of minimum flows, primary, secondary and water harvesting allocable flows

Item	Description	Reference
Groundwater and surface water interactions	Section 3.3.4.7: Groundwater Depletion of Surface Water [Method to implement Section 3.3.3 Policy 10(i)]	Policy 10: How Groundwater Takes will be Classified Policy 12: Consent Application Assessment Criteria – Groundwater (with nature of hydraulic connection)
Over-allocation and measures to avoid / phase out over-allocation	Chapter 3.3.4.10: Phasing Out Exceedances of the Table 3-5 Allocable Flows (Method to implement Section 3.3.3 Policy 19)	Policy 19: Phasing Out Exceedances of the Table 3-5 Allocable Flows
Water shortage conditions	Restrictions/priorities on abstractions for aquifer/catchments in water shortage conditions.	Policy 17: Water Shortage Conditions Policy 18: Levels of Priority to Apply During Water Shortages
Water use metering	Table 3-4 specifies recording types and frequency for surface water takes.	Policy 16: Water Take Recording and Reporting
Information and data (allocation maps)	Water allocation maps available online related to the Waikato Regional Plan.	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/waikato-regional-plan/3-water-module/33-water-takes/water-allocation-maps/
Efficient allocation and use	Specifications in the Waikato Regional Plan.	Policy 2: Efficient Use of Water
Priority of use	Specifications in the Waikato Regional Plan.	Policy 18: Levels of Priority to Apply During Water Shortages

APPENDIX 2 EXAMPLE OF GROUNDWATER MANAGEMENT ZONE DELINEATION

A2.1 Environment Southland Regional Council Groundwater Management Zone

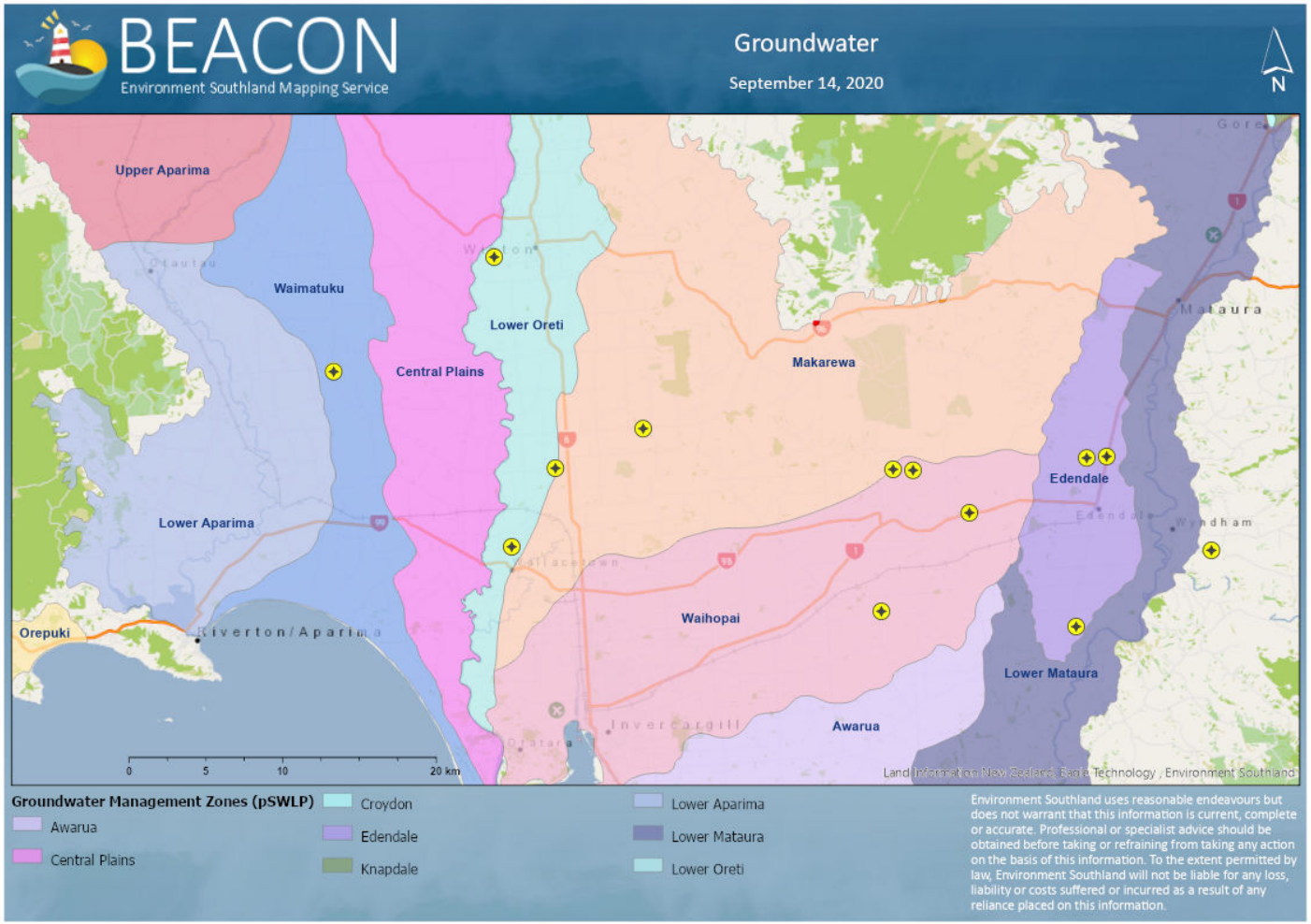

Figure A2.1 Example of Environment Southland groundwater management zones as per delineated in the Proposed Southland Water and Land Plan; monitoring bores in yellow (Environment Southland Regional Council 2020).

A2.2 Greater Wellington Regional Council Groundwater Management Zones

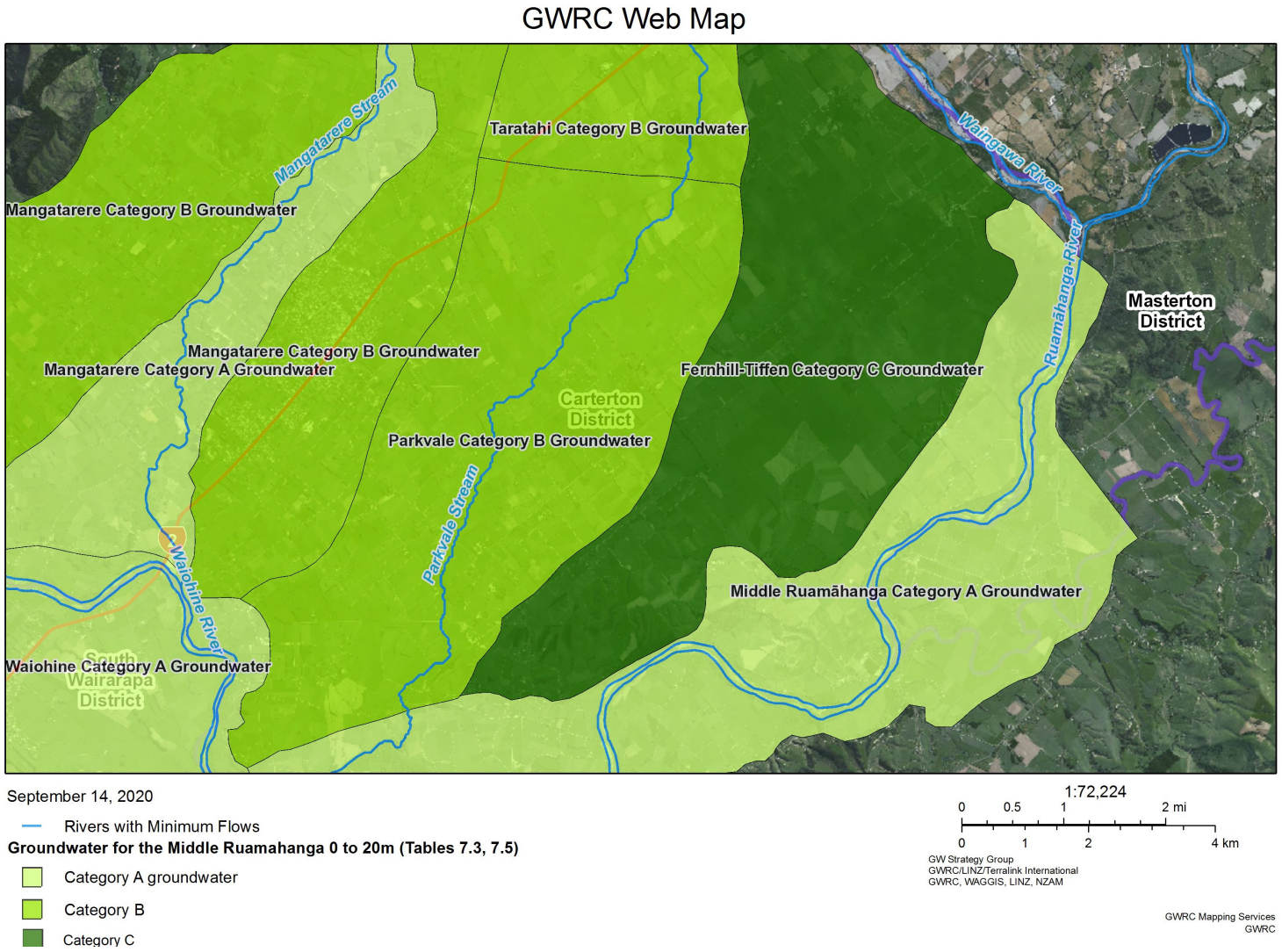

Figure A2.2 Example of Greater Wellington Regional Council groundwater management zones as per delineated in the Proposed Natural Resources Plan 2015.

www.gns.cri.nz

Principal Location

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F +64-3-477 5232

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