Allocation recommendations for the Wellington region

Technical report to support the Proposed Natural Resources Plan

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Executive summary

Allocation limits define the maximum volume or rate of water abstraction and are an important tool for ensuring that the values of water bodies are not unacceptably compromised by consumptive water use.

Greater Wellington Regional Council is intending to notify its proposed Natural Resources Plan (pNRP) in July 2015. This report makes a number of recommendations in support of the pNRP that relate to allocation limits for rivers and streams and groundwater aquifers in the Wellington region as well as Lake Wairarapa.

The primary recommendations of this report are:

- to apply a region-wide default rule for core allocation from rivers and streams that equates to 30% (small rivers/streams) or 50% (larger rivers) of 7-day natural mean annual low flow (MALF);
- to apply a region-wide default rule for supplementary allocation from rivers and streams that allows water (in addition to core allocation) to be abstracted above median flow and requires 50:50 flow sharing above this threshold;
- to apply new groundwater allocation limits in accordance with revised management frameworks developed for the Wairarapa Valley, Hutt Valley and Kapiti Coast. The recommended groundwater allocation limits take particular account of cumulative depletion effects on stream flow and wetlands as well as saline intrusion risk;
- to limit allocation from Lake Wairarapa (and its catchment) to existing levels of allocation and introduce a restriction scheme to ensure that existing takes are appropriately managed during times of genuine lake water stress.

The main principles underpinning the recommendations above are; to more fully reflect the connectivity between surface and groundwater resources, to take a broadly consistent approach across the region to defining the allocation status of water bodies, and to allocate water cautiously especially where information about specific effects is currently limited.

The recommended allocation limits are primarily focused on maintenance of ecological values and, for surface waters in particular, rely heavily on generalised relationships between flow and these values. While there are benefits in having clear, simple and standardised rules for managing allocation there also needs to be planning flexibility long term to ensure limits take account of broader community values and are not overly permissive or conservative. For this reason (among others), all limits summarised in this report, are to be proposed as **interim** in the pNRP. There is a process being undertaken (as of March 2014) by catchment committees to refine, and agree on, longer term limits. An important point is that under interim limits existing consent holders will retain water currently allocated to them.

The overall consequences of water use are determined not just by allocation policies but also other policies such as those relating to minimum flow restrictions. Therefore, the refinement of interim allocation limits will need to occur alongside fuller consideration of other relevant policies.

Contents

1. Introduction

Greater Wellington Regional Council (GWRC) is notifying its proposed Natural Resources Plan (pNRP) for the Wellington region in September 2014. Policies and rules relating to freshwater management will replace those in the existing Regional Freshwater Plan (RFP) (WRC 1999).

This report describes the approach taken to reviewing and recommending water allocation provisions for the pNRP. It is an updated version of a report with the same title that was issued when the draft Natural Resources Plan was notified in September 2014 (Thompson and Mzila 2014). This current report contains some revisions and corrections and replaces the earlier version.

1.1 Scope and intent of report

The purpose of this report is to describe the general logic, rationale and decision-making process behind recommended water allocation provisions for rivers and streams, groundwater aquifers and Lake Wairarapa. The report is intended to make the link between the planning provisions being proposed for these water bodies and the science behind these provisions. Fuller detail on the basis for specific catchment and aquifer provisions is provided in a number of background technical reports that are listed in the reference section.

While minimum flows are mentioned within the context of this report, readers are referred to a companion report (Thompson 2015b) for fuller discussion of minimum flow recommendations.

1.2 Terminology

Some of the more commonly used technical terms in this report are explained in Table 1.1 and illustrated schematically in Figure 1.1.

Table 1.1: Definition of terms and phrases commonly used in this report

Term or phrase	Definition in the context of this report
Allocation block (core allocation)	The total amount of water that may be allocated to resource consent holders from a river, stream or connected groundwater during normal to low flow conditions.
Supplementary allocation flow	The river or stream flow rate above which further allocation (in addition to allocation available at low flow) is allowed (ie, the threshold that enables more water to be taken during mid- to high-range flows).
Supplementary allocation block	The total amount of water that may be allocated to resource consent holders from a river or stream during times that flow exceeds the supplementary allocation flow (see above).
Connected groundwater	Groundwater is described in this report as either *directly connected* or *not directly connected* to surface water. This is a reference to the strength of the hydraulic connection and determines whether groundwater should be managed within the same water budget as surface water or not. See Appendix 2 for further explanation.
Low flow	The reduction in river flow usually experienced during the summer. In some catchments, naturally low base flows are further exacerbated by abstractions or diversions. The mean annual low flow (MALF) is the average of the lowest flows from each year of record and is the index most commonly referred to in this report when describing low flows.

Term or phrase	Definition in the context of this report
Minimum flow	The flow that Greater Wellington Regional Council aims to maintain under low flow conditions and/or uses as a trigger to limit (and often suspend) abstraction (see Thompson 2015b). The flow in a river or stream may naturally drop below the minimum flow following the restriction / suspension of consented abstractions.

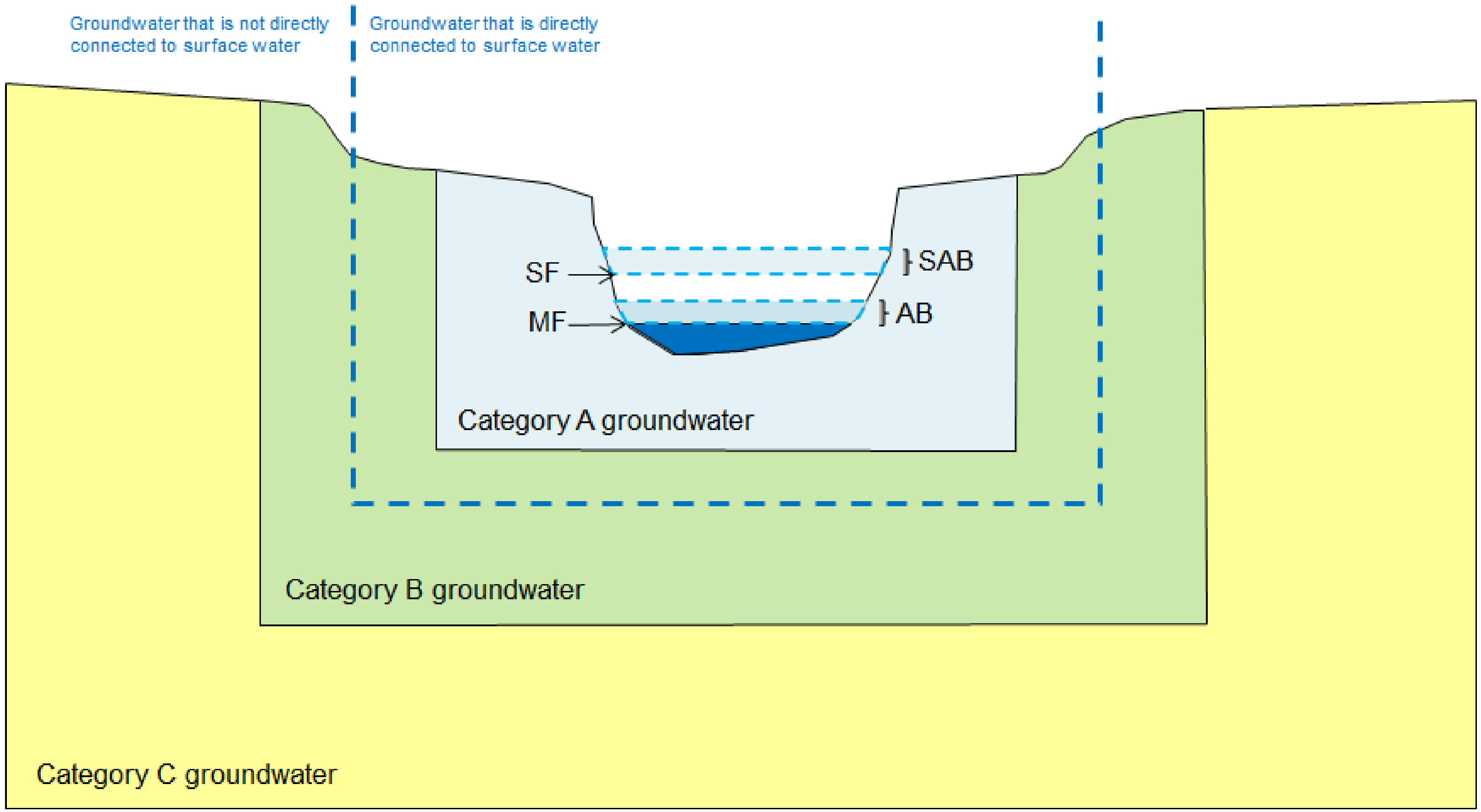

Figure 1.1: Schematic cross section of a river channel and associated groundwater aquifers to illustrate terms defined in Table 1.1 MF=Minimum flow, SF=Supplementary flow, AB=Allocation block, SAB=Supplementary allocation block

2. Background

2.1 Pressure on our water resources

A recent assessment of water use and availability in the Wellington region (Keenan et al, 2012) confirmed that consented allocation has increased significantly since the existing Regional Freshwater Plan became operative (more than doubling in the past two decades). This is primarily due to increased irrigation demand. While this increased allocation has not led to a demonstrable large scale deterioration in environmental quality, there are signs in some catchments of abstraction impacting water quality (eg, Keenan 2009). These observations coupled with a general understanding of the link between increasing abstraction and increased environmental risk means that an informed approach to allocation is needed.

While it is standard GWRC practice for the technical basis of plan provisions for managing allocation to be periodically reviewed and revised, it is especially important that this occurs when pressure on water resources is mounting. Not only is it necessary to ensure that the environmental values of water bodies continue to be adequately cared for but also that water users have appropriate access to the resource.

2.2 Wider context of water management in the Wellington region

This report should be read in the context of the past (ie, Regional Freshwater Plan, WRC 1999) and future management of fresh water in the Wellington region and nationally. Management of water in the immediate future will be through a Regional Plan that is under development. This plan, which will be notified in July 2015, includes region-wide provisions. Over time, with input from five management areas already identified in the region, variations/changes will be recommended from 2016 to 2022 that will refine region-wide provisions to include catchment specific provisions. There is also a longer timeframe that must be considered. The National Policy Statement on Freshwater Management (NPS-FM 2014) includes a set of provisions that must be given effect to in full by 2030.

In developing its new Regional Plan, GWRC is taking a long term view of water management over the next 16 years that builds on the current regional plans. In the case of water quantity provisions, managing the process could include:

- as a first step in 2015, establishing interim region-wide defaults for allocation and flows that must be adhered to by new water users while providing for existing uses to continue
- varying/changing region-wide defaults to catchment specific limits through an ongoing technical programme that will include whaitua[1] recommendations in 2016 (Ruamahanga, Welllington Harbour), 2019 (Porirua Harbour, Kapiti Coast) and 2022 (Wairarapa Eastern Hills).

[1] 'Whaitua' is a term used to describe a catchment committee process being established in the Wellington region (from late 2013). Five whaitua are proposed, covering each of the Ruamahanga River catchment, the eastern Wairarapa hill country, the Hutt River and wellington Harbour catchment, Porirua Harbour catchment and the Kapiti Coast. The whaitua will develop a set of recommendations that may supercede many of the regional plan provisions, including interim minimum flow and allocation limits.

- carrying out any work recommended by whaitua to implement comprehensive long term allocation limits that give effect to the NPS-FM (2014) prior to 2030.

- at all stages, increasing the flexibility of water management and efficiency of water use.

Overall, a steady and progressive approach to more effective water quantity and quality management is the approach GWRC prefers over coming years. In relation to the region-wide provisions for water quantity management currently being suggested, such an approach means that any changes will be incremental rather than rapid.

2.3 Current allocation provisions

Current water quantity provisions are set out in Section 6 of the RFP (WRC 1999). Minimum flows, core and supplementary allocations and step-down flows/allocations for rivers are listed in Table 6.1 of the RFP while aquifer safe yields are listed in Tables 6.2 to 6.5. Explanatory notes follow the tables in both cases.

Weaknesses of existing provisions are described in more detail later in the report, but in summary are considered to be:

- Inconsistency in the application of some methods, particularly for determining river allocation volumes;

- Over-estimation of aquifer safe yield volumes as a result of assigning a high proportion of total aquifer water budget (annual rainfall recharge) for use;

- A lack of explicit consideration of the interaction between groundwater and surface water and the cumulative impacts of allocation;

- A lack of region-wide default provisions or methods for rivers and aquifers that are not listed in Tables 6.1 to 6.5 of the RFP.

These weaknesses generally reflect the relative lack of information available when the existing provisions were formulated in 1997. There is also now a greater precedent and unity in New Zealand for the selection of methods for sustainable water allocation and this is a major driver for the current revision of provisions.

3. Methodology – developing allocation provisions

This section describes the general methodology used by GWRC to develop new meter allocation provisions. More detail on the technical basis for specific recommendations is provided in Sections 4, 5 and 6.

3.1 Guiding principles for technical review

Technical work by GWRC has sought to begin addressing the main weaknesses in existing provisions (listed previously in Section 2.3) and has been guided by several key principles:

- **Integrated management of surface and groundwater resources.** In practice, this means groundwater aquifers have been re-categorised according to the extent of hydraulic connection with surface waters. Aquifers with a direct connection to surface water are to be managed within the same allocation budget as surface water – a significant shift from the existing regional plan framework. It also means explicit consideration of the cumulative impact of allocation, where appropriate, in the limit-setting process.

- **Consistency and transparency in the approach to managing allocation.** This has included the use of region-wide 'rules of thumb' for defining allocation status based on the application of national guidelines (collective wisdom) and default criteria.

- **Use of expert judgement in the absence of clear decision-making criteria.** In most cases there is no obvious answer when considering what degree of allocation impact is acceptable. However, developing a line of reasoning among a group of technical and policy experts, and engaging independent peer review, is a valid way to arrive at a robust recommendation.

- **The level of effort and rigour in the limit-setting process should generally reflect the value in which the resource is held combined with the level of demand/stress it is under.** In practice, this means the most rigorous assessment has been applied in the Wairarapa Valley, the Kapiti Coast and the Hutt Valley.

3.2 Management objectives and interim limits

Provisions for allocation are being recommended as 'interim' in recognition that the Wellington region is only part way into a limit-setting process. In line with the progressive implementation programme set out in the NPS-FM (2014), it is intended that interim provisions are refined into agreed limits over coming years. The process to enable this will involve a combination of continued technical and policy assessment and community consultation.

In their most complete form, allocation limits will represent a point of agreement between interested parties (including the wider community) after full consideration of in-stream and out-of-stream objectives and values, and the necessary trade-offs between these values, has been made. In the meantime, interim provisions are largely focussed on the maintenance of ecological values and the avoidance of long term decline in water resources; both of which are considered fundamental aspects of sustainable freshwater management under the RMA. It is more desirable to allocate further water in the future if, and when, it becomes apparent that it is safe to do so, than it is to try to recover from over-allocation. Where rules-of-thumb indicate catchments are highly, fully or potentially over-allocated, further allocation should be avoided until more detailed analysis of sustainable abstraction limits can be completed.

While sustainable use of water resources is the overarching management objective of the recommended allocation framework, there are sub-regional differences in the way the framework has been applied. For example:

- The Wairarapa Valley is essentially a closed hydrogeological basin drained by the Ruamahanga River. Surface and ground water demand is relatively high throughout the valley, including along the major tributaries of the Ruamahanga River, and there is significant ground and surface water interaction. Therefore, a key objective in limit setting is to manage the cumulative impacts of total abstractive demand on surface waters at a valley-wide scale.

- In contrast, the Kapiti Coast area comprises a series of river and stream catchments and associated groundwater aquifers that each discharge to sea along a relatively narrow coastal strip. While there is significant interaction between rivers and aquifers, including across catchment boundaries, it is not appropriate to manage for a total cumulative abstractive effect across the whole Kapiti Coast area. The focus on the Kapiti Coast is therefore on setting appropriate limits for discrete hydrological units.

- Wetlands feature more prominently as a management objective on the Kapiti Coast than elsewhere in the region while salt water encroachment (caused by over-abstraction) is a risk that must be managed on the Kapiti Coast and in the Hutt Valley, but is not present in the Wairarapa Valley.

3.3 Technical approach

3.3.1 Resource investigations in high water use areas

The bulk of technical review work by GWRC has focused on developing a better understanding of the region's groundwater resources. This is because continued allocation of groundwater under existing RFP policies is considered to present the greatest risk of undesirable water resource depletion[2].

The main output of the groundwater investigations has been the development of a technical framework for the integrated management of ground and surface water resources. This framework sets out a new categorisation scheme for groundwater abstractions that ensures the degree of hydraulic connectivity between the bore and nearby surface waters is taken into account when determining allocation volumes. Mapping of abstraction categories and estimation of depletion effects associated with these categories has been made

[2] Surface water allocation limits in the existing RFP have been reached in most parts of the region already so further direct abstraction from stressed water bodies is generally already prohibited.

possible by the revision or development of several numerical groundwater models covering the Wairarapa and Hutt valleys and the Kapiti Coast.

Readers are referred to the technical reports summarised in Table 3.1 (and listed in the Reference section) for a full description of the numerical models and integrated management frameworks:

Table 3.1: Technical reports supporting groundwater allocation recommendations (see the Reference section for full report details)

Area	Report
Wairarapa Valley	Gyopari and McAlister (2010a). *Wairarapa Valley groundwater resource investigation: **Upper Valley** catchment hydrogeology and modelling*.
	Gyopari and McAlister (2010b). *Wairarapa Valley groundwater resource investigation: **Middle Valley** catchment hydrogeology and modelling.*
	Gyopari and McAlister (2010c). *Wairarapa Valley groundwater resource investigation: **Lower Valley** catchment hydrogeology and modelling*.
	Hughes and Gyopari (2011) (revised 2014). *Wairarapa Valley groundwater resource investigation: Proposed framework for conjunctive water management.*
Hutt Valley	Gyopari (2015). *Conjunctive water management recommendations for the Hutt Valley*
Kapiti Coast	Mzila et al (2014). *Kapiti Coast groundwater resource investigation: Catchment hydrogeology and modelling* Mzila et al (2015). *Kapiti Coast groundwater resource investigation: Proposed framework for conjunctive water management.*

3.3.2 Use of national guidance for default limits

Since the existing RFP was made operative, considerable effort from the freshwater resource management community has been put in to providing national guidance for limit setting. One document in particular, the *proposed National Environmental Standard for ecological flows and water levels* (Ministry for the Environment 2008) has been utilised by GWRC to inform river and stream allocation recommendations. While nationally-derived default limits are by definition a blunt instrument in some circumstances, they are a useful yardstick for assessing appropriate boundaries of resource use in advance of more comprehensive investigation.

3.3.3 Protocols for low water use areas

Outside of the main three sub-regions (Wairarapa and Hutt valleys and Kapiti Coast), default allocation limits will still apply to rivers and streams but in many cases, it is expected that insufficient information will be held by GWRC to fully inform the limits (eg, in some ungauged catchments it may not be possible from existing datasets to estimate flow statistics like mean annual low flow). In such cases, consent applicants will be expected to furnish the required information in consultation with GWRC.

For groundwater, there are no default allocation limits being recommended outside of the main three sub-regions; limits should be determined on a case by case basis following a protocol that includes consideration of stream and wetland depletion effects and effects on other users. The detail of this protocol is under development but, at the time of writing this report, has not yet been finalised.

3.4 Implication for water users

A key consideration when deciding how water will be allocated in the region is how water users will be affected. The main implications for water users of the new recommendations are summarised in Section 4.4 and changes in the allocation status of water bodies arising from the new recommendations are summarised in Appendices 4. However, it is not within the scope of this report to provide a full and detailed assessment of how users will be impacted.

With regard to existing users, the interim approach to water allocation recommended in the pNRP includes the principle that users can retain water currently allocated through existing resource consents. Retaining water that is currently allocated will be subject to use being efficient and meeting minimum flows and water levels over a transitional period of four years.

The reason for adopting the principle that existing users can retain water is that the social and economic benefits associated with existing water use should only be altered in the context of a thorough analysis of all relevant values that will be explored in the whaitua process. Adopting such a principle is consistent with the first-in-first-serve convention of the Resource Management Act (RMA). While different conventions can be applied under the RMA, first-in-first serve is an appropriate starting point for allocating water while a comprehensive and lasting approach to water allocation and limits are progressed at the catchment scale through the whaitua process.

3.5 Methodological limitations

Determining appropriate allocation blocks is a complicated task. Science informs the decision-making butthe recommendations summarised in this report are mostly constrained to ecological bottom lines. While this fulfils key requirements of the RMA decision-making process, it is acknowledged that there are wider community interests yet to be addressed which may impact on the volume of water available for extractive and other uses. It is anticipated this will happen incrementally through further technical refinements and community consultation during the regional plan process for interim provisions and subsequently through the whaitua and longer term limit-setting processes.

Specific methodological limitations of the approach taken are discussed in background technical reports (and a fuller description is provided in Appendix 3). The key limitations can be summarised as:

- **Depth of understanding:** The scientific rationale for defining ecological bottom lines is stronger in some circumstances than in others. Generally, a reasonably good technical rationale has been developed for setting minimum flows in rivers and streams by measuring or modelling relationships between flow, habitat quality and other life supporting parameters. But the science is much less well developed with respect to higher flow thresholds (ie, for supplementary flows and allocation) and the amount of flow alteration that can be tolerated. As a result, it becomes necessary to adopt precautionary rules of thumb to establish some flow and allocation provisions rather than specifically reasoned numbers.

- **Scale issues:** The overall framework for establishing flow and allocation provisions is designed to manage water resources at a catchment scale and during times of water stress. There may be periods of time and/or localised points within catchments where the provisions do not adequately represent water availability.

- **Modelling uncertainties.** Obtaining accurate estimates of statistics such as mean annual low flow (MALF) can be difficult because of existing abstraction effects and monitoring constraints. Modelling and extrapolation from recorded data is required in some cases. Likewise**,** the numerical groundwater models used to develop groundwater allocation options are necessarily simplified representations of complex natural geological environments. They unavoidably therefore have an inherent uncertainty and cannot be entirely accurate in their predictions.

- **Integration of water quality provisions:** Provisions for water quantity must be integrated with those for water quality to achieve sustainable management of fresh water. Currently, this has not been achieved, partly because no water quality limits have yet been suggested and also because there is no agreed technical basis for delivering fully integrated provisions.

Collectively, the factors outlined above contribute to uncertainty associated with the technical approach to establishing flow and allocation provisions. Uncertainty has been minimised by adopting best practice methods and commissioning peer review at various stages. On balance, it is considered that the collective uncertainty does not significantly detract from the validity of the approach or the robustness of the recommendations. Recommendations are considered likely to be conservative – in favour of maintaining ecological bottom lines and minimising flow-related degradation – but not overly so.

The interim nature of the recommended provisions recognises that some limitations need to be further addressed and provides the opportunity for refinement. This may include adjustments to provisions based on a broader canvass of views about whether limits are more or less conservative than they ought to be.

4. Allocation limits for rivers and groundwater

This section provides a summary explanation of the technical basis for recommended allocation limits for rivers and groundwater (see Appendix 1 for catchment specific limits). Explanations are split between (1) rivers and directly connected groundwater and (2) groundwater with no direct hydraulic connection to surface water. The allocation status of rivers and aquifers under existing RFP provisions is compared to the potential future allocation status under new recommended limits.

4.1 Existing situation

Core allocation limits in the existing RFP have been calculated in a variety of ways for different individual rivers; from simply adopting the actual rate of allocation on the date of the RFP becoming operative to the use of hydrological statistics to define a proportional cap (eg, 60% of the 1 in 5 year low flow). There is little consistency in approach across catchments and, sometimes, the description of catchment allocation status has not fully reflected the combined effect of all abstractions from upstream tributaries.

More importantly however, the current RFP essentially manages groundwater and surface water as separate entities and does not explicitly consider the impacts of groundwater abstraction on surface water on a catchment or sub-catchment basis[3]. The plan designates a number of groundwater management zones for the region with associated 'safe yields' based principally upon groundwater recharge and/or throughflow calculation. The interconnection between zones or the influence of connected surface waters is generally not considered.

The concept of 'safe yield' adopted in the current RFP calculations assumed that all aquifer inflow was essentially available for allocation. Current sustainable aquifer management practice however dictates that only a portion of aquifer recharge can be utilised to prevent adversely affecting groundwater dependent ecosystems which are sustained by aquifer discharge. Many of the groundwater zone safe yields in the current RFP are therefore no longer considered 'safe' or appropriate in the context of long term water resource management.

4.2 Summary of the new recommendations

There are three types of allocation limit being recommended:

1. **A catchment-specific <u>numerical</u> allocation limit** specified as cumulative maximum instantaneous rate of take (given in litres/second and based on region-wide default criteria). These are listed in Tables A1.1, A1.3 and A1.5 for relatively high value/high demand catchments. These numerical allocation limits apply to all upstream tributaries of the named river/stream (as well as directly connected groundwater),

2. **A region-wide <u>default</u> allocation limit** covering all rivers and streams (and directly connected groundwater) that are neither listed in Tables A1.1,

[3] Although there are provisions for addressing the direct effects of groundwater abstraction from some riparian aquifers on adjacent connected surface waters where this is considered appropriate.

A1.3 and A1.5, nor tributaries of these listed waterways. These default limits are based on a proportion of mean annual low flow.

3. **Groundwater management zone allocation limits** for groundwater that is not directly connected to surface water and covered by the limits above. These limits are specified as annual maximum volumes in Tables A1.2, A1.4 and A1.6.

As with minimum flows, the allocation limit recommendations (catchment-specific or default) are based mainly on the premise of maintaining ecological values.

4.3 Technical explanation

4.3.1 Reason for change in approach

New allocation recommendations seek to address some the limitations in the existing RFP approach just described. A key feature of the recommendations is that surface water allocation limits apply both to direct abstractions from the river or stream and groundwater abstractions that are deemed to be directly connected to these waterways (Category A). Groundwater abstractions that are deemed to not have direct connection to surface water (Category C) have a separate allocation budget but one that is still referenced to long term depletion effects where appropriate (see next section).

Another key feature with regard to the Wairarapa Valley is that the availability of water at any location within the greater Ruamahanga River catchment (all major and minor tributaries included) is assessed against local **and** catchment-wide allocation criteria (see Section 4.3.3b).

4.3.2 Basis for groundwater categorisation (A, B, C)

Appendix 2 summarises the definitions for Category A, B and C groundwater. The basis for the groundwater categorisation is described in detail in a series of conjunctive management framework reports for the Wairarapa Valley, Hutt Valley and Kapiti Coast by Hughes and Gyopari (2011 and revised 2014), Gyopari (2015) and Mzila et al (2014 and 2015), respectively. Essentially the categories relate to the magnitude of surface water depletion effect that is likely to be caused by groundwater abstraction.

It is important to note that there is not an allocation volume assigned to each abstraction category; the categories are simply a means by which to determine whether groundwater taken from any given location should come from the surface water budget or the groundwater budget, or in part from both.

4.3.3 Basis for allocation limits; rivers and directly connected groundwater

As already discussed, GWRC has not yet gone through a process of determining allocation limits based on a balance of in-stream and out-of-stream (ie, security of supply) values. Such a process is not science-driven but requires community and water user input to determine the acceptability of trade-offs. As an interim measure it is proposed that surface water (and directly connected groundwater) allocation limits be based on default values that are aimed at maintaining ecological values.

(a) Default limits

The *Proposed National Environmental Standard on ecological flows and water levels* (pNES, Ministry for the Environment 2008) recommends that the following default limits should be adopted:

*For rivers and streams with **mean flows less than or equal to 5 m^3/s**, an allocation limit of whichever is the greater of*

- 30% of MALF or
- The total allocation from the catchment

*For rivers and streams with **mean flows greater than or equal to 5 m^3/s**, an allocation limit of whichever is the greater of*

- 50% of MALF or
- The total allocation from the catchment

While these default limits have not been legislated, the technical basis for them is the result of deliberations by a consortium of New Zealand experts and is therefore considered to be an important guide for GWRC. The general premise of the recommended limits (30% and 50% of MALF) is that, when combined with minimum flows similar in nature to those recommended in the pNES, the more significant detrimental impacts associated with abstraction (ie, extended low flow durations causing algae blooms and aquatic habitat degradation) are less likely to occur.

The pNES recommends adopting the above defaults where catchment-specific provisions do not already exist. GWRC have opted to use the defaults in this sense, but also to use the defaults to revise existing limits; many of the specific limits defined in the past are arbitrary and the defaults at least provide a consistent set of criteria with some ecological basis with which to assess existing levels of allocation.

While the default limits are effects-based, in that they have an established ecological rationale based on observations in New Zealand freshwater settings, they are not expected to offer an appropriate level of flow maintenance at all scales, and in all types of catchment. There may be situations where more or less allocation than permitted by the default limits is appropriate based on consideration of catchment-specific and local-scale factors. Nevertheless, until full catchment-specific analysis is undertaken the default limits are considered a useful rule-of-thumb for managing surface water allocation.

Some preliminary desktop analysis has been completed to try to better understand how relevant and meaningful the pNES default limits are in the Wellington regional context. Figure 4.1 compares the average number of low flow days (ie, flow is less that the 7d MALF) per year for a selection of rivers and streams under recommended minimum flow rules) and various allocation scenarios. Some general patterns emerge:

- For Tararua-fed rivers, allocation limits equating to 20% of 7dMALF-N do not lead to significant increases in the number of low flow days (ie, remains below 30 per year on average). For Tararua-fed rivers in the Wairarapa, allocation limits equating to 40% of 7dMALF-N are also relatively ‘safe’, although this increased level of allocation for the Hutt, Waikanae and Otaki rivers is likely to lead to a more significant increase in low flow days.

- Foothill rivers and streams are more sensitive than the larger rivers and allocation limits equating to 20% 7d MALF may be enough to increase low flow days to above 30 per year in some of these systems (eg, Pauatahanui Stream, Kopuaranga River). Allocation limits of 40% 7d MALF may be detrimental in all cases.

- Rivers in the eastern hill country of the Wairarapa (eg, Whareama River, Pahaoa River) are characterised by a high number of naturally low flow days (close to 30). Allocation set as a proportion of 7d MALF has little further effect because 7d MALF is so low in these rivers (well under 100 L/s).

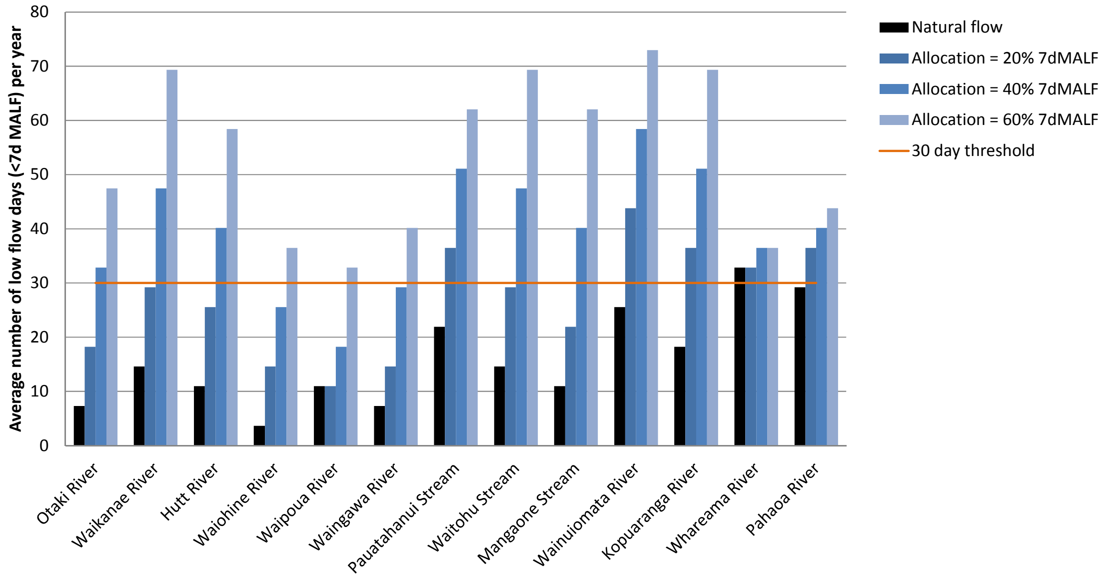

Figure 4.1: Average number of low flow days (ie, flow<7d MALF) per year for a selection of rivers and streams under recommended minimum flow rules (refer to Table 4.1 in Thompson (2015) and various allocation scenarios. The horizontal red line (based on a ‘rule of thumb’ in Beca (2008)) represents a proportion of time above which detrimental effects are more likely to be noticed. Rivers are generally grouped as follows: Tararua-fed rivers at the left, foothill rivers and streams in the middle and eastern Wairarapa rivers at the far right.

Figure 4.2 shows how various allocation scenarios might be expected to impact on individual low flow events for three rivers – the Otaki, Kopuaranga and Whareama – that represent different catchment types (high, medium and low base flow respectively). In the context of the default limit definitions, the Otaki River is considered a large river (mean flow is greater than 5 m^3/s) while the other two are small rivers (with a mean flow of less than 5 m^3/s). The main observations from Figure 4.2 are:

- The number of low flow events (ie, defined here as events with a duration of 14 or more consecutive days of flow less than MALF) increases with progressively increased allocation in all three rivers, but most markedly so in the Otaki and Kopuaranga rivers; in these rivers almost twice as many low flow events are expected under a 60%-of-MALF allocation regime than a 20%-of-MALF regime.

- The duration of individual events also increases as allocation increases, but in subtly different ways and from different baselines across river types; for example, the median low flow event duration increases from 15 days under natural conditions to 23 days under a 60%-of-MALF scenario for the Otaki River and from 24 days to 28 days under the same scenarios for the Kopuaranga River. The Whareama River median essentially remains the same across scenarios although the duration of extreme events increases with increasing allocation.

- The impact of 40%-of-MALF allocation is substantially higher for the Kopuaranga River than for the Otaki River (with respect to number of low flow events being extended beyond 30 consecutive days, which is considered indicative of a point beyond which noticeable detrimental effects may be more likely to occur).

Overall, the analysis supports the notion of higher allocation limits for larger rivers in the Wellington region and that the recommended 30% and 50% MALF for small and large rivers, respectively, are appropriate (in the absence of more specific information).

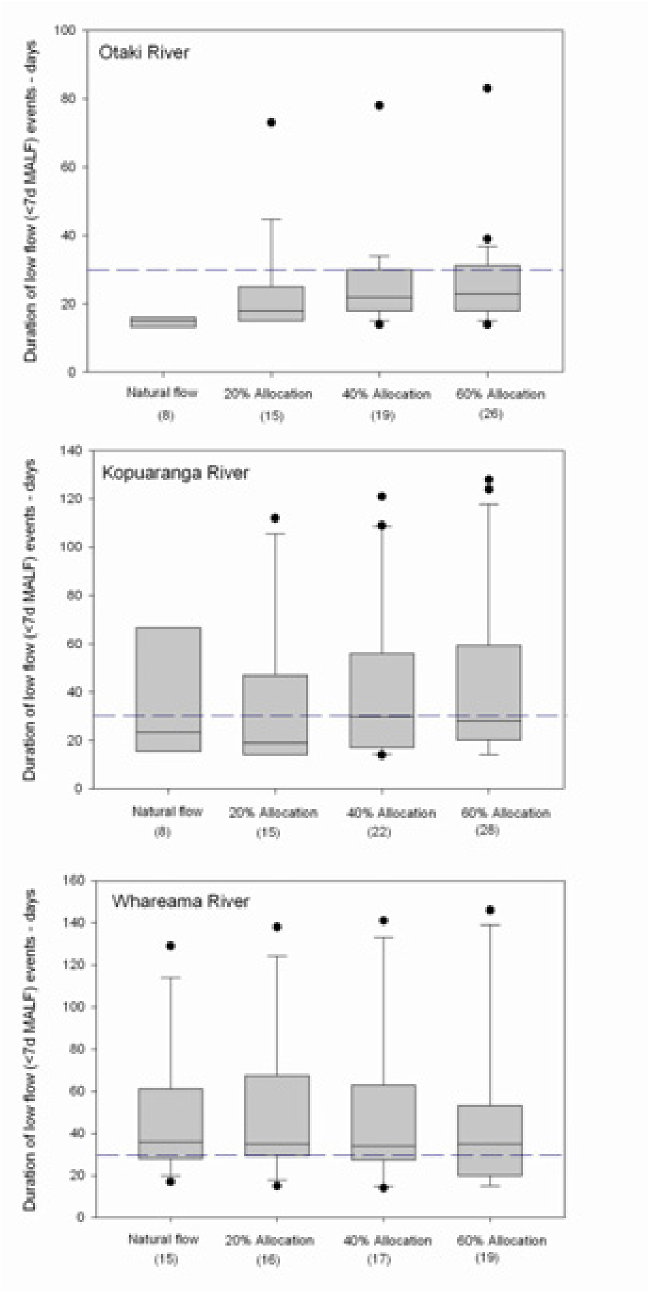

Figure 4.2: The duration (in days) of discrete low flow events for the natural flow regime compared to allocation scenarios for three rivers (based on 1990–2010 flow records). Low flow events are defined as those where flow is less than MALF for 14 or more days (note: two low flow events that are separated by 5 or less days of higher flow are considered a single event). The number of events in each scenario is shown in brackets below the scenario label on the *x*-axis. Box and whisker plots show minimum, maximum, 5th, 25th, 50th, 75th and 95th percentiles. The dashed blue lines denote an event duration of 30 consecutive days; this is considered indicative of a point above which noticeable detrimental effects may be more likely to occur.

(b) Catchment management units and sub-units

Catchment management units have been defined for the purposes of setting numerical allocation limits in different ways across the region depending on the focus of management objectives.

For the allocation of surface water (and directly connected groundwater) catchment management units equate to the area defined by the primary catchment of the river or stream to the point of discharge to sea. A single allocation limit is recommended for each catchment management unit, generally based on the amount of water available in the lowest parts of the catchment (as defined by 7 day MALF).

In the case of the Ruamahanga River catchment, several management **sub-units** have also been defined in recognition of the relatively large catchment size and importance of many tributary rivers and streams as sources of allocable water. An allocation limit is recommended for each sub-unit based on the amount of water available in each discrete area but a single allocation limit is also recommended for the whole Ruamahanga River[4] to manage the total cumulative effect of all sub-unit water use.

(c) Consideration of reach-based limits

Where catchments exhibit a typical incremental flow gain in a downstream direction it is appropriate to simply allocate water in proportion with the amount of water available at the catchment mouth. However, where flow patterns within a catchment are highly variable, allocating according to what is available at the mouth may lead to over-allocation in upstream reaches, or, conversely, prevent allocation of water that may be more abundant higher in the catchment.

A good example of a catchment in the Wellington region that has a highly spatially variable flow regime is the Waipoua River. Figure 4.3 shows the pattern of natural flow loss and gain through this catchment. Seven day MALF in the upper and lower reaches is 0.375 m^3/s and 0.490 m^3/s, respectively, but is only about 0.215 m^3/s in its middle reaches. In this example, basing an allocation limit solely on the end-of-catchment MALF, could potentially lead to higher than desirable allocation levels in the middle reaches.

[4] Noting that the Ruamahanga River catchment management unit is defined in this report as terminating at the confluence of (but not including) the Lake Wairarapa outlet. Lake Wairarapa is considered a separate catchment management unit while the lowest reaches of the Ruamahanga River (ie, downstream of Lake Wairarapa) are influenced by tides and it is not considered appropriate to manage allocation of surface water in this area in the same way as the rest of the Ruamahanga River.

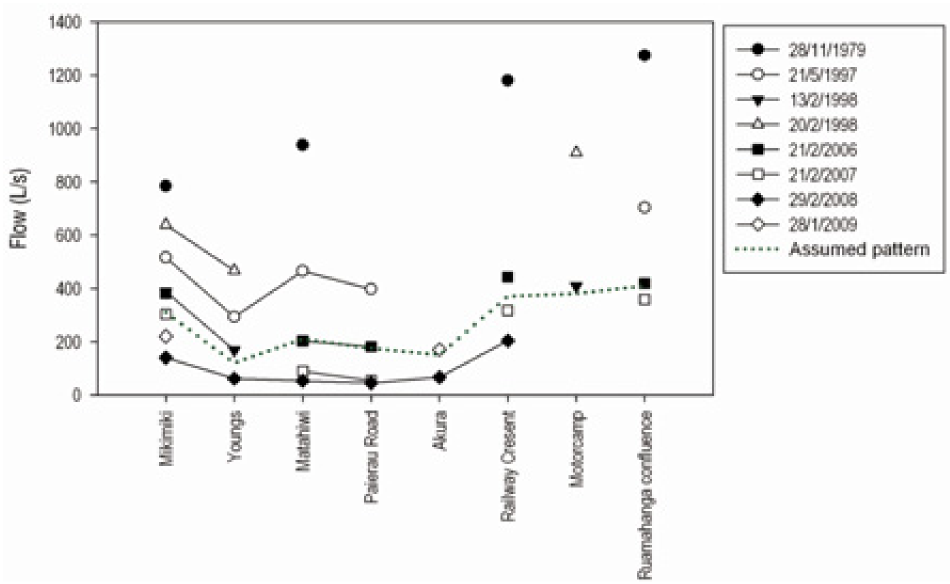

Figure 4.3: Low flow patterns from upstream (left) to downstream (right) in the Waipoua River

To address the situation just described, consideration was given to assigning reach-based allocation limits (ie, sub-catchment limits nested within parent catchment limits). Some reach-based limits were put forward in the draft Natural Resources Plan. However, GWRC subsequently reached the view that the extent of nesting and sub-catchment detail made interpretation of the overall allocation limit framework overly complicated. GWRC was also concerned that the flow dynamics associated with groundwater gain and loss from a river are very complex and applying multiple reach-based allocation limits may give the impression of greater certainty about how these dynamics are effected by allocation than is actually the case.

For now, the approach proposed for the pNRP is to apply a single allocation limit for each catchment of interest and this limit is based on the maximum observed or estimated MALF in the mid to lower reaches of the catchment. At the same time a general policy relating to spatial flow variability and availability is to be introduced to the pNRP to allow some discretion to ensure any new water takes are appropriately distributed within a catchment (to protect the more vulnerable reaches).

In time it may be possible to introduce reach-based limits but this will require more specific information about how surface and groundwater interactions and how the effects of different levels of allocation propagate through a catchment.

4.3.4 Basis for allocation limits; groundwater with no direct hydraulic connection to surface water (Category C)

While the degree of hydraulic connection between Category C groundwater and surface waters is relatively low, in many situations there is still some cumulative depletion effect occurring over the course of many weeks to months. It is recommended that allocation limits should take account of this effect where appropriate (ie, where potentially sensitive surface water bodies exist within the zone of influence of seasonal groundwater drawdown). Where there are no sensitive water bodies at risk, Category C groundwater allocation limits can be based solely on aquifer recharge and throughflow.

The basis for individual Category C zone allocation limits is summarised in Tables A1.2, A1.4 and A1.6 and described in a general sense in the following sections.

(a) Limits based on surface water depletion

Defining depletion criteria for Category C groundwater allocation limits is struck by the same limitation discussed earlier for the river and highly connected groundwater; that is, because GWRC has not yet gone through a full community-led process of balancing in-stream and out-of-stream values, determining levels of 'acceptable effect' from groundwater depletion cannot be done in a definitive sense. As an interim measure, recommended allocation limits (that incorporate stream depletion criteria) are based on expert judgement that attempts to balance the likely acceptability of impact with the existing level of depletion already being caused by Category C takes.

Generally, recommendations have been developed along a broadly consistent line of thinking to limit any depletion from Category C abstractions (in addition to that already occurring due to direct surface water and directly connected groundwater takes) to:

- Less than 5% of MALF of the larger, highly allocated, rivers
- Less than 20% of MALF of smaller rivers and streams.

The higher proportional limit for smaller rivers and streams may seem counter-intuitive. It is not intended to signal a higher tolerance for impact in these systems *per se* but simply reflects the fact that existing depletion levels are relatively high because river/stream flow rates are low and bore water in these areas has therefore been the most secure source of supply.

Following the determination of a Category C allocation limit based on consideration of depletion factors, the limit value (annual groundwater volume) was cross-referenced against estimated aquifer recharge to check that it met with good practice (see next section), and adjusted if necessary.

(b) Consideration of aquifer recharge

The average amount of effective recharge to an aquifer is described by the term 'mean annual recharge' (MAR). As discussed, in the past, safe yield limits have often been calculated on the assumption that all of the recharge is available to be allocated (ie, safe yield = 100% MAR). However, this approach is now considered overly generous as it allows no contingency for successive dry years when allocation may exceed recharge. During such times aquifers may be 'mined' or depleted to the extent that unacceptable impacts on surface water bodies and groundwater users occur; potential impacts include falling water levels and saline intrusion.

The approach taken under current recommendations, where stream depletion impacts have been identified, was to cross reference allocation limits to the lower quartile of annual recharge (rather than the mean) and, as a guide, keep allocation below 20-30% of lower quartile recharge. In practice this means that once a groundwater allocation limit was identified on the basis of predicted stream depletion effects, it was checked against the relevant lower quartile recharge and if it amounted to more than 30% of the recharge value, a lower allocation limit was considered.

To illustrate the approach by way of example; Table A1.2 in Appendix 1 shows that the proposed groundwater allocation limit in the Te Ore Ore zone is 0.48 million m^3/year. This limit was based on ensuring that the predicted seasonal depletion effect was not greater than 9% of MALF for the Poterau Stream and 0.5% of MALF for the Ruamahanga River. Once the limit (0.48 million m^3/year) was identified, it was checked against the annual recharge data (shown in Figure 4.4) and found to be 27% of the lower quartile (and meeting the criteria discussed above). Figure 5.4 also shows the large extent of inter-annual variability in recharge and that there are several occasions when at least two successive years of recharge well below the mean occur. If the allocation limit was referenced against mean annual recharge then abstraction would outstrip recharge by a large amount during these dry spells.

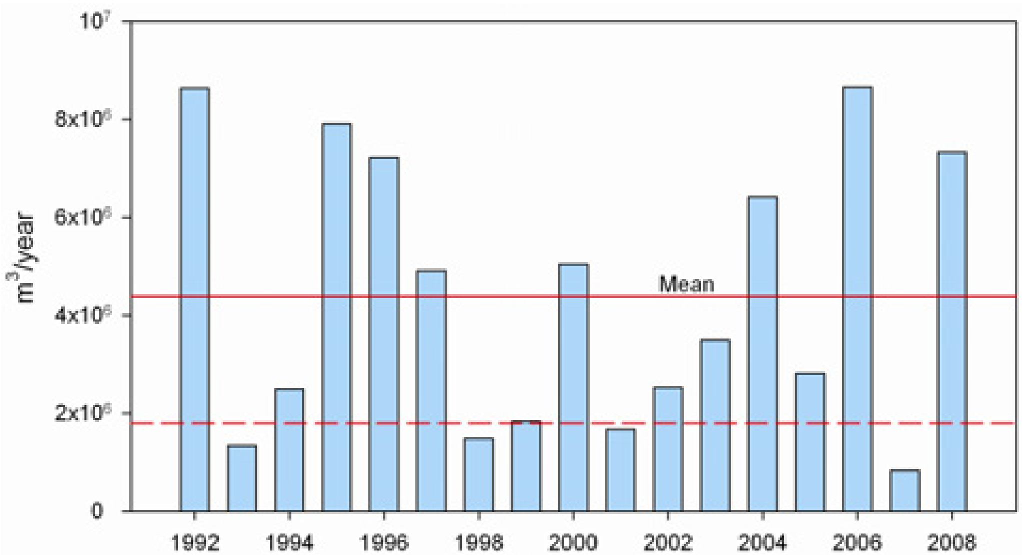

Figure 4.4: Modelled annual rainfall recharge for the Te Ore Ore zone in the Upper Valley catchment between 1992 and 2008. A mean (average) recharge of 4.4 x 10^6 m^3/year is indicated as is the lower quartile value of 1.8 x 10^6 m^3/year (dashed line).

In some groundwater management zones no particular surface water depletion risk was identified, and in such cases allocation limits are based on a more generous proportion of annual recharge. As a general guide, the approach taken was to keep total allocation below 50% of MAR.

4.3.5 Variations in the basis for determining groundwater limits

Conceptually, the technical basis for setting allocation limits was consistent across the region with the descriptions in the previous section. However, there are some unique features of the Hutt Valley and Kapiti Coast groundwater systems that led to variations in the way the framework is applied.

In both the Hutt Valley and the Kapiti Coast, aquifers are generally more vertically continuous than in the Wairarapa Valley. This means there is a higher degree of 'leakiness' between shallow and deep parts of the aquifers and, as a consequence, that the impact of groundwater abstraction, even at substantial depths, can have a significant impact on surface water bodies. For this reason there is very little Category C groundwater within the Hutt Valley or Kapiti Coast management zones (ie, no groundwater that is sufficiently isolated from surface waters to warrant being defined as Category C). There is still a groundwater allocation volume in these areas determined (in part) on the basis of stream flow depletion effects but this volume of water is distributed among Category B takes only.

Another feature unique to the Kapiti Coast and Hutt Valley is that allocation limits are partially based on salt water intrusion risk. For the Kapiti Coast, allocation limits were set such that cumulative groundwater drawdown at the coast did not exceed 0.8 m (Mzila et al 2015) and in the Hutt Valley the recommended groundwater allocation limit for the Waiwhetu Aquifer was set to maintain an artesian head pressure of at least 2 m above mean sea level (Gyopari 2015). An additional consideration on the Kapiti Coast was the effect of cumulative groundwater allocation on wetland water levels. Criteria specifying a maximum drawdown due to cumulative groundwater abstraction of 0.2 m below natural background water levels were incorporated in the setting of allocation limits (Mzila et al 2015).

4.4 Implication of recommended changes

Appendix 4 compares the allocation status of rivers and groundwater aquifers under the new recommended limits with current allocation status[5].

Under the recommended changes to surface water allocation (Appendix 4) there is effectively no core allocation remaining in the Ruamahanga River catchment (including Lake Wairarapa). Under the existing plan, small amounts of core allocation remain available in a few areas (eg, Parkvale Stream, Papawai Stream, Tauherenikau River), however, when the proposed allocation limits are applied along with consideration of cumulative impacts of further allocation on the mainstem Ruamahanga River and Lake Wairarapa, these areas become fully allocated. Overall, however, Appendix 4 shows that besides some minor changes associated with the application of new methodologies for defining allocation status, the general picture with respect to water availability across the region has not changed dramatically. One change of note is that several of the rivers in the central part of the region that are used for bulk town supply (eg, the upper reaches of the Hutt, Wainuiomata, Orongorongo and Waikanae rivers) will be considered fully allocated under new recommended limits. Currently, while these rivers are widely accepted to be fully allocated, they are not formally considered so as no core allocation is specified in the existing RFP.

Appendix 4 also compares the allocation status of existing groundwater management zones to their re-configured counterparts in the new

[5] Note the assessment in Appendix 4 is for indicative purposes only as 'current status' changes over time according to regularly updated consent information

recommendations. Generally there is less water available to new groundwater users than indicated by the existing RFP, mainly because Category A groundwater has been made distinct from other groundwater and is largely fully allocated. However, in practice, new applications for water in these Category A areas have been treated with a high level of caution for some time already.

5. Supplementary (mid-range to high flow) allocation limits for rivers

This section provides a summary explanation of the technical basis for the recommended supplementary allocation limits (ie, those allocation limits that apply at mid- to high range flows).

5.1 Existing situation

The current RFP identifies supplementary flow thresholds for some rivers above which water is made available (in addition to core allocation). It is difficult to trace the exact basis for the supplementary threshold numbers in the current RFP. Only the Mangatarere Stream threshold appears to have explicit reasoning – to maintain optimum brown trout habitat. The others are largely arbitrary and vary from river to river – some supplementary flow allocation levels are only marginally above minimum flow levels whilst others are more genuine mid-range flow thresholds. No supplementary allocation amounts are specified in the RFP, with this aspect left to GWRC discretion case-by-case. In practice, supplementary allocation in the Wellington region has seen little demand to date. However, should demand increase there is significant degree of uncertainty about whether the existing provisions are sufficient in all/most cases to maintain environmental values.

5.2 Summary of the new recommendations

It is recommended that existing supplementary allocation policies are superceded by a default rule that states supplementary allocation only be available (in addition to core allocation) when natural river flows exceed **median flow**. Furthermore water is only available providing that:

- the frequency of flushing flows that exceed three times the **median flow** of the river is not changed, and
- 50% of the river flow above the **median flow** remains in the river.

This policy is intended to apply region-wide by default. However, discretion could be applied to activities operating outside of the default criteria, providing that an appropriate catchment-specific assessment of effects is submitted.

The technical basis and rationale for supplementary flow proposals is described in more detail in Thompson (2015a) and summarised in the following sections.

5.3 Technical explanation

5.3.1 Basis for new recommendations

There is limited data and knowledge with which to derive ecologically explicit supplementary flow thresholds. Unlike minimum flow setting where there is a generally accepted convention of applying flow-habitat relationships, no such established method exists for higher flow setting. To help establish some meaningful criteria in the absence of accepted standards or rules of thumb an expert panel was assembled by GWRC in November 2011. Key points from the discussion of that group and agreed advice that was forthcoming are provided in Thompson (2015a).

The group identified the following aspects of higher flow regimes that were considered relevant to supplementary flow setting:

- **Median flow – an ecologically relevant threshold.** Research in New Zealand indicates that median flow is an ecologically relevant flow statistic relating to trout carrying capacity and stream productivity. Jowett (1990, 1992) found that invertebrate food-producing habitat at the median flow was strongly associated with trout abundance. Many large rivers in the region are recognised (eg, in the Regional Policy Statement, GWRC (2013)) for offering important trout habitat and having regionally significant recreational values for their trout fisheries. It is therefore suggested that there is a biological rationale for adopted, as a general rule, median flow as a supplementary flow threshold for valued trout rivers. In the absence of comparable information with which to nominate a biologically relevant flow threshold for other fish species, a region-wide rule of thumb based on median flow is favoured.

- **Periphyton is a key indicator.** Periphyton (algae) growths and blooms occur in many Wellington region rivers, particularly after long periods of stable base flow. While warm weather promotes algae growth it is important to note that blooms can also occur in winter conditions if flows are stable for long enough. Periphyton blooms are unsightly, sometimes pose a nuisance to swimmers and other recreationists and can result in habitat degradation for aquatic species (mainly due to oxygen depletion). Benthic cyanobacteria can be toxic and is known to proliferate on occasion in Wellington rivers. Given the range of values affected and relatively well understood relationship between periphyton and flow (see flushing flows next), periphyton is seen as the key indicator for consideration when setting supplementary flow thresholds and limits.

- **Flushing flow preservation is important.** Flushing flows ensure fine sediment, periphyton and other aquatic vegetation does not accumulate at a site with adverse effects on aquatic ecosystem health and other values. New Zealand research has demonstrated that flows of about three times the median are likely to provide suitable flushing flows in most rivers. It is therefore important to preserve the frequency with which these flushing flows occur. The annual frequency of flows exceeding three times the median flow is commonly referred to as FRE3.

On considering the above criteria put forward by the expert group, and a range of supplementary flow threshold options based around those criteria, GWRC staff selected a single option to recommend as a region-wide default (previously described in Section 5.2). In selecting this option, preference was given to taking a precautionary appoach and adopting criteria that had some precendence within water management policy elsewhere in New Zealand.

No clear or meaningful criteria were identified by the expert group for establishing the amount of water that should be made available once the supplementary flow threshold (ie, median flow) has been exceeded. In the absence of such criteria it is suggested that up to 50% of flow removal be permitted, thereby providing equal ‘share’ for water users and for maintenance of instream values.

It is noted that a recent review of regional council policies on mid-range flow management (Hay and Kitson 2013) stated general support for the approach being put forward here by GWRC; ie, the use of median flow and a flow sharing arrangement above that to preserve flushing flow characteristics.

6. Lake Wairarapa water level and allocation limits

This section provides a summary explanation of the technical basis for the recommended water level and allocation provisions for Lake Wairarapa. Refer to Appendix 1 for the specific limits.

6.1 Existing situation

The only policy criteria for managing Lake Wairarapa water levels in the existing RFP are the seasonal target levels established in the Lake Wairarapa Management Plan (Robertson 1991). A barrage gate at the lake outlet is manipulated by GWRC to try to generally meet the seasonal target levels, while also ensuring that the flood management functions of the lake are not compromised. Currently there are no provisions in the RFP to manage consented abstractions from the lake to ensure that they do not cause (or contribute to) undesirable reductions in water level. There is also no allocation limit for the lake in the existing RFP.

6.2 Summary of the new recommendation

Table 6.1 provides two sets of recommended policy criteria for managing Lake Wairarapa water levels; the first is a set of seasonal minimum target levels and the second is a set of three rules for actively managing the direct abstraction of water from the lake or its marginal drains (to help give effect to the seasonal target policy).

Table 6.1: Minimum lake level targets and minimum water levels for Lake Wairarapa

<table>
<tr><th>Time period</th><th>Minimum lake level at Burlings recorder</th><th>Minimum water levels for the purpose of allocating water</th></tr>
<tr><td>1 December to 29 February</td><td>10.15 m</td><td rowspan="4">For the purpose of allocating water, minimum water levels in Lake Wairarapa shall be determined by:
• minimum lake levels, and
• the minimum flow for the Tauherenikau River, and
• no net decline in lake level over the preceding five days.</td></tr>
<tr><td>1 March to 31 May</td><td>10.00 m</td></tr>
<tr><td>1 June to 30 September</td><td>9.95 m</td></tr>
<tr><td>1 October to 30 November</td><td>10.00 m</td></tr>
</table>

Table A1.1 in Appendix 1 provides proposed allocation limits for the Lake Wairarapa catchment management unit and its sub-units. These limits apply to both direct takes from the lake itself and also surface and connected groundwater takes from the wider lake catchment.

6.3 Technical explanation

6.3.1 Basis for water level limits

The recommended seasonal target levels in Table 6.1 are the same as those currently in use. There has been no formal review of the Lake Wairarapa Management Plan to inform a possible alternative set of criteria.

For the purpose of managing consented allocation from the lake it is recommended that the appropriate course of action (eg, restricton or cease take) is determined by taking into account the status of **all** of the following:

- minimum target lake levels,
- trend in lake level over the preceding five days, and
- flow in the Tauherenikau River relative to its specified minimum flow

In practice, this is intended to mean that if the lake level is below its seasonal minimum target level **and** has been trending downwards for at least five days **and** the Tauherenikau River is at or below its minimum flow, then direct abstraction from the lake should cease. The reason for requiring all three conditions to be met simultaneously, rather than just one (such as the target lake level), is to ensure that restrictions are only imposed in the event of genuine high water stress in the lake and its catchment. The artificially managed nature of water levels in Lake Wairarapa, along with the complex influence of levels in Lake Onoke and the Lower Ruamahanga River, means that there are times when tributary rivers to the lake are below minimum flow and/or target lake levels are not met but lake levels are rising. Likewise, there are times when there is a relatively good river flow into the lake but seasonal minimum target lake levels have still not been achieved. At such times it is considered inappropriate to restrict abstraction from the lake because neither represent periods of genuine catchment water stress.

6.3.2 Basis for water allocation limits

The recommended interim limit for allocation of water from the Lake Wairarapa catchment management unit is 1.80 m^3/s. This equates to the existing (as at 31 July 2015) maximum level of depletion resulting from consented takes from the lake itself as well as tributary rivers and streams and directly connected groundwater.

The limit has been informed by the preliminary findings of a water balance study undertaken over the summer of 2012/13 (Thompson and Mzila, 2015). This study found that the lake is potentially relatively sensitive to increases in allocation. This is primarily because the bed gradient of the eastern shoreline has a very shallow gradient (approximately 1:1000) and, therefore small changes in lake level can result in large shoreline changes. For example, if direct lake allocation were to double it is estimated that there could be a 0.10 m reduction in lake water levels during stable dry periods (assuming no change in the operation of the barrage gate); such a reduction could translate to a shoreline recession on the eastern lake margin during these times of around 100 m.

It is stressed here that the recommended interim allocation limit of 1.80 m^3/s is not based on an explicit assessment of the environmental impact of shoreline recessions due to increased allocation (ie, it has not yet been established whether or not meaningful environmental degradation would be associated with the scale of shoreline changes predicted under increased allocation). It simply reflects the line of reasoning that any increase in allocation would be difficult to justify given:

- the potential sensitivity of the lake to abstraction,
- the difficulty already experienced in achieving summer minimum lake target levels (see Thompson and Mzila 2015) and
- the lack of information about the environmental consequences of reductions in level.

It is considered prudent to adopt a precautionary approach until alternative allocation scenarios can be debated in the wider context of Lake Wairarapa management. Refinements to the Thompson and Mzila (2015) study are also required before the findings become sufficiently robust to form the basis of longer term allocation proposals.

7. Summary

This report makes a number of recommendations for the proposed Natural Resources Plan that relate to allocation limits for rivers and groundwater in the Wellington region.

The primary recommendations are:

- to apply a region-wide default rule for core allocation from rivers and streams that equates to 30% or 50% of seven day natural mean annual low flow (depending on flow rate). Where 7dMALF is known, the allocation limit has been defined as a numerical limit (in litres per second or l/s);

- to apply a region-wide default rule for supplementary allocation from rivers and streams that allows water (in addition to core allocation) to be abstracted above median flow and requires 50:50 flow sharing above this threshold;

- to allocate water from rivers and streams according to limits for local catchment management sub-unit as well as 'parent' catchment management units;

- to apply new groundwater allocation limits in accordance with the revised management frameworks developed for the Wairarapa Valley, Hutt Valley and Kapiti Coast. The recommended groundwater allocation limits take particular account of cumulative depletion effects on stream flow and wetlands as well as saline intrusion risk;

- to limit allocation from the Lake Wairarapa catchment management unit to the existing maximum depletion level (associated with consented abstraction) of $1.8m^3/s$. Furthermore, to introduce a restriction scheme to ensure that existing takes are appropriately managed during times of genuine lake water stress (ie, when the lake water level is below target levels, trending down and tributary rivers/streams are below their minimum flows).

The main principles underpinning the recommendations above are; to more fully reflect the connectivity between surface and groundwater resources, to take a broadly consistent approach across the region to defining the allocation status of water bodies and to allocate water cautiously especially where information about specific effects is currently limited.

The recommended limits are primarily focused on maintenance of ecological values and, for surface waters in particular, rely heavily on generalised relationships between flow and these values. While there are benefits in having clear, simple and standardised rules for managing allocation there also needs to be planning flexibility long term to ensure limits take account of broader community values and are not overly permissive or conservative. For this reason (among others), all limits summarised in this report, are considered interim until such time as catchment committees refine, and agree on, longer term limits. An important point is that under interim limits existing consent holders will retain water currently allocated to them.

The overall consequences of water use are determined not just by allocation policies but also other policies such as those relating to minimum flow restrictions. Therefore, the refinement of interim allocation limits will need to occur alongside fuller consideration of other relevant policies.

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Appendix 1: Allocation limits

Table A1.1: Ruamahanga River catchment surface water allocation limits for river management units, discrete sub-units and directly connected groundwater

Management Unit	Sub-unit	Allocation limit (L/s)	MALF criteria applied[1,2]
Ruamahanga River		7,535	Equates to 50% of 7d MALF (15,070 L/s)
	Kopuaranga River	180	Equates to 30% of 7d MALF (605 L/s)
	Waipoua River	145	Equates to 30% of 7d MALF (490 L/s)
	Waingawa River	920	Equates to 50% of 7d MALF (1,835 L/s[3])
	Upper Ruamahanga River	1,200	Equates to 50% of 7d MALF (1,400 L/s)
	Parkvale Stream	40	Equates to 30% of 7d MALF (140 L/s)
	Booths Creek	25	Equates to 30% of 7d MALF (80 L/s)
	Mangatarere Stream	110	Equates to 30% of 7d MALF (330 L/s)
	Waiohine River	1,590	Equates to 50% of 7d MALF (3,180 L/s)
	Papawai Stream	65	Equates to 30% of 7d MALF (210 L/s)
	Middle Ruamahanga River	1,240	Equates to 50% of 7d MALF (2,480 L/s)
	Huangarua River	110	Equates to 30% of 7d MALF (360 L/s)
	Lower Ruamahanga River	1,475	Equates to 50% of 7d MALF (2,950 L/s)
Lake Wairarapa		1,800	Equates to current maximum level of lake depletion resulting from direct takes from the lake and tributaries as well as directly connected groundwater
	Tauherenikau River	410	Equates to 50% of 7d MALF (820 L/s[4])
	Otukura Stream	30	Equates to 30% of 7d MALF (100 L/s)

[1] Unless otherwise noted, 7 day MALF values are estimates of naturalised 7dMALF at the downstream-most point of the management unit or sub-unit being considered

[2] The 7dMALF values (upon which allocation limits are derived) are for the discrete sub-units being considered only and do not incorporate flow contributions from other listed sub-units. For example, the estimated 7dMALF value for the bottom of the Waiohine River catchment has been adjusted to remove the contribution from the Mangatarere Stream. Likewise the Upper, Middle and Lower Ruamahanga River 7dMALF estimates have had all upstream flow contributions removed.

[3] Estimated at SH2

[4] Estimated as the average for the upper plain

Table A1.2: Wairarapa Valley groundwater allocation limits for groundwater that is not directly connected to surface water

Groundwater Management Zone	Allocation Limit (Mm^3/year)	Summary of criteria applied
Upper Ruamahanga	3.55	2.5% depletion of Ruamahanga River Approximately 20% of lower quartile LSR
Te Ore Ore	0.48	9% depletion of Poterau Stream 0.5% depletion of Ruamahanga River Approximately 30% of lower quartile LSR Limit groundwater drawdown to within range presently experienced
Waingawa	1.90	3% cumulative depletion of Waingawa and Waipoua rivers and Masterton springs 2.4% depletion of Ruamahanga River Approximately 15% or lower quartile LSR
Middle Ruamahanga	n/a	All Category A groundwater and therefore determined by surface water allocation limit
Fernhill-Tiffen	1.20	Approximately 80% of lower quartile LSR. No hydraulically connected surface water bodies so the usual proportion of LSR (20-30% lower quartile LSR) can be safely exceeded
Taratahi	1.40	20% cumulative depletion of Masterton/Carterton Fault spring discharges Approximately 17% of lower quartile LSR.
Parkvale [unconf = 0-15 m] [conf = >15 m]	0.35 [unconf] 1.55 [conf]	Combined 13% depletion (10% from confined and 3% from unconfined) of total MALF in Parkvale Stream and Booths Creek Combined 0.5% depletion of Ruamahanga River MALF Combined 50% of lower quartile LSR (above the recommended range of 20-30%)
Mangatarere	2.30	20% cumulative depletion on Mangatarere River MALF at mouth Approximately 10% of lower quartile LSR. A higher limit cannot be justified given extent of depletion already occurring
Waiohine	n/a	All Category A groundwater and therefore determined by surface water allocation limit
Moiki	n/a	All Category A groundwater and therefore determined by surface water allocation limit
Lower Ruamahanga	n/a	All Category A groundwater and therefore determined by surface water allocation limit
Huangarua	0.65	47% lower quartile LSR (20% mean annual LSR) Considered prudent to limit to less than 50% lower quartile LSR due to unknown extent of hydraulic connection to the Huangarua River
Martinborough	0.80	120% of lower quartile LSR and 37% of mean annual LSR. No hydraulically connected surface water bodies so the usual proportion of LSR (20-30% lower quartile LSR) can be safely exceeded. Primary consideration is to avoid long term aquifer drawdown

Groundwater Management Zone	Allocation Limit (Mm^3/year)	Summary of criteria applied
Dry River	0.65	83% of lower quartile LSR and 40% of mean annual LSR. Very limited understanding about the extent of hydraulic connection with surface water bodies so while it is considered reasonable to exceed the usual proportion of LSR (20-30% lower quartile LSR), it is prudent to maintain the allocation limit below 50% of mean annual recharge.
Tauherenikau	6.60	8% depletion of Tauherenikau River MALF in lower reaches Approximately 20% depletion of total spring MALF (Otukura, Featherston Springs, Stonestead/Dock Creek) Approximately 25% of lower quartile LSR.
Lake	6.75	25% reduction in total groundwater inflow to Lake Wairarapa Equates to about 5% of total Lake Wairarapa inflow Recommendation consistent with maintaining groundwater drawdowns within existing range and not inducing further lake depletion effect
Onoke	2.10	40% throughflow recharge from side valley aquifers 73% of modelled surface water discharge Chosen to ensure that the daily allocation rate remains comfortably below the predicted groundwater discharge rate and that most of the groundwater throughflow from side valleys is not allocated in case further development in these valleys occurs

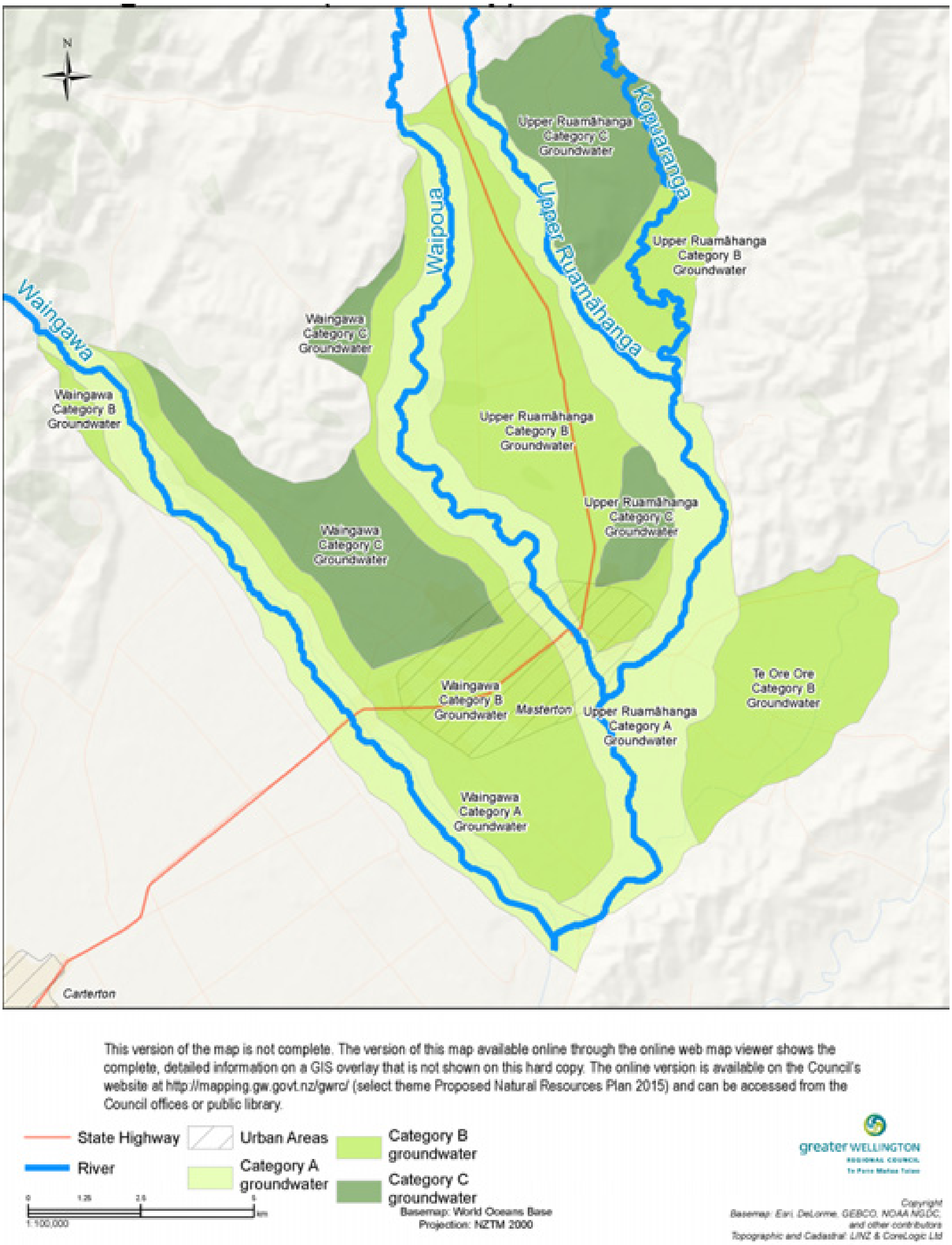

Figure A1.1: Upper Ruamahanga River. River management sub-units and groundwater abstraction categories to a depth below ground of <u>up to 20m</u>. See Table A1.1 and A1.2 for allocation limits associated with rivers and groundwater in this map.

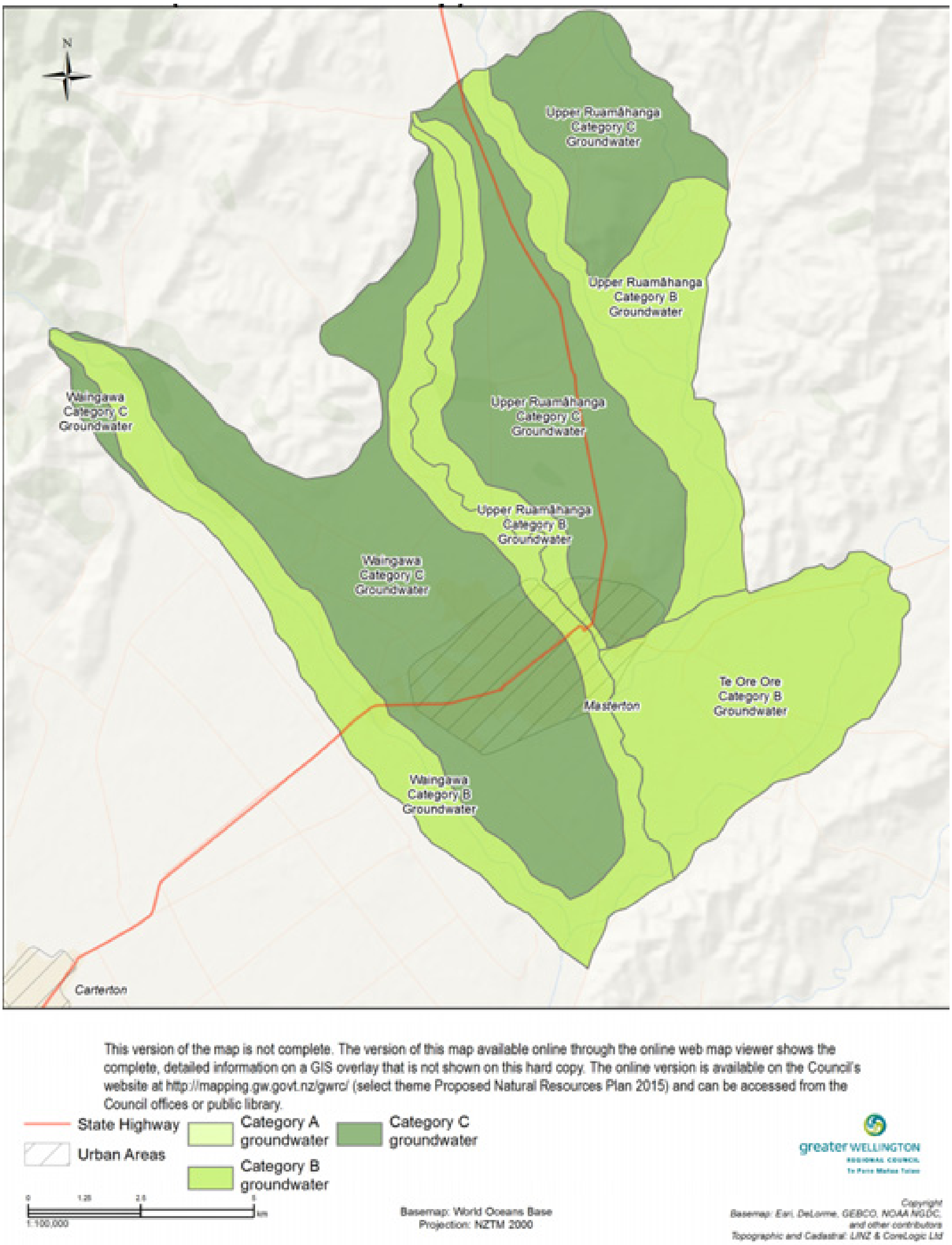

Figure A1.2: Upper Ruamahanga River. Groundwater abstraction categories at a depth below ground of <u>between 20m and 30m</u>. See Table A1.2 for allocation limits associated with the groundwater in this map.

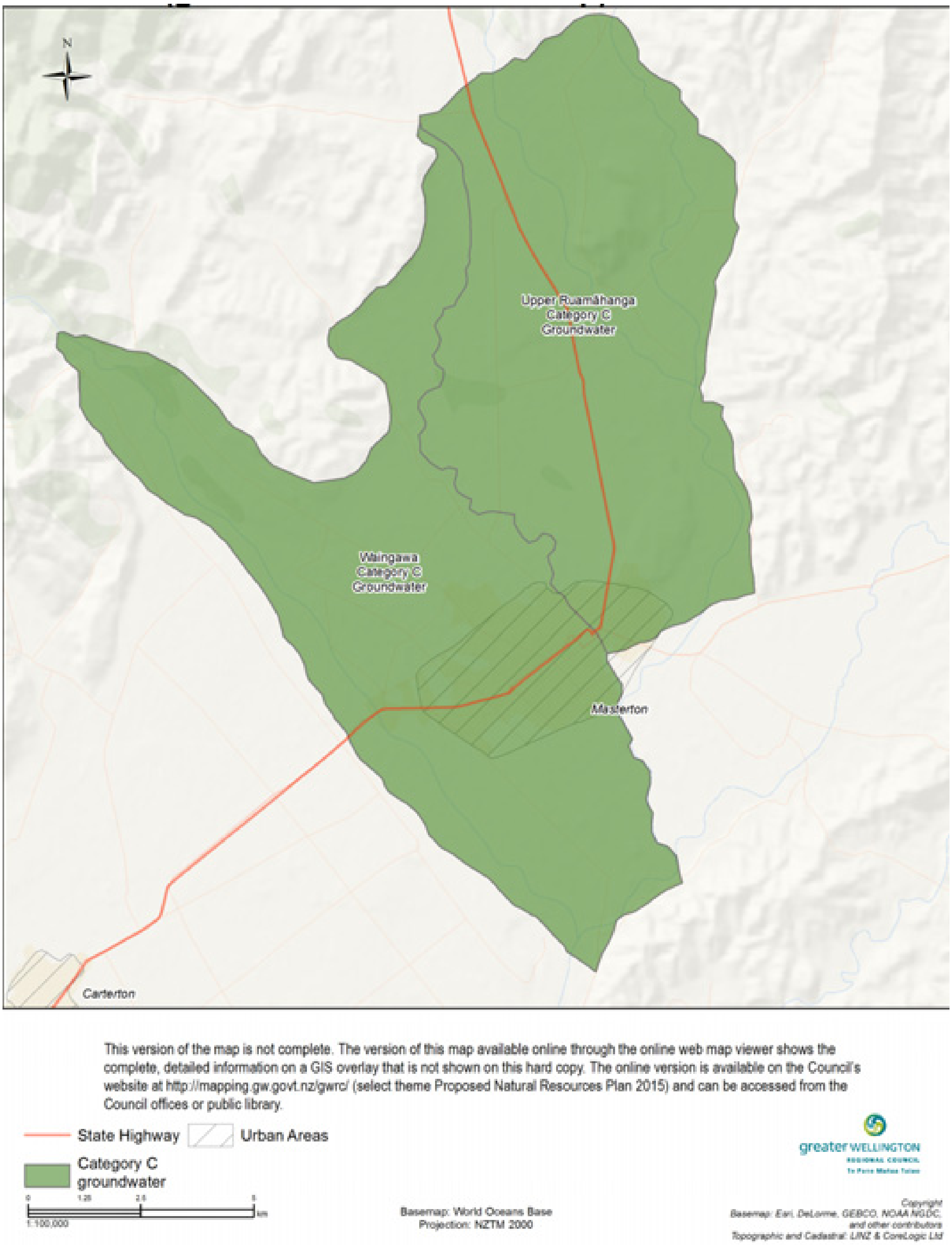

Figure A1.3: Upper Ruamahanga River. Groundwater abstraction categories at a depth below ground of <u>greater than 30m</u>. See Table A1.2 for allocation limits associated with the groundwater in this map.

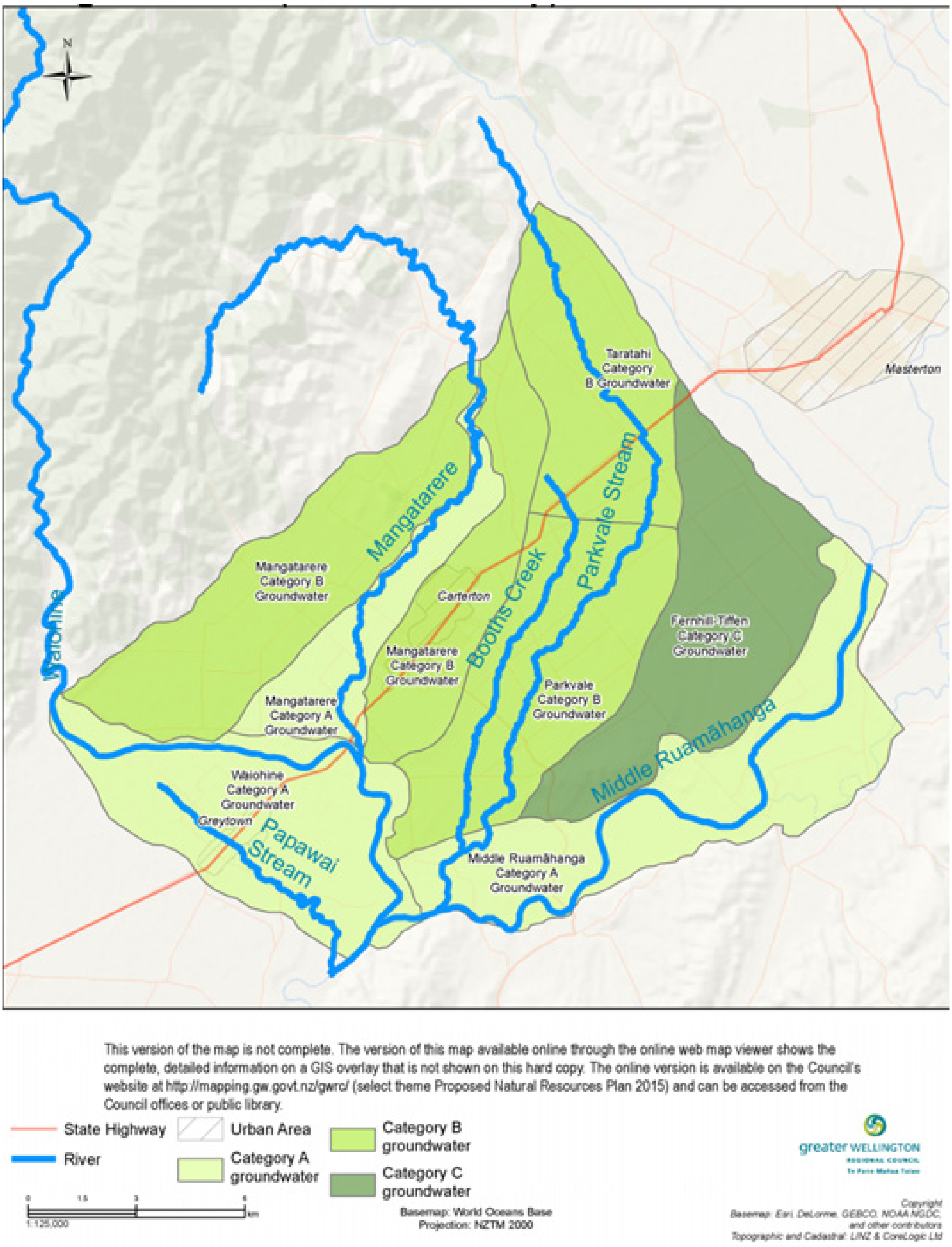

Figure A1.4: Middle Ruamahanga River. River management sub-units and groundwater abstraction categories to a depth below ground of <u>up to 20m</u>. See Table A1.1 and A1.2 for allocation limits associated with rivers and groundwater in this map.

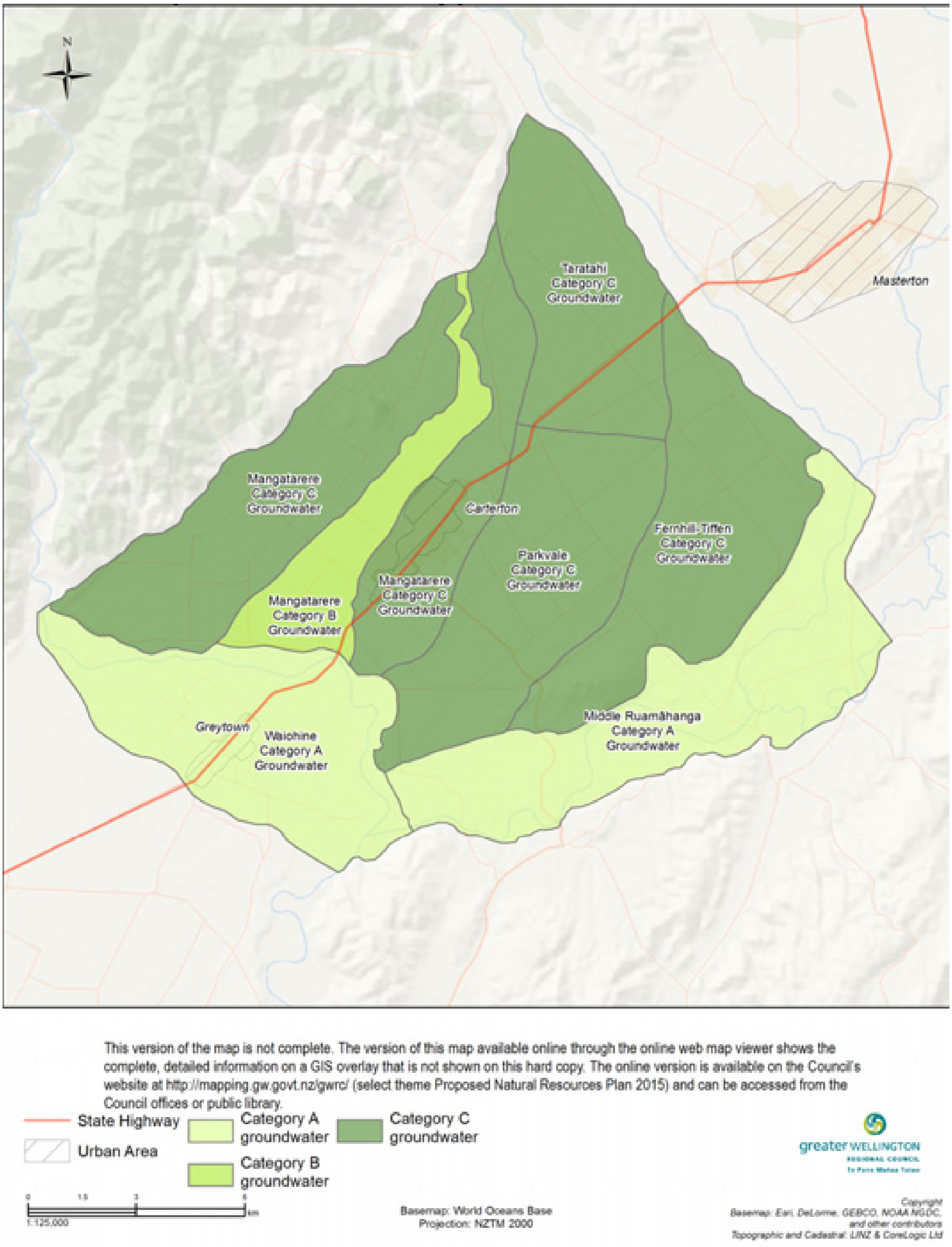

Figure A1.5: Middle Ruamahanga River. Groundwater abstraction categories at a depth below ground of between 20m and 30m. See Table A1.2 for allocation limits associated with the groundwater in this map.

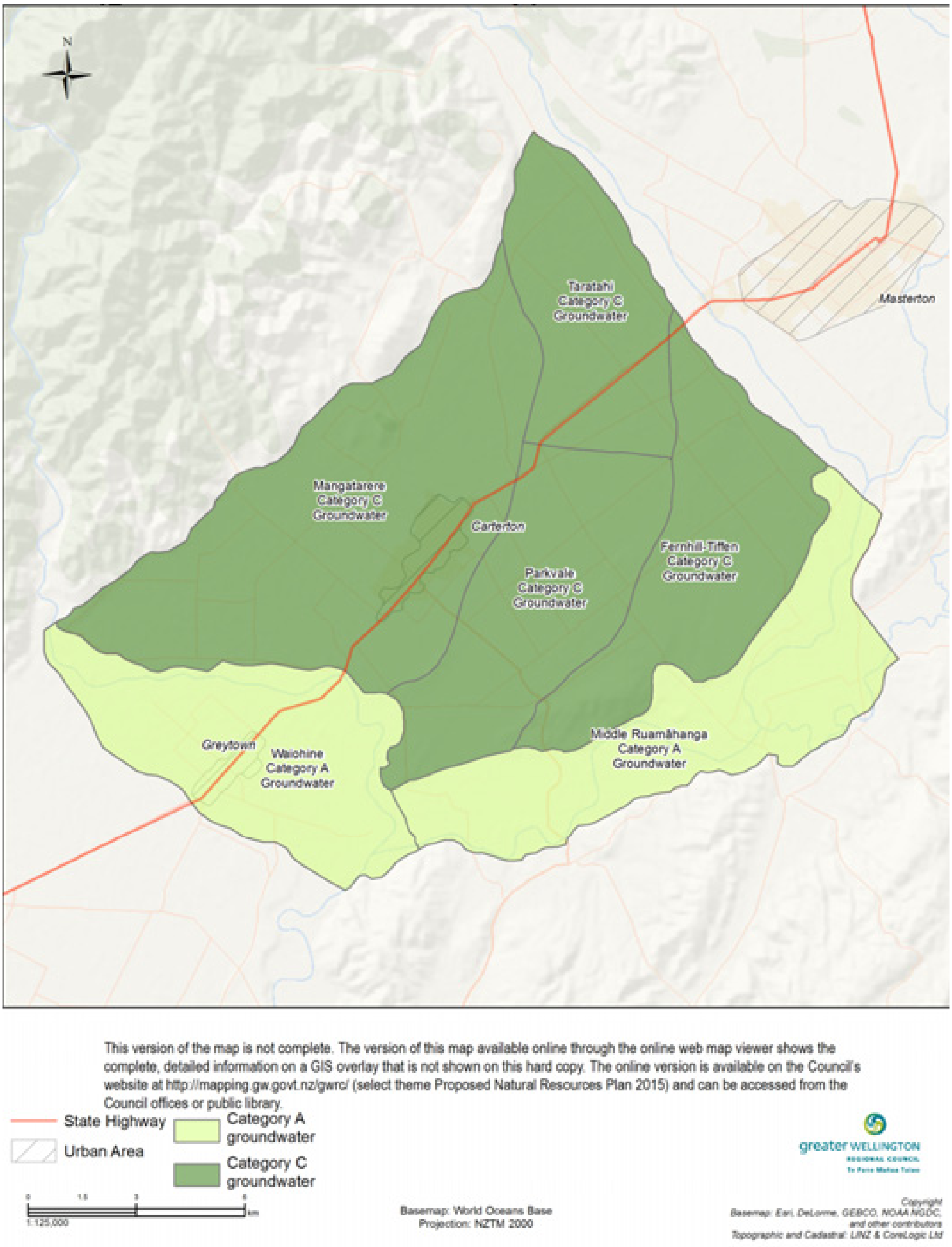

Figure A1.6: Middle Ruamahanga River. Groundwater abstraction categories at a depth below ground of <u>greater than 30m</u>. See Table A1.2 for allocation limits associated with the groundwater in this map.

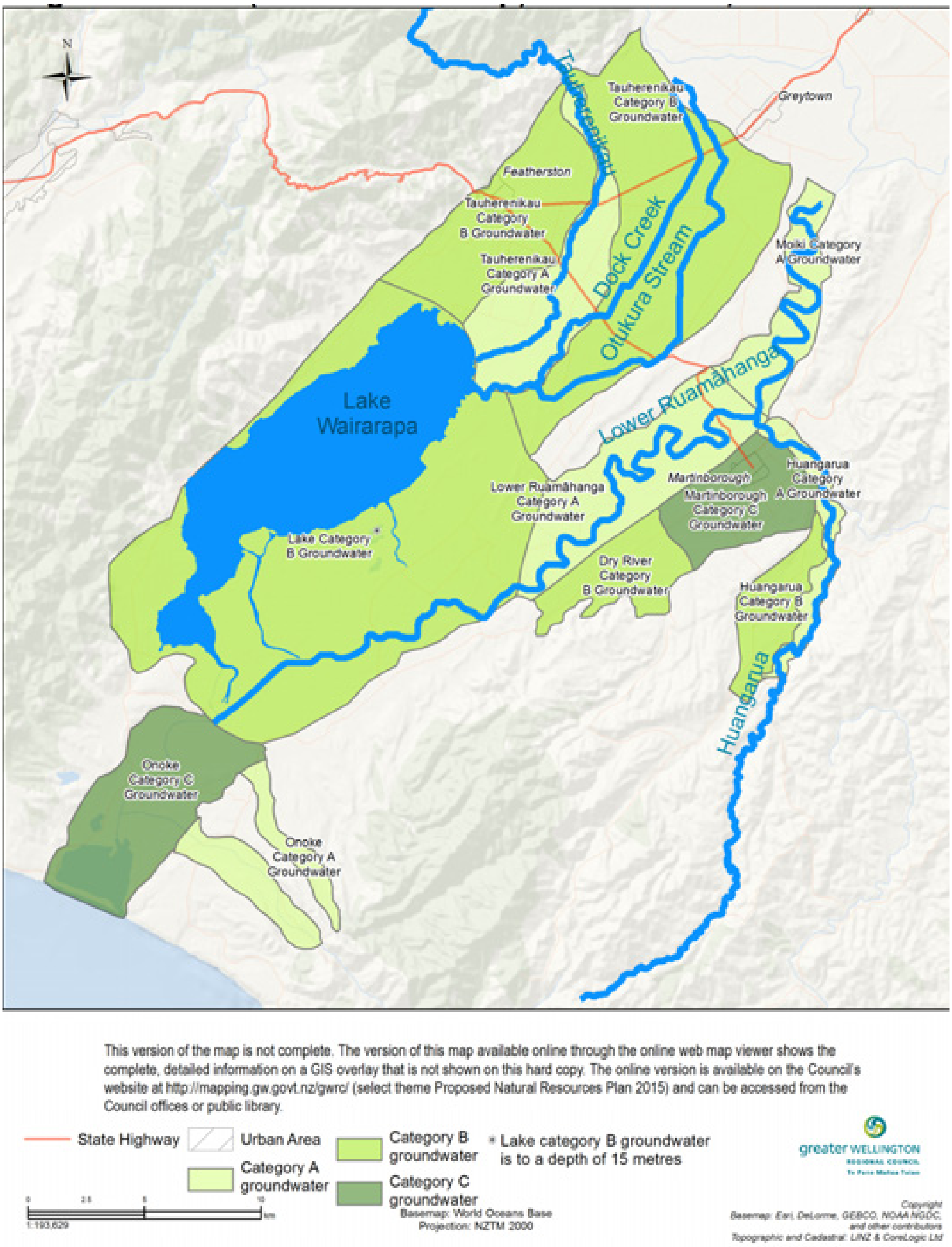

Figure A1.7: Lower Ruamahanga River. River management sub-units and groundwater abstraction categories to a depth below ground of <u>up to 20m</u>. See Table A1.1 and A1.2 for allocation limits associated with rivers and groundwater in this map.

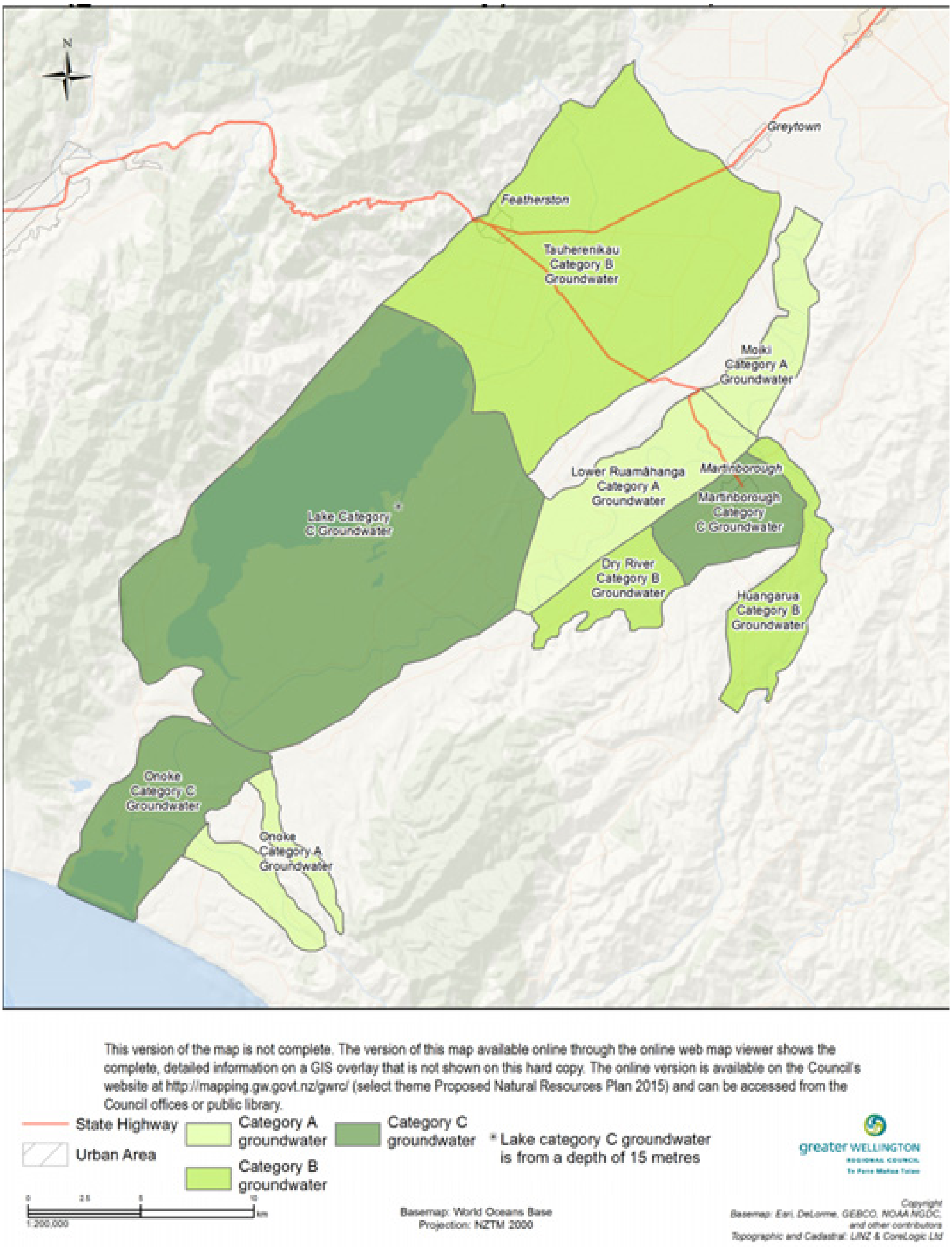

Figure A1.8: Lower Ruamahanga River. Groundwater abstraction categories at a depth below ground of greater than 20m. See Table A1.2 for allocation limits associated with the groundwater in this map.

Table A1.3: Hutt, Wainuiomata and Orongorongo river surface water allocation limits for river management units and directly connected groundwater

Management Unit	Sub-Unit	Allocation limit (L/s)	Comment[1]
Hutt River	No sub units	2,140	Equates to 50% of 7d MALF (4,280 L/s)
Wainuiomata River	No sub units	180	Equates to 30% of 7d MALF (600 L/s)
Orongorongo River	No sub units	95	Equates to 30% of 7d MALF (320 L/s[2])

[1] Unless otherwise noted, 7d MALF values are estimates of naturalised 7dMALF at the downstream-most point of the management unit or sub-unit being considered

[2] Estimate is for the upper river reaches ('Truss Bridge' monitoring site)

Table A1.4: Hutt Valley groundwater allocation limits for groundwater that is not directly connected to surface water

Groundwater Management Zone	Allocation Limit (Mm^3/year)	Summary of criteria applied
Upper Hutt	0.77	Represents 1% depletion of 7d MALF at Taita Gorge (4,505 L/s)
Lower Hutt	36.5 [Waiwhetu Aquifer including Taita Alluvium and Moera Aquifer]	Based on HAM3 modelling of maximum abstraction before saline intrusion risk becomes unacceptable (ie, when aquifer levels reduce below 2 masl). Note that this figure of 36.5 Mm^3/yr represents total groundwater allocated including a fraction that relates to river flow depletion (600 L/s).

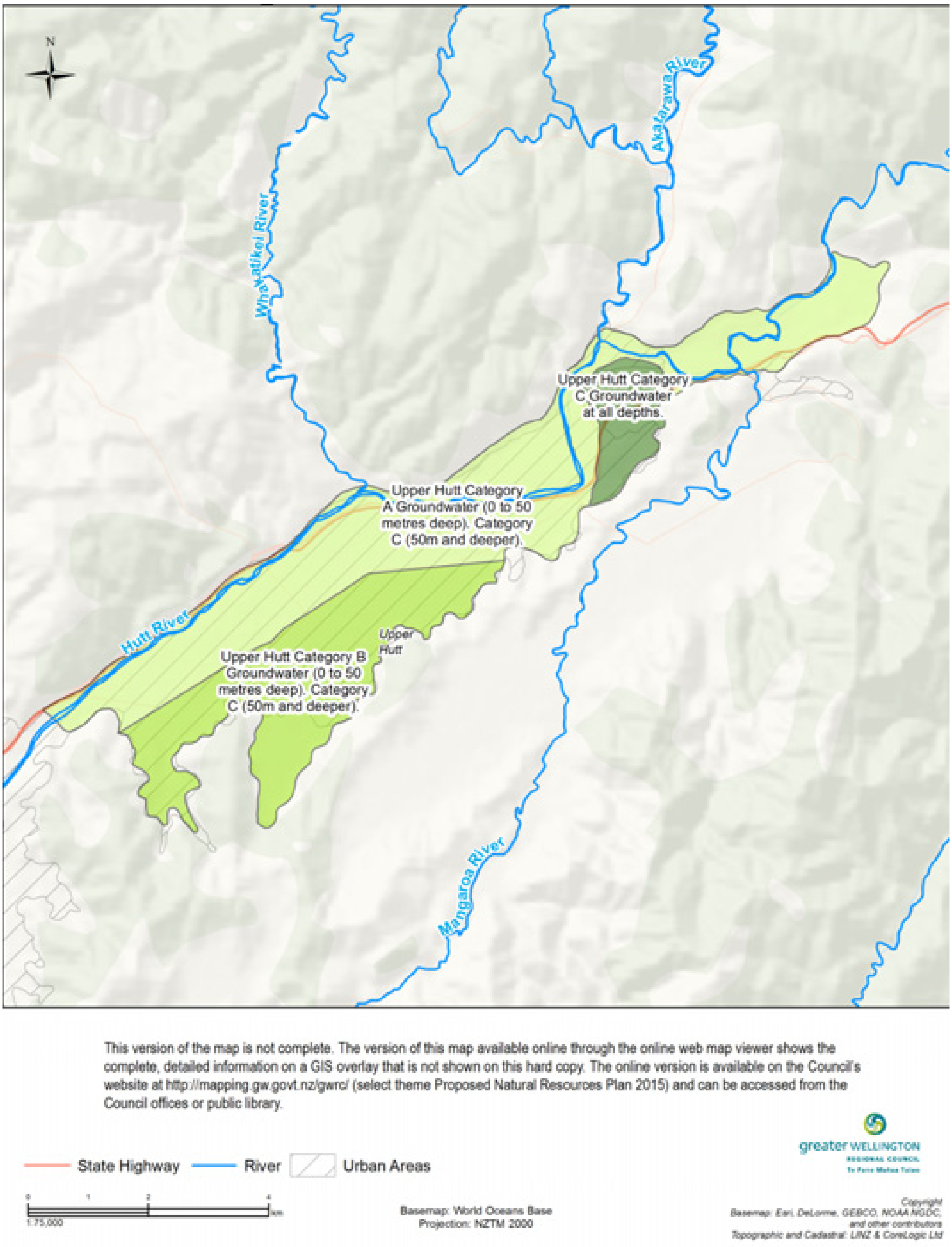

Figure A1.9: Upper Hutt Valley groundwater abstraction categories. See Table A1.4 for allocation limits associated with groundwater in this map.

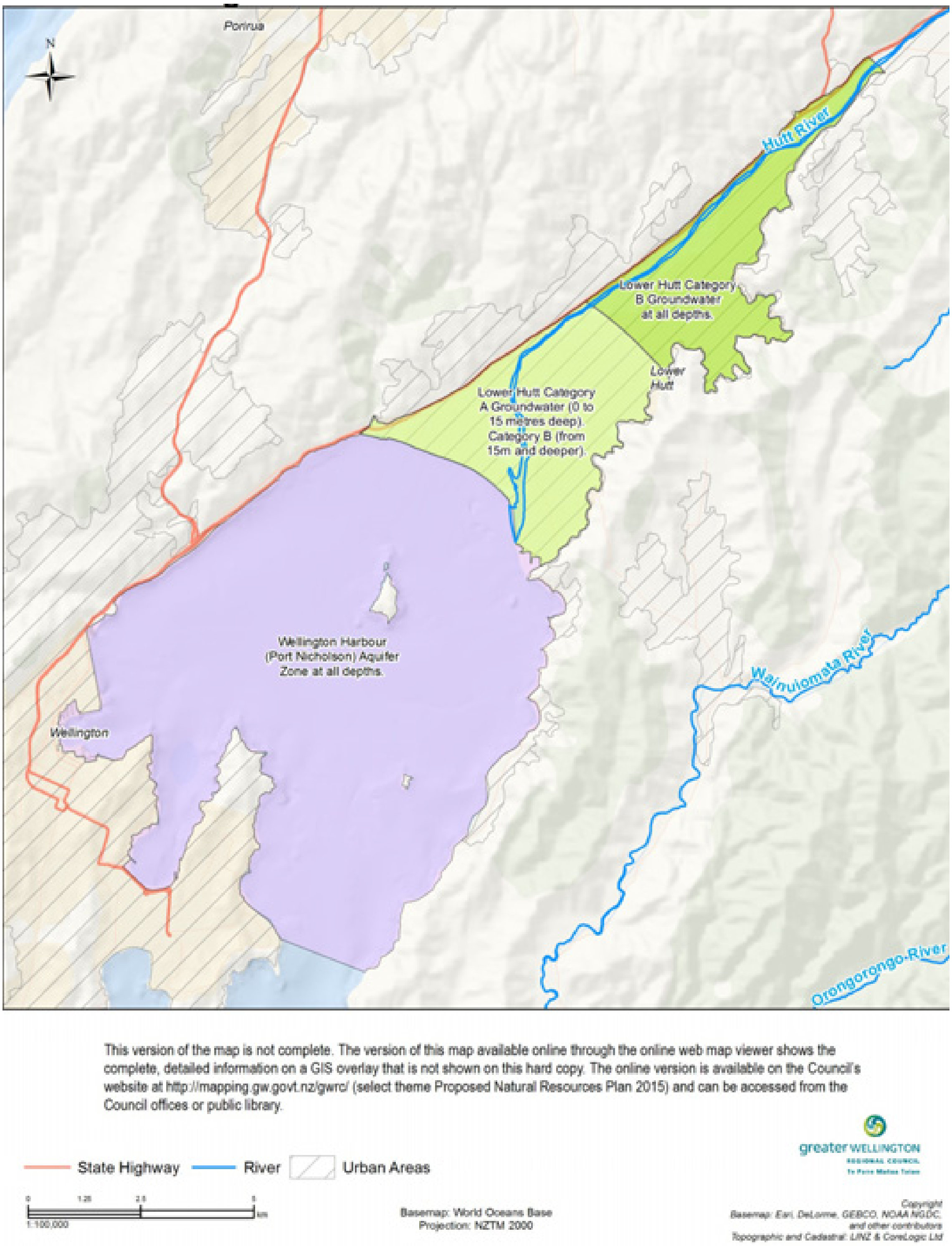

Figure A1.10: Lower Hutt Valley groundwater abstraction categories. See Table A1.4 for allocation limits associated with groundwater in this map.

Table A1.5: Kapiti Coast surface water allocation limits for river management units and directly connected groundwater

Management Unit	Sub-Unit	Allocation limit (L/s)	Comment[1]
Waitohu Stream	No sub units	45	Equates to 30% 7d MALF[2] (150 L/s)
Otaki River	No sub units	1,970	Equates to 50% 7d MALF (3,940 L/s)
Mangaone Stream	No sub units	45	Equates to 30% 7d MALF (155 L/s)
Waikanae River	No sub units	220	Equates to 30% 7d MALF[2] (730 L/s)

[1] Unless otherwise noted, 7d MALF values are estimates of naturalised 7dMALF at the downstream-most point of the management unit or sub-unit being considered

[2] 7d MALF value in this case is an estimate of naturalised 7dMALF based on the average of three sites across the coastal plain

Table A1.6: Kapiti Coast groundwater allocation limits for groundwater that is not directly connected to surface water

Groundwater Management Zone	Allocation Limit (Mm^3/year)	Summary of criteria applied
Waitohu	1.08	Constrained by maximum drawdown of 0.2 m beneath wetlands Other considerations include ensuring coastal drawdown is <1m and cumulative depletion of 7d MALF remains below 30%
Te Horo	1.62	Constrained by maximum 30% lower quartile LSR Other considerations include ensuring coastal drawdown is <1m and cumulative depletion of 7d MALF remains below 30% and drawdown beneath wetlands <0.2m
Waikanae	2.70	Constrained by maximum drawdown of 0.2 m beneath wetlands Other considerations include ensuring coastal drawdown is <1m and depletion of 7d MALF is low (about 7.5%) since the Waikanae River is already fully allocated
Raumati	1.23	Constrained by maximum 30% depletion of 7d MALF Other considerations include ensuring coastal drawdown is <1m, drawdown beneath wetlands <0.2m and allocation doesn't exceed 30% of the lower quartile LSR

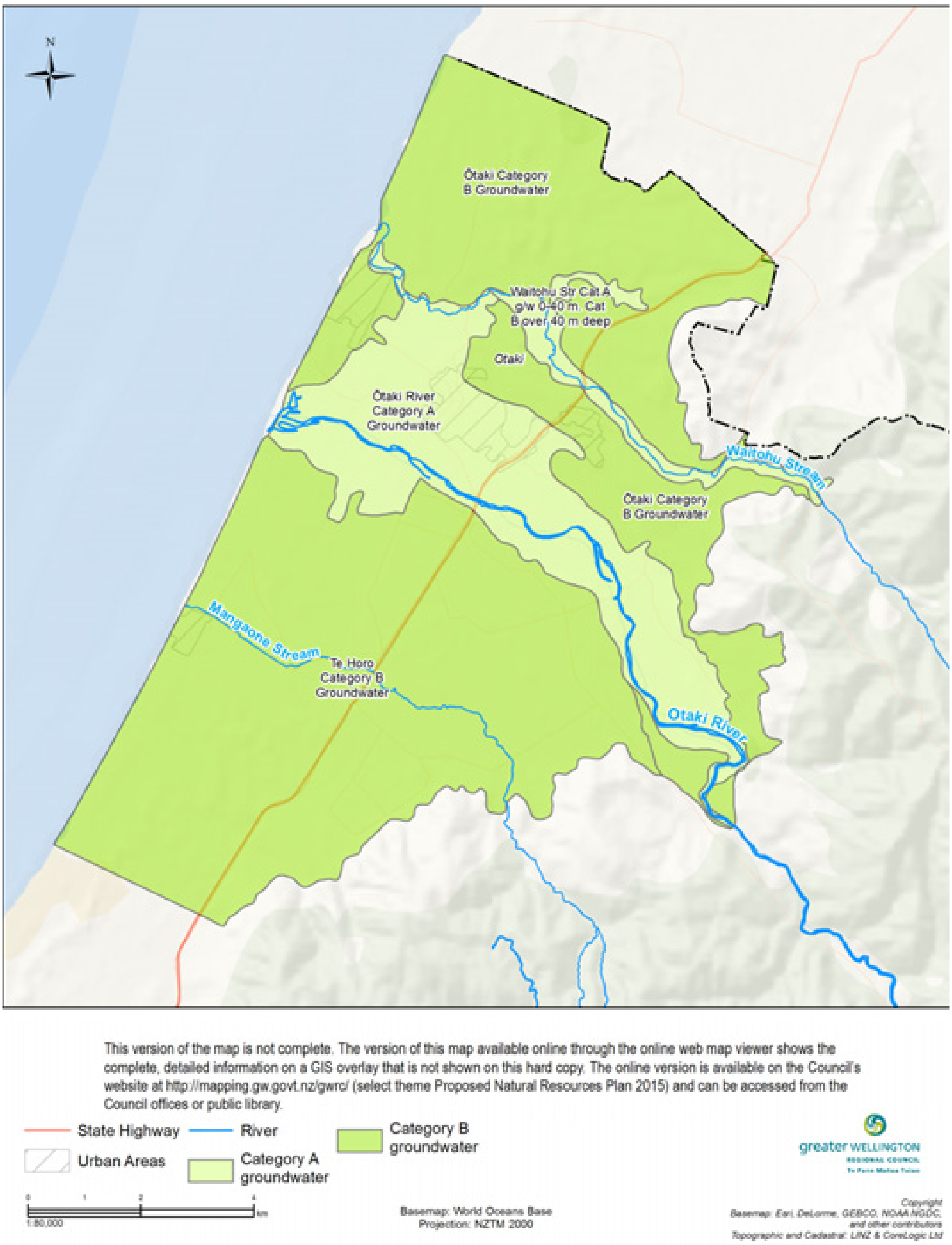

Figure A1.11: Kapiti Coast (north) rivers and groundwater abstraction categories. See Table A1.5 and A1.6 for allocation limits associated with rivers and groundwater in this map.

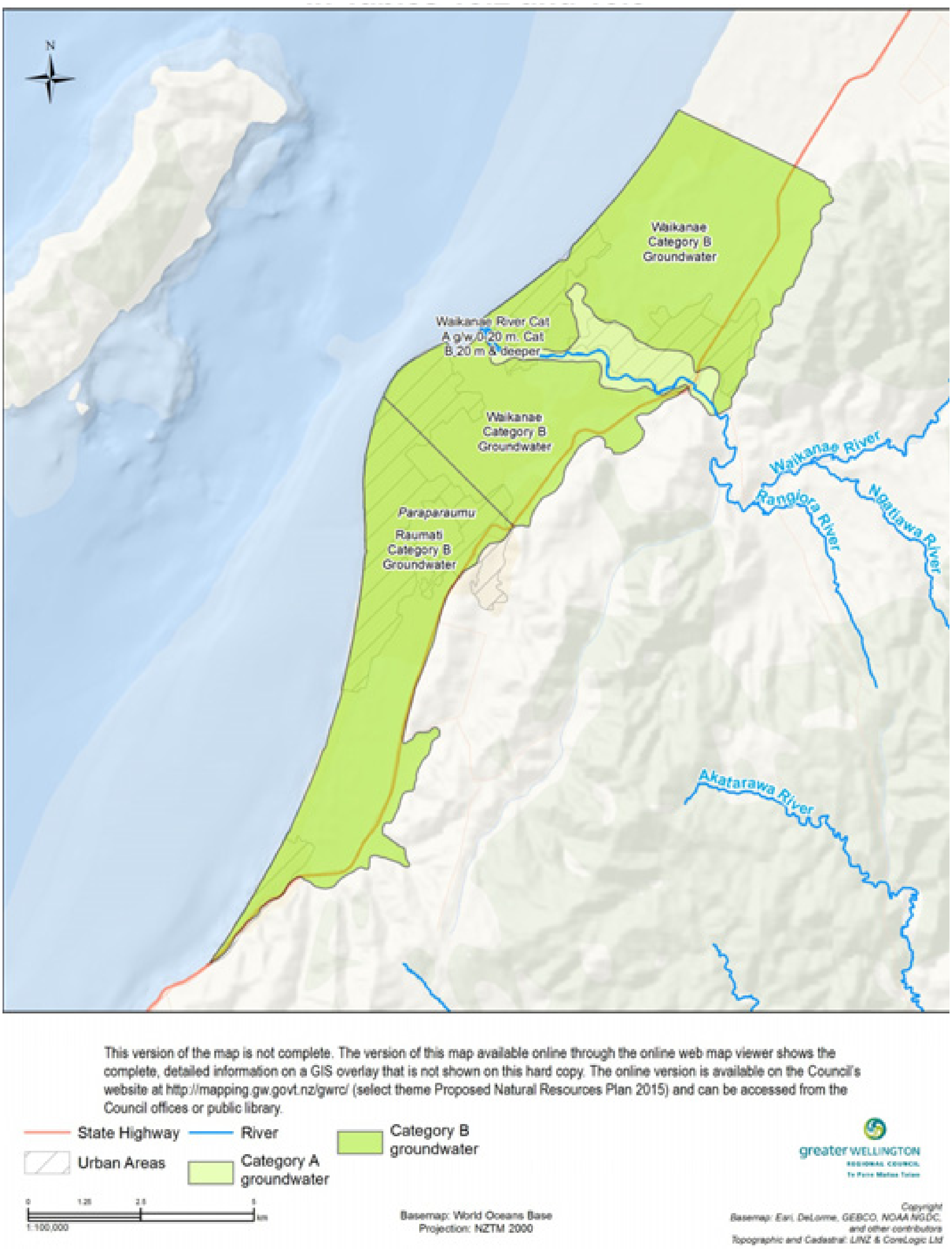

Figure A1.12: Kapiti Coast (south) rivers and groundwater abstraction categories. See Table A1.5 and A1.6 for allocation limits associated with rivers and groundwater in this map.

Appendix 2: Classifying and managing groundwater and surface water

Note: Refer to Hughes and Gyopari (2011) for more detailed descriptions

Classification of connection between groundwater and surface water		General description of the magnitude of surface water depletion effect and aquifer characteristics	General management approach
Category A groundwater	Groundwater directly connected to surface water	Stream depletion effects begin almost immediately after the commencement of **groundwater** abstraction and increase rapidly over subsequent days. Over the course of weeks to months the volume of **groundwater** pumped almost entirely represents flow depletion from local surface waters. Depletion effects dissipate quickly when pumping stops. **Category A groundwater** aquifers are generally shallow, highly permeable gravels that occur along the riparian margins of the main river systems. **Category A groundwater** takes are expressed in litres/sec (based on a weekly average).	**Groundwater** takes in aquifers directly connected to surface water are subject to the same allocation limits and restrictions as surface water takes unless there is clear hydrogeological evidence demonstrating that surface water depletion effects from takes are less than expected. Such new clear hydrogeological evidence may be advanced by a resource consent applicant seeking a new resource consent or an existing user amending an existing resource consent. Saltwater intrusion into an aquifer or the landward movement of the salt water/fresh water interface shall be prevented.
Category B groundwater	Groundwater directly connected to surface water Groundwater not directly connected to surface water	Compared with takes in **category A groundwater**, the onset of stream depletion effects is less immediate and it often takes weeks rather than days for the effect to become significant. However, over the course of months the volume of **groundwater** pumped that is directly connected to surface water represents at least 60% flow depletion from local surface waters. Depletion effects dissipate more slowly than takes from category A **groundwater** when pumping stops. **Category B groundwater** considered to be available as **surface water allocation** is expressed in litres/sec (based on a weekly average). **Category B groundwater** that is directly connected to surface water is: • **Groundwater** with a rate of take at the point of abstraction (based on a weekly average) of greater than 5 litres per second, and • **groundwater** which over the course of a pumping season represents a flow depletion from local surface waters of greater than 60% of the rate of take **or** greater than 10 L/s. The component of **category B groundwater** takes considered to not be directly connected to surface water is the balance of the amount assessed as being directly connected (ie. up to 40%).	**Category B groundwater** aquifers that are directly connected to surface water are subject to the same allocation limits and restrictions as surface water . **Groundwater** that is not directly connected to surface water is subject to separate **groundwater allocation** limits. The allocation for individual takes at a location in **category B groundwater** is based on a pumping test that provides hydrogeological evidence demonstrating the effects of taking water on surface water. A pumping test is required by a resource consent applicant seeking a new resource consent or by an existing user with an existing resource consent seeking an increased amount of water. Due to the potential **for category B groundwater** aquifers to have a less direct effect on surface water than equivalent takes from category A areas, **groundwater** takes within category B with a weekly average abstraction rate less than 5 litres per second shall be managed solely as **groundwater** takes. Saltwater intrusion into an aquifer or the landward movement of the salt water/fresh water interface shall be prevented.
Category C groundwater	Groundwater not directly connected to surface water	**Groundwater** takes may contribute to stream flow depletion at a catchment scale over the course of a pumping season but effects are much less immediate and significant than for **category A groundwater** and **category B groundwater** takes. Aquifers with a limited degree of connection generally comprise low permeability geology and/or are the farthest removed from surface waters (e.g. deep confined aquifers).	Takes from **category C groundwater** are not subject to allocation limits and restrictions that relate to surface water but rely on separate limits on **groundwater allocation** in Whaitua chapters 8, . A pumping test is required by a resource consent applicant seeking a new resource consent or by an existing user with an existing resource consent seeking an increased amount of water.

Appendix 3: Discussion of uncertainties and limitations

Overall, the minimum flow and allocation recommendations outlined in this document are considered to be more robust and regionally consistent than the current RFP provisions. This is mainly because some comprehensive studies have been carried out in recent years and there is generally more technical information available to guide decision making. Nevertheless, limitations and uncertainties remain, from general philosophical differences about the 'best' way to set limits to detailed methodological considerations. This section summarises some of the key limitations and concludes with a comment about how conservative the framework is considered to be.

General comment

Determining 'safe' flow and allocation limits is a complicated task. Science informs the decision-making but, ultimately, judgements about the acceptability of effects are value-based. The largest limitation of the recommendations put forward is that they are mostly constrained to ecological bottom lines. While these are a key component of the RMA decision-making process, they do not represent the full breadth of community interest.

The scientific rationale for defining ecological bottom lines is stronger in some circumstances than in others. Generally, a reasonably good technical rationale can be developed for setting minimum flows in rivers and streams by measuring or modelling relationships between flow, habitat quality and other life supporting parameters. But the science is much less well developed with respect to higher flow thresholds (ie, for supplementary allocation) and the amount of flow loss that can be tolerated. As a result, it becomes necessary to adopt precautionary rules of thumb to set some limits rather than specifically reasoned numbers.

Spatial and temporal scale limitations

The overall flow setting framework is designed to manage water resources at a catchment scale and during times of water stress. In practice this means that limits have been set largely on the basis of flows, levels and water balances that represent primary river catchments and aquifers and also the time of year when the cumulative impact of water demand and water stress can be highest (ie, at the end of the irrigation season when the maximum depletion effect associated with a full season of groundwater pumping can potentially combine with a late summer flow recession). While this scale of application is considered appropriate for the purpose of formulating regional plan provisions, there are limitations:

- Catchment-scale technical characterisations may not be accurate for, or properly represent, all local scale features. An example of this is the groundwater category (A,B,C) boundaries. These have been defined to broadly characterise discrete and distinctly functioning hydrogeological units. They will not capture all of the heterogeneity within those units and may not accurately reflect unit boundaries at the farm scale in all cases. Another example is the flow estimates used to set minimum flows river allocation limits. While some effort has been made to down-scale management limits to sub-catchments where there are complex flow patterns, there may still be situations where the recommended limits prove inadequate to manage local-scale effects (or conversely where the limits prove too conservative).

- By having a single ‘static’ set of recommended limits that are primarily focused on sustainability of use during times of water stress there is potential for water to be ‘locked up’ at other times. For example, if there are several consecutive wetter-than-average years there could be a reasonable argument for allocating more water, especially from groundwater reserves. A related consideration is that of climate variability. The flows, levels and water balances used as the basis for limits reflect a discrete climatic period in time and on-going confidence in the limits is partly based on an assumption that near-future climate and hydrological variability will be similar to the period of assessment.

To partly address the first limitation, discretion from GWRC will still be required to ensure that local-scale impacts of any particular activity are not more than anticipated but also that users are not unfairly treated as a result of any coarse scale anomalies. With regard to the second limitation, more dynamic approaches to allocation are desirable but require much more technical support and administration to provide users with certainty about security of supply while making sure the appropriate effects triggers are in place. The only meaningful way to address limitations associated with climate stationarity is to conduct periodic reviews and update the technical information underpinning minimum flow and allocation limits. This will ensure that any onset of any significant change in the natural catchment water balance is identified and the allocation regime adjusted accordingly.

Estimating MALF

Estimates of naturalised MALF underpin many of the proposed minimum flow and allocation limits. GWRC has been through an exercise of naturalising MALF for key locations in the region and methods include analysis of flow records and concurrent gauging results (focused on periods of abstraction restriction or suspension) and interpretation of riparian groundwater level records. When possible, major inputs (eg, discharges) and abstractions (including water races) have been accounted for. However, there are some important general assumptions and limitations to note with respect to the flow naturalisation methodology:

- Due to the absence of actual abstraction data, detailed time series modelling (ie, to reconstruct a ‘natural’ hydrograph) has not been undertaken. Rather, static blocks of abstraction and discharge have been added or subtracted from estimated MALF flows.

- Abstraction adjustment has focused on direct surface water takes and only included riparian groundwater takes where a direct hydraulic connection has historically been recognised (eg, via resource consent conditions). Additional depletion of low flows (and MALF) occurring as a result of other groundwater takes – such as those with a lower degree of hydraulic connection and described as ‘category B’ and ‘category C’ areas by Hughes & Gyopari (2011, revised in 2014) – has not been accounted for (except in the main stem Ruamahanga River).

- Permitted activity water use has not been explicitly accounted for.

In broad terms, naturalised MALF in catchments with significant groundwater abstraction and/or permitted use is more likely to have been over-estimated than underestimated. However when factors such as water race and irrigation runoff returns are considered, any overestimate may potentially be offset to some extent. Overall, it is considered that the MALF estimates are not significantly biased in one direction or another and represent a reasonable basis upon which to derive minimum flow and allocation limits.

An important point is that since both minimum flow and allocation limits are based on MALF, then while an overestimate of MALF may lead to a higher than necessary minimum flow, it will also allow for a higher allocation limit (and vice versa).

Groundwater modelling and conjunctive management framework

Development of the recommended groundwater allocation options for the Wairarapa Valley and Kapiti Coast has relied upon numerical groundwater models (eg, Gyopari and McAlister, 2010 a,b,c). Because these models are necessarily simplified representations of complex natural geological environments, they unavoidably have an inherent uncertainty. No model can be 100% accurate in its predictions. A full discussion of the most important aspects of the modelling work that introduce uncertainty is had in Hughes and Gyopari (2013 revised conjunctive report). They can be summarised as follows:

- **Model architecture, calibration, predictive power.** The construction and development of numerical groundwater models always suffers from a lack of sub-surface data (geology, water levels etc) and the Wairarapa and Kapiti models were no exception. However, by following a robust process both during the conceptualistion phase and during the calibration process, model uncertainty has been minimised and quantified. The numerical models developed for the Wairarapa Valley and Kapiti Coast have both been declared fit for the purpose of determining an allocation regime (and effect of groundwater pumping on surface waters) by independent peer reviewers. Furthermore, an independent quantitative predictive uncertainty analysis was commissioned for part of the Wairarapa model (ESR 2012). In general, the calculated standard errors of the stream depletion predictions were found to be within 10% of the calibrated estimate. Groundwater through-flow predictions had a similar magnitude of standard error. These calculated standard errors generally indicate confidence can be had in the recommended groundwater allocation options.

- **Surface flow statistics.** Since the groundwater allocation volumes are referenced in most cases to surface flow statistics, uncertainties in the latter effect the former. MALF is the most commonly referenced flow statistic and is discussed in the previous section (along with comment on the related effect of irrigation returns).

- **Modelled water use.** The scenario modelling undertaken to develop allocation limits assumes that water use occurs across an entire 180-day irrigation season which, although possible under existing resource consent conditions, is typically in excess of the duration of actual water use. Since surface water depletion is often dependent on the duration of abstraction, this assumption is considered to provide a conservative assessment of likely effects on surface water (i.e. provide an overestimate of the effect on surface water). However, this effect is not considered to be significant in most cases since a modelled depletion effect close to the seasonal maximum was often reached well before 180 days (typically the depletion effect would increase rapidly over the first 100 days and then plateau off towards 180 days); this indicates choosing a much shorter irrigation season would have little impact on the allocation recommendations. In addition to the duration of abstraction, there is some uncertainty relating to how much water was actually abstracted compared with how much has been allocated on paper (in the absence of full length pumping records for all groundwater abstractions). However, modelling work has sought to reduce this uncertainty as much as possible by relying on bore record surveys in several catchments to apply a correction factor to consented pumping rates.

Integrating water quality

A further consideration is the integration of water quantity and quality provisions. Integration of these provisions must occur to achieve sustainable management of fresh water. Currently, this has not been achieved, partly because no water quality limits have yet been suggested and also because there is no agreed technical basis for delivering fully integrated provisions.

Framework conservatism

Collectively, the factors outlined in the preceding sections contribute to uncertainty associated with application of the proposed conjunctive management framework and the derivation of flow and allocation limits. However, on balance, it is considered that this uncertainty does not significantly detract from the validity of the approach or the robustness of the recommendations. Recommendations are likely to be conservative - in favour of maintaining ecological bottom lines and minimising flow-related degradation - but not overly so.

As indicated at the beginning of this section, some proposals – particularly those for supplementary allocation and Lake Wairarapa – have been developed on preliminary science and lines of reasoning. In recognition of this limitation, these proposals have deliberately erred on the side of caution to a greater extent than proposals with a better developed scientific basis.

The interim nature of the proposed limits provides the opportunity for further refinement, which may include adjustments based on a broader canvass of views about whether limits are more or less conservative than they ought to be.

Appendix 4: Allocation status of rivers under existing provisions and new recommendations

Note: The information presented in these tables represents GWRC's best estimate of allocation status at the time numbers were revised in June 2015. The figures are subject to change over time as abstraction activities change and MALF and other hydrological statistics are routinely updated.

Ruamahanga whaitua

Surface water allocation status under existing RFP provisions and PNRP recommendations

<table>
<tr><th rowspan="2">Catchment management units or sub-units</th><th colspan="3">Existing RFP provisions</th><th colspan="4">PNRP recommendations</th></tr>
<tr><th>Current core allocation (L/s)</th><th>Core or capped allocation limit (L/s)</th><th>Allocation status</th><th>Current core and directly connected groundwater allocation (L/s)</th><th>Core allocation limit (L/s)</th><th>Allocation status</th><th>Comment</th></tr>
<tr><td>RUAMAHANGA RIVER</td><td colspan="3">No provision</td><td>7,590</td><td>7,535</td><td>+100% allocated</td><td>The allocation status of the whole catchment is 101% of the allocation limit - it must be lower than 100% before water can be allocated in sub-catchments</td></tr>
<tr><td>Kopuaranga River</td><td>125</td><td>125</td><td>100% allocated</td><td>150</td><td>180</td><td>83% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>Waipoua River</td><td>65</td><td>90</td><td>72% allocated</td><td>129</td><td>145</td><td>89% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>*Makoura Stream</td><td>46</td><td>40</td><td>100% allocated</td><td colspan="4">Not in draft NRP recommendations</td></tr>
<tr><td>Waingawa River</td><td>1064</td><td>1040</td><td>100% allocated</td><td>1197</td><td>920</td><td>+100% allocated</td><td></td></tr>
<tr><td>Upper Ruamahanga River</td><td>781</td><td>800</td><td>98% allocated</td><td>1,072</td><td>1,195</td><td>90% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>*Parkvale Stream</td><td>84</td><td>160</td><td>53% allocated</td><td>160</td><td>40</td><td>+100% allocated</td><td></td></tr>
<tr><td>*Booths Creek</td><td>97</td><td>100</td><td>97% allocated</td><td>109</td><td>25</td><td>+100% allocated</td><td></td></tr>
<tr><td rowspan="2">Mangatarere Stream</td><td>176</td><td>180</td><td>98% allocated</td><td rowspan="2">479</td><td rowspan="2">110</td><td rowspan="2">+100% allocated</td><td rowspan="2"></td></tr>
<tr><td>168</td><td>140</td><td>100% allocated</td></tr>
<tr><td>*Taueru River</td><td>82</td><td>50</td><td>100% allocated</td><td colspan="4">Not in draft NRP recommendations</td></tr>
<tr><td>*Makahakaha Stream</td><td>31</td><td>50</td><td>62% allocated</td><td colspan="4">Not in draft NRP recommendations</td></tr>
<tr><td>Waiohine River</td><td>731</td><td>740</td><td>99% allocated</td><td>1,004</td><td>1,590</td><td>63% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>*Papawai Stream</td><td>120</td><td>200</td><td>60% allocated</td><td>219</td><td>65</td><td>+100% allocated</td><td></td></tr>
<tr><td>Middle Ruamahanga River</td><td colspan="3">See Upper Ruamahanga River above</td><td>941</td><td>1,240</td><td>76% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>Huangarua River</td><td colspan="3">No provision</td><td>92</td><td>110</td><td>84% allocated</td><td>Actual availability of water subject to whole catchment allocation status</td></tr>
<tr><td>Lower Ruamahanga River</td><td>1313</td><td>1500</td><td>88% allocated</td><td>2,422</td><td>1,475</td><td>+100% allocated</td><td></td></tr>
<tr><td>LAKE WAIRARAPA</td><td colspan="3">No provision</td><td>1,800</td><td>1,800</td><td>100% allocated</td><td>The allocation status of the whole catchment must be lower than 100% before water can be allocated in sub-catchments</td></tr>
<tr><td>Tauherenikau River</td><td>212</td><td>405</td><td>52% allocated</td><td>234</td><td>410</td><td>57% allocated</td><td>Actual availability of water subject to Lake Wairarapa allocation status</td></tr>
<tr><td>* Otukura Stream</td><td>46</td><td>60</td><td>77% allocated</td><td>165</td><td>30</td><td>+100% allocated</td><td></td></tr>
<tr><td>*Dock Creek</td><td>335</td><td>210</td><td>100% allocated</td><td colspan="4">Not in draft NRP recommendations</td></tr>
</table>

*These limits are capped allocation limits where potential over allocation was identified through a change to the RFP in May 2009. Since that time some consents have been surrendered or reduced during consent renewal.

Groundwater allocation status under existing RFP provisions and PNRP recommendations

Existing RFP provisions and allocation status					PNRP recommendations and allocation status				
Existing zone name	Current allocation (Mm³/year)	RFP allocation limit (Mm³/year)	Allocation status		**New zone name**	Current allocation Cat C (Mm³/year)	PNRP allocation limit Cat C (Mm³/year)	Allocation status	
			All aquifers[2]	Deep aquifers				Category A	Category C
Opaki	0.05	2.3	<50 % allocated		Upper Ruamahanga	0.473	3.55	+100% allocated (due to fully allocated status of Ruamahanga River)	<50% allocated
Upper Opaki	0.56	4.5	<50 % allocated						
Rathkeale	1.65	3.0	55% allocated						
Te Ore Ore	1.223 (shallow) 2.613 (deep)	3 (shallow) 4.5 (deep)	<50 % allocated	58% allocated	Te Ore Ore	0.716	0.48	+100% allocated (due to fully allocated status of Ruamahanga River)	+100% allocated
Fernridge	0	1.5	<50 % allocated		Waingawa	0.714	1.90	100% allocated	<50% allocated
Upper Plain	3.58	17.0	<50 % allocated						
Masterton	0.249 (shallow) 0.027 (deep)	3.2 (shallow) 2.3 (deep)	<50 % allocated	<50 % allocated					
Fern Hill	1.163	4.7	<50 % allocated		Fernhill-Tiffen	1.157	1.2	No Cat A	96% allocated
Middle Ruamahanga	6.548 (shallow) 1.500 (deep)	7.3 (shallow) 2.2 (deep)	90% allocated	68% allocated	Middle Ruamahanga	No Cat C		+100% allocated (due to fully allocated status of Ruamahanga River)	No Cat C
Parkvale	1.049 (shallow) 2.531 (deep)	3.5 (shallow) 2.62 (deep)	<50 % allocated	97% allocated	Parkvale	0.289 (sh)	0.35	No Cat A	83% allocated
						1.80 (dp)	1.55	No Cat A	+100% allocated
East Taratahi	0.03 (shallow) 0.19 (deep)	14 (shallow) 1.7 (deep)	<50 % allocated	<50 % allocated	Taratahi	0.37	1.4	No Cat A	<50 % allocated
West Taratahi	0.534	5.3	<50 % allocated						
Mangatarere	1.147	7.6	<50 % allocated		Mangatarere	2.57	2.3	+100% allocated	+100% allocated
Matarawa	0.241	10.0	<50 % allocated						
Carterton	2.630	3.9	67% allocated						
Hodders	1.658	4.0	<50 % allocated						
Greytown	3.344	20	<50 % allocated		Waiohine	No Cat C		+100% allocated (due to fully allocated status of Ruamahanga River)	No Cat C
Ahikouka	2.265	3.3	69% allocated						
Woodside	0.592	16	<50 % allocated		Tauherenikau	4.387	6.6	+100% allocated (due to fully allocated status of Lake Wairarapa)	66% allocated
Moroa	0.172	0.7	<50 % allocated						
Battersea	1.848	2.4	77% allocated						
Tauherenikau	4.079	20.0	<50 % allocated						
South Featherston	1.500	5.3	<50 % allocated						
Whangaehu / Tuhitarata	0.129	0.5	<50 % allocated		Lake	5.952	6.75	No Cat A	88% allocated
Aquifer 2	10.67	13.5	79 % allocated						
Aquifer 3	3.254	7.7	<50 % allocated						
Tawaha	8.953	11	81% allocated		Lower Ruamahanga	No Cat C		+100% allocated (due to fully allocated status of Ruamahanga River)	No Cat C
Riverside	3.9	3.9	100% allocated		Moiki	No Cat C		+100% allocated (due to fully allocated status of Ruamahanga River)	No Cat C
Martinborough Western Terraces	0.813	1.38	59% allocated		Martinborough	0.942	0.8	No Cat A	+100% allocated
Martinborough Eastern Terraces	0.284	0.42	68% allocated						
Huangarua	0.311 (shallow) 1.292 (deep)	0.9 (shallow) 1.2 (deep)	<50 % allocated	100% allocated	Huangarua	0.649	0.65	+100% allocated (due to fully allocated status of Ruamahanga River)	+100% allocated
Pirinoa Terraces	0	18.1	<50 % allocated		Not in the new framework				
Taunui	0.280	0.8	<50 % allocated		Onoke	1.058	2.1	Allocation status unknown	50% allocated
Turanaganui	0..894	1.1	81% allocated						

[2] Status descriptions apply to all aquifers in the zone unless a deep aquifer unit has been described separately in the adjacent column (to the right)

Hutt Valley and Wellington Harbour whaitua

Surface water allocation status under existing RFP provisions and PNRP recommendations

Catchment management units	**Existing RFP provisions and allocation status**			**PNRP recommendations and allocation status**			
	Current core allocation (L/s)	Core or capped allocation limit (L/s)	Allocation status	Current core and directly connected groundwater allocation (L/s)	Core allocation limit (L/s)	Allocation status	Comment
Hutt River	1850 [upper reach]	n/a[1]	n/a[1]	2520	2140	+100% allocated	
	66 [lower reach]	300	<50% allocated				
Wainuiomata River	1095 [upper]	n/a[1]	n/a[1]	1134	180	+100% allocated	
	33 [lower]	65	51% allocated				
Orongorongo River	1132	n/a[1]	n/a[1]	1132	95	+100% allocated	

[1] No core allocation limit specified in RFP for this reach so existing allocation status cannot be defined

Groundwater allocation status under existing RFP provisions and PNRP recommendations

Existing RFP provisions and allocation status[1]					**PNRP recommendations and allocation status**				
Existing zone name	Current allocation (Mm^3/year)	RFP allocation limit (Mm^3/year) "safe yield"	Allocation status: All aquifers[2]	Deep aquifers	**New zone name**	Current allocation Cat B/C (Mm^3/year)	PNRP allocation limit Cat B/C (Mm^3/year)	Allocation status: Category A	Category B/C
Upper Hutt	0.34*	26.90	<50% allocated	n/a	Upper Hutt	0.15	0.77	+100% allocated	<50% allocated
Lower Hutt	33.75	33.00	100% allocated	n/a	Lower Hutt	33.04	36.50	+100% allocated	91% allocated
Mangaroa	0.01	18.40	<50% allocated	n/a	Not in the new framework. Groundwater use from these aquifers is so minor that they have not been listed in the PNRP.				
Pakuratahi	0.01	5.90	<50% allocated	n/a					
Akatarawa	0.01	3.60	<50% allocated	n/a					
Wainuiomata	0.01	3.00	<50% allocated	n/a					

[1] Existing allocation volumes and status are sourced primarily from Keenan et al (2012), although some values have been updated (indicated by a *) where significant changes in allocation have occurred since 2010

[2] Status descriptions apply to all aquifers in the zone unless a deep aquifer unit has been described separately in the adjacent column (to the right)

Kapiti Coast whaitua

Surface water allocation status under existing RFP provisions and PNRP recommendations

Catchment management units	Existing RFP provisions and allocation status			PNRP recommendations and allocation status			
	Current core allocation (L/s)	Core or capped allocation limit (L/s)	Allocation status	Current core and directly connected groundwater allocation (L/s)	Core allocation limit (L/s)	Allocation status	Comment
Waitohu Stream	0	57	<50% allocated	99	45	+100% allocated	
Otaki River	157	2120	<50% allocated	286	1970	<50% allocated	
Mangaone Stream	24	25	96% allocated	38	45	85% allocated	The 38 L/s may incorporate a small amount of depletion effect that occurs in small streams in the Te Horo zone other than the Mangaone Stream
Waikanae River	463	n/a[1]	n/a[1]	468	220	+100% allocated	

[1] No core allocation limit specified in RFP for this reach so existing allocation status cannot be defined

Groundwater allocation status under existing RFP provisions and PNRP recommendations

Existing RFP provisions and allocation status[1]					PNRP recommendations and allocation status				
Existing zone name	Current allocation (Mm^3/year)	RFP allocation limit (Mm^3/year) "safe yield"	Allocation status		New zone name	Current allocation Cat B/C (Mm^3/year)	PNRP allocation limit Cat B/C (Mm^3/year)	Allocation status	
			All aquifers[2]	Deep aquifers				Category A	Category B/C
Waitohu	0.54	6.40	<50% allocated	n/a	Waitohu	0.16	1.08	Waitohu Category A = 100% allocated	Waitohu Category C = <50% allocated
Otaki	5.70	11.30	51% allocated	n/a				Otaki Category A = <50% allocated	Otaki Category C = <50% allocated
Hautere	0.78	6.70	<50% allocated	n/a	Te Horo	1.21	1.62	No Category A	75% allocated
Coastal	0.61	6.80	<50% allocated	n/a					
Waikanae	9.20	10.70	86% allocated	n/a	Waikanae	2.70	2.70	100% allocated	100% allocated
Raumati/Paekakariki	0.38	4.80	<50% allocated	n/a	Raumati	0.94	1.22	No Category A	76% allocated

[1] Existing allocation volumes and status are sourced primarily from Keenan et al (2012), although some values have been updated (indicated by a *) where significant changes in allocation have occurred since 2010

[2] Status descriptions apply to all aquifers in the zone unless a deep aquifer unit has been described separately in the adjacent column (to the right)