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Assessment of Improvements to Environment Waikato's Water Allocation Processes and Procedures

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Executive Summary

The purpose of this project is to identify and determine options for improvement of water allocation processes and procedures in the Waikato Region. It is part of an on-going commitment by Environment Waikato to the development of water resource management. It follows on from earlier work that determined irrigation requirements, productivity and efficiency.

Management context

The management context for water allocation is that established under the Act, Regional Policy Statement and Regional Plans (Transitional and Proposed). The principal allocation outcomes are those associated with priority water uses: reasonable use for livestock, domestic and fire-fighting, efficient water use and protection of in-stream values (environmental and cultural). The water module of the plan establishes surface water classes and associated criteria for allocation limits for all uses. The plan rules define categories of water use (authorised, permitted, controlled and discretionary), and in the cases of permitted takes, levels of use from surface water and groundwater.

Waihou catchment

The project is based on a case study of the Waihou catchment as an example of the allocation issues and options facing the region. Land use within the catchment is typical of much of the region, being a combination of dairy farming (40%) and forestry (production (8%) and native (34%)). The cumulative water availability is estimated to be approximately 240 Mm^3/yr, of which two thirds is groundwater and one third surface water. The surface water resources have been the most heavily developed, due to ready access and suitable water quality. The cumulative allocation of surface water is approaching the upper allocation limit of 10% of Q_5, and there is concern regarding allocation to meet future growth in demand. The principal uses of consented takes within the catchment are for irrigation (54%), supply networks (town and rural schemes) (29%) and industry (16%). In addition to consented takes, non-consented takes for livestock and non-reticulated domestic use (authorised under the RMA) and permitted takes are estimated to be equivalent to 8 Mm^3/yr (20% of total annual water use of 40 Mm^3/yr).

Allocation issues and options

The study identified a number of issues and constraints to water allocation. These can be grouped according to the principal water management objectives as listed below:

- Allocation efficiency is constrained by current consent and water management procedures:
  - High takes rate (greater than the equivalent 24 hour rate) that lock-up allocable surface water. This is the equivalent of more than 700 l/s or 30% of allocable resources.
  - Variability of seasonal demand within and between seasons. Irrigation demand is low on the season margins and at times when there may be alternative demand e.g. frost-protection. During low demand in the Waihou for the periods Nov-Dec and Mar-Apr, allocated resources are under-utilised by at least 15%, the equivalent of 350 l/s.
  - Water use lower than consented take rates and volumes. Comparison of consents and water use records indicated that actual use is approximately 80% of the consented take (based on records for supply networks). This effectively reduced allocation efficiency by at least 10%.
  - Accounting for discharges. Under-accounting for discharges to surface water (of comparable or higher quality water) leads to under-estimation of allocable surface water.

- Economic efficiency of water use is constrained by:
  - Consent duration. Consent durations vary from 3 to 30 years. Short durations while adopted as part of the management process (for synchronising review period etc.), can increase supply risk and therefore limit investment in water infrastructure e.g. irrigation, supply systems.
  - Allocable resources. Surface water availability is limited by current allocation criteria (% of Q_5). This could be increased with the allocation of a proportion of resources above Q_5. An allocation of 30% of median winter flow would yield 100 Mm^3/yr (though it is acknowledged that the cost of development is higher due to storage requirements).
  - High priority use. As demonstrated in the Waihou, there is a need to protect high priority use such as community supply networks (Hauraki Plains Scheme) during low flow periods. This is currently achieved through consent conditions restricting water take when king tides coincide with low flows. However, it may be better achieved through the establishment of minimum flow and restriction mechanisms within the regional plan.
- Protection of in-stream values could be improved by:
  - Accounting for authorised and permitted use based on water demand per land use type, as part of the determination of cumulative demand.
  - Formalisation of restrictions on takes with establishment of minimum flows, threshold allocation level (75%) for review of allocation criteria and in-stream values, and establishment of restriction regimes for water use categories.
  - Integration of water use records in consent processes to provide estimates of actual demand in the assessment of cumulative demand levels.

Implementation options

The study identified a range of potential improvements to current allocation methods and management. These improvements are a combination of changes to consent processes, institutional procedures and additions to plan rules. These are:

- Defining daily take period for high take rates (greater than a nominal daily rate).
- Defining the irrigation season (Nov-Apr) within which takes are operative (and within specified number of take days, generally 120 days per season).
- Specification of maximum daily take rate (m^3/d) for irrigation season margins Nov-Dec and Mar-Apr.
- Logging of takes greater than 10 l/s to verify: daily take period (where relevant), seasonal daily take and to provide accurate water use records for assessment of cumulative demand.
- Consent processes (cumulative demand) amended to include estimation of recharge from discharges and actual water use reviews.
- Establishment of additional surface water allocation tiers, (B and C), for allocations above Q_5 and from winter median flow.
- Establishment of allocation threshold(s) for review of in-stream values and allocation limits.
- Establishment of rules on restriction of takes during periods of low flow for principal water use categories.
- Definition of minimum flow levels at which water takes cease or is severely limited.

1 Introduction

This report presents the findings and recommendations of a study of water allocation processes in the Waikato Region. It is intended to identify constraints to current processes and to propose improvements to the way water is allocated and managed in the region.

The Waikato Region to date generally (apart from the Pukekohe area) has not had major issues regarding water allocations, with relatively high water availability and modest demand. However, the surface water resources are coming under pressure to meet increasing domestic and irrigation demand. Water allocation methods and processes are a crucial component of the overall strategy for regional resource management. This study lists a series of improvements to current processes that will contribute to better achieving policy and plan objectives in terms of water use and protection of environmental values.

1.1 Project Outline

The principal objective of the project is to identify and recommend options for improvements in the processes and procedures for water resource allocation and management in the Waikato Region. This was achieved in three steps: determination of key issues and constraints, identification of alternative management options and assessment of implementation methods. The findings of these steps were presented in three interim reports.

The study is based on the Waihou catchment as an example of the key water allocation and management issues and options. It also takes into consideration, where relevant, other issues outside the Waihou that are common to other parts of the Waikato.

Appendix A lists details of the project objective, methods and outputs as presented in the proposal for services.

1.2 Interim Reports

As indicated above, the study preliminary findings were presented in three interim reports. These reports formed the foundation for discussion with EW on various issues and options for improving allocation processes. This current report is a compilation of the description, analysis and recommendations presented in the interim reports, and incorporates amendments and additions highlighted in discussion with EW staff.

1.3 Related Studies

There are a number of general and specific studies and publications relevant to this study. These include:

- Irrigation efficiency and water allocation in the Waihou catchment. The project determined irrigation and water allocation efficiency within the Waihou catchment. The irrigation efficiency component of the study is based on a case study of 10 pastoral irrigation systems (ARL, 2004a).
- Water allocation study. In 2000 the Ministry for the Environment commissioned a review of water allocation policy and plans in New Zealand. The study provides an overview of the (then) status of water allocation in New Zealand, and specifically in 14 regions and districts including the Waikato (LE, 2000).
- Cropwater requirements. The 1997 study by Landcare and others provided the foundation for current water allocation for irrigation in the Waikato. The study determined reasonable and efficient irrigation demand for a number of representative locations, soils and crops (Landcare, 1997). This forms the basis of irrigation requirements adopted in the regional plan (proposed) (Table 3.4).

- Soil and water studies. Since the 1980s there have been a number of soil and water studies of selected areas and catchments by Environment Waikato and predecessor organisations. The studies are in various stages of completion from draft to final. They have been recently reviewed by EW as part of the water allocation initiative, and provide some useful information and thoughts on water allocation and management in the region. They also largely form the foundation for allocable flows for rule 3.3.4.10 in the Proposed Regional Plan (Table 3.3).

1.4 Data and Information Sources

Data and information has been obtained from a number of sources including:

- Water take consents; Environment Waikato provided information on consent takes and applications from surface and groundwater.
- Flow records; Environment Waikato provided flow records for the Waihou and tributary rivers.
- Matamata-Piako and Hauraki District Councils provided information on supply network water production.
- Climate records; rainfall and potential evapotranspiration records were supplied by NIWA for modelling of seasonal irrigation demand.
- Agricultural census; land use and livestock values were obtained from the MAF agricultural census and agricultural database.
- Population census; urban population numbers were obtained from District Councils (Hauraki and Matamata-Piako) and MOH register of public water supply systems.
- Hauraki Plains Water Supply Scheme; information on the scheme was supplied by phone by the Hauraki District Council. A summary of the scheme is currently being prepared for the district asset management plan, which will provide further information on water demand and production.

1.5 Report Outline

Study findings are presented in the following sections:

2) Management context; outline of the management context for water resource allocation in the Waikato Region.
3) Waihou catchment; description of the Waihou catchment and key water resource and demand issues.
4) Allocation issues and options; determination of key constraints to water allocation and use, and list of actions for implementation of improvements in allocation outcomes.
5) Conclusions and recommendations.

2 Management Context

The context for management of water within the region is established by national and regional policy statements and plans. It is within this context that this study is based, and for which it is ultimately intended to improve outcomes to match policy and plan objectives. This section presents a summary of the water resource management context as a framework for water allocation. It is not intended to be a critique of current policies and plans, but an overview of the regional framework for management of water allocations.

2.1 Regional Policies and Plans

The Waikato Regional Policy Statement (WRPS) and Proposed Waikato Regional Plan (PWRP) provide the principal framework for water resource management in the Waikato Region. The key relevant elements of the statement and plan to this study are listed below.

Operative Waikato Regional Policy Statement (October 2000)
The statement is consistent with the RMA and other national policies and plans and forms the overall foundation for natural resource management in the Waikato Region. The key elements of the statement relevant to this study are water resource issues and policies related to water quality, protection of flow regimes and efficiency of use. These elements form the foundation for the classification of water resources and allocations developed in the regional plan. In particular, the implementation methods for efficient water use include development of water allocation strategies and application of the resource consent process along with conservation practices, consultation and public awareness.

Transitional Regional Plan
The Transitional Regional Plan was formulated in the early 1990s as an interim step to the development of an operative regional plan. It was largely formulated from the synthesis elements of existing regional and catchment plans. While submissions on the Proposed Regional Plan are still outstanding, some elements of the Transitional Plan are still operative. These include the general authorisations (1 and 3) for take of 15 m^3/d for livestock, sprays and dips, and domestic use from all water sources.

Proposed Waikato Regional Plan
The proposed plan was notified in 1998 and subsequently amended in response to submissions. However, there are still a number of Environment Court references on the plan pending hearing and resolution.

The plan identifies the issues, objectives, goals and implementation methods for water resource management in the region. The key issues and policies related to this study are protection of flow regimes and efficient water use for sustainability of water resources (and associated environmental and cultural values) and resource utilization.

The water module of the plan establishes water management classes: natural state, contact recreation, fishery and general. For surface water catchments, total allocable volume is defined for upland and lowland as a percentage of Q_5. A groundwater take above the permitted level and conditions is a discretionary activity, and therefore assessed for drawdown interference effects with neighbouring wells and cumulative effects.

The implementation methods define water take requirements. These are:

- Reasonable domestic, livestock and fire-fighting are authorised and exempt from consent requirements (as per the RMA, but conditional on environmental effects).

- Permitted takes from surface water are up to 15 cubic metres per day (m^3/d) (conditional on intake velocity etc.), and 30 m^3/d from the Waikato River and sections of the Waipa River.
- Construction of dams with catchment area of less than 100 hectares is a permitted activity (conditional on dam location, height and storage volume). Dams outside these criteria are a discretionary activity requiring a resource consent.
- Permitted takes from groundwater are up to 30 m^3/d (except in the Tuatenui and Whakapipi catchments where it is 15 m^3/d) (Rule 3.3.4.8).
- Controlled takes from surface water are greater than permitted takes and from sources with cumulative take volumes less than the allocable volume (and conditional on water class and intake requirements).
- Discretionary takes for surface water are takes (excluding permitted takes) from sources with cumulative takes greater than the allocable volume and conditional on the applicant proving that there are no adverse effects.
- Discretionary takes from groundwater are those greater than permitted takes.

The Waihou catchment falls within the category of 'other catchments' in the plan classification and therefore the default allocable volume of 10% of Q_5 (upland and lowland) applies. The plan does not formally establish minimum surface water flows, with the exception of the Mangatawhiri River (Franklin District). Restrictions on surface water have been limited to streams near Pukekohe which are at or close to full allocation.

The plan does not formally establish allocation limits for groundwater. Groundwater allocations, apart from authorised and permitted takes, are based on a case-by-case basis and take into consideration well proximity to surface water and other wells and cumulative take within a specified radius.

While there is comment on the potential for water harvesting and storage in the plan, there are no specifications for water allocations specifically for this purpose.

2.2 Allocation Process

The allocation process is the overall linkage of WRPS and PWRP objectives, policies and rules through to implementation of water use criteria and monitoring. The key elements of the process are:

- Definition of resource management objectives i.e. sustainability, efficient use, protection of in-stream values etc.
- Definition of allocable resources – based on protection of in-stream values. In the Waikato these are percentage of Q_5 for surface water and sustainability of groundwater (though as mentioned above, not specified in the plan).
- Definition of water use criteria – i.e. authorised use (under the RMA), permitted takes, controlled and discretionary takes.
- Implementation of the consent process – i.e. application of the consent process for management of water allocations. This includes a number of internal mechanisms i.e. determination of cumulative take, determination of efficient use (based on regional guidelines), monitoring of compliance (including water use compliance).
- Monitoring of resources – i.e. monitoring of water resources to verify in-stream values are being maintained, and where necessary apply restrictions to protect in-stream values.
- Management of water takes to protect in-stream values during periods of low flow or low water levels.

The key outcomes for allocation processes in the Waikato Region are:

a) Compliance of consented takes to ensure cumulative take rates are within allocable limits as defined by water source classification and allocable method (% of Q_5 for run-of-river flow). The objectives of protection of water quality and flow regimes are dependent on allocation methods (consent activities as well as other non-regulatory measures i.e., research, public awareness etc.).

b) Efficiency of water use, i.e. the optimum use of allocable resources to meet demand for water. This essentially has two related elements; the first is the allocation efficiency which is how much of allocable resource is actually used. The second element is the economic efficiency of resource use, which is the optimisation of the benefits from the allocation of water resources. The latter is particularly relevant when allocable limits are reached, as water availability may become a limiting factor to economic development.

A key policy objective is to encourage "*the most highly valued and efficient use of water"*. This is to be achieved through use of plans and resource consents, and includes use of conservation, metering and economic methods (such as tradable water permits).

Current allocation processes, while being effective in meeting the first outcome (i.e. conservatively determining cumulative take rate and volumes), in some instances are less effective in achieving the second outcome (i.e. efficiency of water use). The following sections discuss these issues and options for overcoming current constraints as well as improving allocation processes and ultimately water management outcomes.

Figure 1 shows the relationship between the key elements of the allocation process and linkages to resource monitoring and assessment.

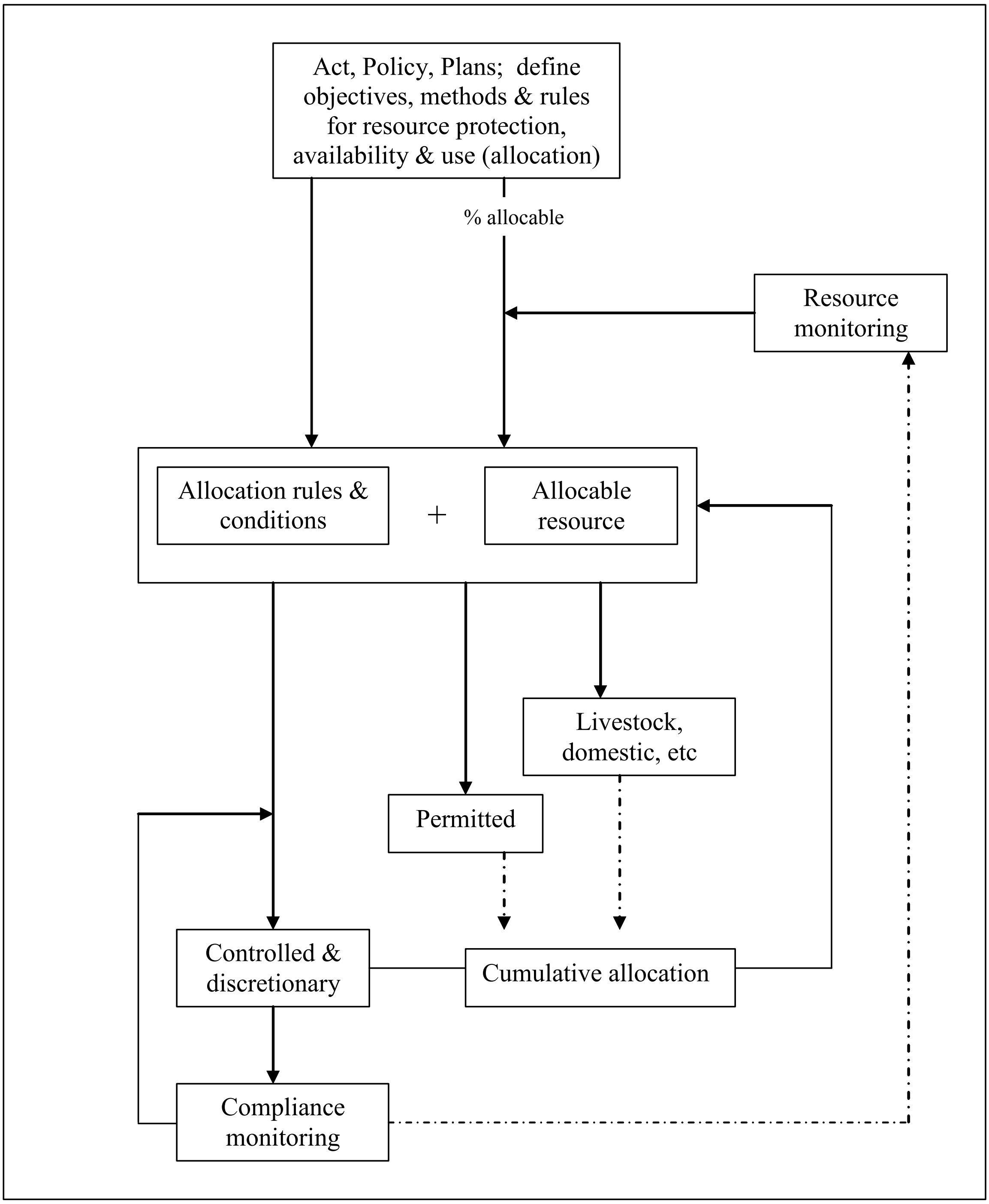

Figure 1: Allocation process

3 Waihou Catchment

The study is based on the Waihou catchment as a case example of the water resource, demand and allocation issues in the Waikato Region. The subsections below and accompanying figures and tables present a summary of the key features and issues. The subsequent sections draw on information for the Waihou where relevant to demonstrate the issues, cost and benefits of changes to water allocation processes.

The Waihou is located in the northeast of the Waikato Region, and to the east of the main Waikato catchment. For the Waikato, it is a medium sized catchment of just over 2,000 square kilometres (km^2) (compared to the Waikato catchment of more than 14,000 km^2). As shown in Figure 2, the south and west of the catchment is dominated by the Mamaku Plateau and Kaimai Ranges respectively, with extensive areas of native and production forests. The west and north of the catchment form part of the Hauraki Flood Plain (along with the adjacent Piako catchment), on which the principal land use is livestock farming, principally dairying. Approximately 60% of the total catchment area is livestock and vegetable production land uses.

3.1 Water Resources

The water resources of the catchment include surface water of the Waihou River and tributary rivers (Ohinemuri and Hikutaia) and streams, dams, groundwater and rainwater (for domestic water supply).

Table 1 presents a summary of water availability based on current allocation criteria (10% of Q_5), recharge estimates and consent records. It shows that surface water (run-of-streams) under current allocation criteria is about a third of total water availability and groundwater two thirds. However, as discussed below, the surface water resources have been the most heavily developed, due to ready access to numerous rivers and streams. Groundwater has been less well developed, in part due to constraints on water quality in the lower catchment with high iron levels, and possibly due to costs and variability of yields in the mid and upper catchment. There are a relatively small number of dams for water supply, mainly due to the ready access to surface water.

Table 1: Summary of water availability

Water resource	Rate (l/s)	Annual (Mm^3/yr)	%
Surface water	2,480	78	32
Dams		2	1
Groundwater	5,000[1]	158	66
Total	7,480	238	

(1) Based on a nominal yield of 5 $l/s/km^2$ over approximately 50% of catchment area

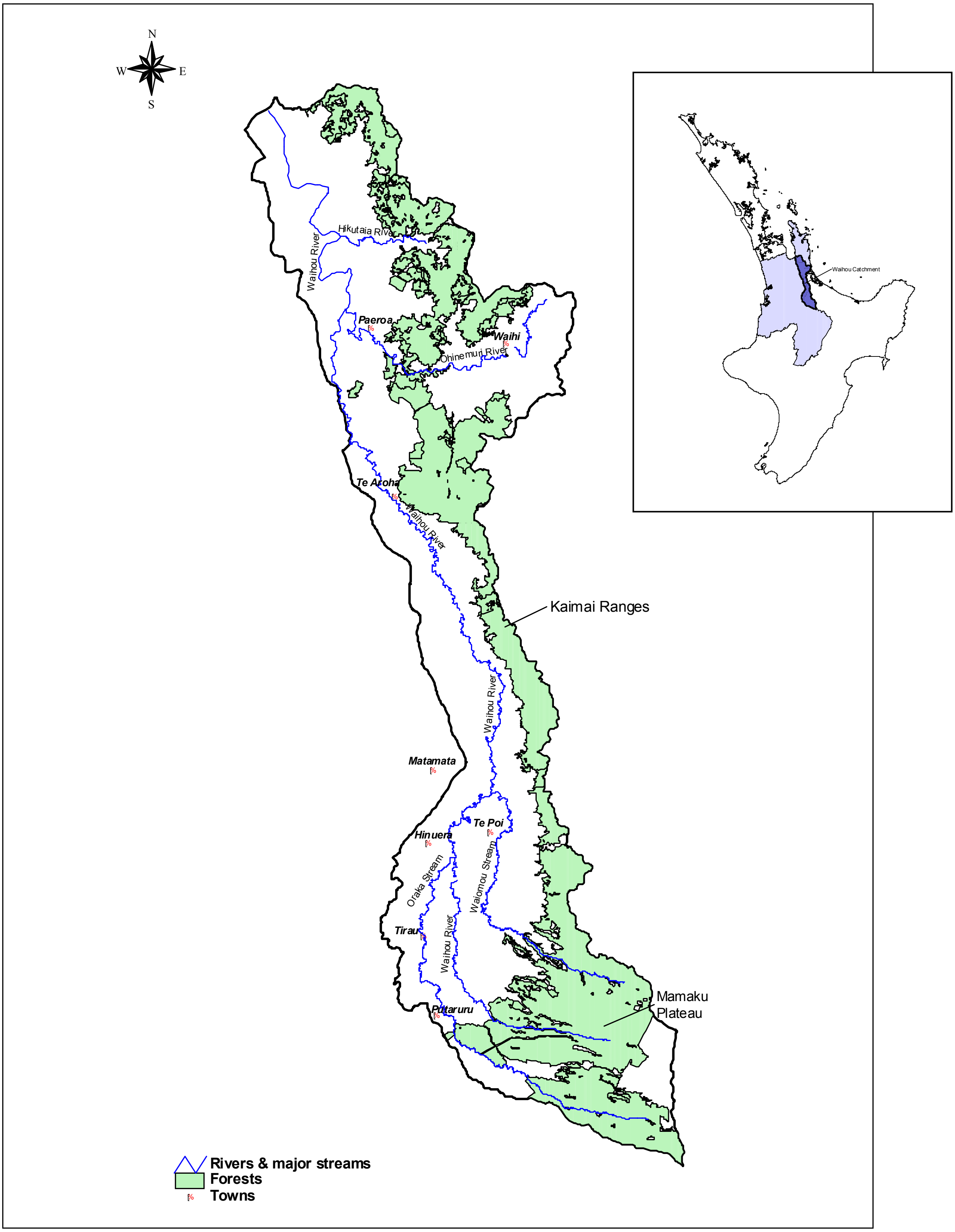

Figure 2: Waihou catchment

Rainwater is probably utilized for household supply in rural areas not supplied from municipal or rural supply networks. Evidence from other regions shows that typically 80% of rural households use rainwater due to constraints on availability, quality and cost of alternative surface water or groundwater sources.

In addition to the above resources, there is significant potential for the harvesting of surface water resources above current allocation limits (i.e. % of Q_5). A provisional estimate based on 30% of median winter flows (Jul-Aug) would yield in excess of 100 Mm^3 per year.

3.2 Water Allocations

Water demand within the catchment is from a combination of takes: authorised (as per the RMA for livestock, domestic and fire-fighting), permitted and consented (controlled and discretionary) and range of consumptive uses. The subsections below present a summary of water allocations by take and use (network supply, irrigation, industrial and other).

Consented takes
Environment Waikato records show that there are currently 90 consented takes from surface water (58) and groundwater (32) with cumulative daily volume of nearly 140,000 m^3/d. There are also 14 consented dams within the catchment of which three are for water supply, though take volumes are unspecified.

As indicated in Table 2 the majority (97%) of the consented take (135,411 m^3/d) is from surface water. In addition to consented takes there are 14 consent applications pending; 11 for surface water (cumulative rate of 26,210 m^3/d) and 3 for groundwater (cumulative rate of 1,470 m^3/d).

Table 2: Summary of takes and consent applications

Consented takes	**No.**	**Rate**	
		m^3/d	**%**
Surface water	58	135,411	97
Groundwater	32	4,250	3
Subtotal	**90**	**139,661**	
Consent applications	**No.**	**Rate**	
		m^3/d	**%**
Surface water	11	26,210	95
Groundwater	3	1,470	5
Subtotal	**14**	**27,680**	
Total	**104**	**167,341**	

For the purposes of this study, consented takes have been grouped into four categories. These are:

- ***Supply Networks.*** There are 17 town and rural supply networks of which 15 primarily take from surface water sources. The combined consented take for these schemes is about 64,500 m^3/d or an equivalent take rate (24 hr) of 889 l/s. However, the estimate includes backup takes for Te Aroha from the Waihou River of 8,000 m^3/d, so the actual cumulative consented take rate for the supply networks is closer to 56,500 m^3/d or 800 l/s.

- ***Irrigation.*** Irrigation takes are mostly for pasture for dairy farming, though there are smaller takes for horticulture and golf courses. Based on the peak daily demand rates, the total irrigated area is estimated to be about 1,500 ha. This area formed the basis for assessment of seasonal water use discussed below. There are a total of 30 takes from surface water with a cumulative take rate of 1,456 litres per second. A number of the irrigation takes are based on daily take duration of less than 24 hours, to match irrigation system design and operation, typically 10 to 12 hours per day for Long-lateral (Bosch) and K-line systems. Irrigation is normally scheduled for night operation due to lower power tariffs and to allow time for shifting of sprinklers (2-4 man hours per day) following morning milking.

- ***Industry.*** The industry takes are dominated by one large take by the Anchor dairy factory at Tirau, with a daily take and rate of 20,000 m^3 and 230 l/s respectively. It also has consents for water discharges for cooling water and treated wastewater equivalent to the water take rate. As indicated in Section 3.3.3 both the water take and discharges show a seasonal trend associated with milk production. There is also industrial water use within at least two of the supply networks; in Paeroa there is a meatworks (Richmonds), and the Te Aroha network supplies both a meatworks (Richmonds) and poultry processor (Inghams) currently with a combined take of about 3,500 m^3/d, but is predicted to increase to 4,500 m^3/d in the near future.

- ***Others.*** The other takes are relatively minor (cumulatively less than 1% of consented takes) and include water for small scale fish farming, frost protection and farm water supply.

Table 3 shows consented takes by main use categories from surface water and groundwater. Cumulative instantaneous take rate from surface water sources is 2,334 litres/sec (l/s) and close to the total allocable take for the catchment (2,485 l/s). Current applications for surface water takes (11) have a cumulative take rate of 303 litres per second, and if approved will push the cumulative take to more than 2,600 l/s. Hence, there is some concern about allocable surface water resources within the catchment. However, there are a number of issues regarding the records and estimates of water use that should be taken into consideration, as discussed below and in the following sections.

Table 3: Summary of consented water takes

Use Category	Surface Water			Groundwater		Total		
	No.	m^3/d	l/s	No.	m^3/d	No.	m^3/d	%
Irrigation	30	73,838	1,456	6	2,100	36	75,938	54
Water supply	12	39,487	601	6	971	18	40,458	29
Industry	8	21,511	267	4	275	12	21,786	16
Other	8	575	11	16	904	24	1,479	1
Total	**58**	**135,411**	**2,334**	**35**	**4,250**	**93**	**139,661**	

Water takes within the Waihou and other catchments are issued with a range of standard and specific conditions. For surface water takes, these include requirements for take structures and mesh sizing. Installation of water meters and recording and reporting of water use is generally a condition on most water takes. The purpose of metering use is to confirm compliance with take rates (daily and, in the case of surface water takes, instantaneous) requirements. Experience on this and similar projects in the Waikato indicates variable levels of success in achieving the real intent of recording water use, i.e., to gain accurate and reliable records. Some of the key problems and issues are:

- Accuracy and reliability of meters.
- Enforceability of compliance for accurate reporting at a frequency useful for resource management.
- Attitude of water users to the accurate reporting of water use.
- Cost of more reliable technical solutions.
- Institutional resources (human, technical and financial) to process data and timely use of the data; this is also part of a broader issue regarding the management of resource and consent data sets for water management.

The term of a consented take is an important consideration in some cases, such as with irrigation takes due to associated investment in plant and machinery, and in others due to the surety of supply (for example community water supplies).

Within the Waihou a variety of specific consent conditions have evolved over the past 10 years, related to restrictions on surface water takes, due to the impact of low flows and high tides on the Hauraki Plains Scheme take at Kerepehi. The key issue relates to the coincidence between king tides and low flows in the Waihou River, which increases water turbidity and reduces water treatment production (thereby reducing water supply). The current criteria for restrictions on upstream takes occur when a king tide coincides (greater than 3.5 m at Auckland) with a flow rate of less than 24 m^3/s at Te Aroha.

Authorised (RMA) and Permitted takes

Non-consented water takes include those authorised under the RMA for livestock, domestic and fire-fighting, and permitted takes at less than specified daily rates (i.e. 15 m^3/d from surface water and 30 m^3/d from groundwater). Neither take is registered on consent or allocation databases, therefore not accounted for in assessment of cumulative take. For the purposes of determination of demand (section 3.3) the takes have been combined. It is assumed that, within the Waihou catchment, these takes primarily meet livestock and dairy shed requirements (milk cooling and yard washdown). They may also meet rural domestic (outside supply networks) and small industry demand, though as discussed in 3.1, rainwater is also likely to be a major contributor for these uses.

For the purposes of this study, the estimate of authorised and permitted takes is based on water use for livestock and dairy shed requirements. In summary this is based on a total area of livestock farming of approximately 120,000 hectares, with the balance of the catchment in forests (production and native) and non-agricultural land use. It is estimated that average daily demand (ADD) is in the order of 20,000 m^3/d, with peak daily demand (PDD) of 30,000 m^3/d and total annual water demand of 6.3 Mm^3/yr. These values have been incorporated into the assessment of seasonal demand in the following section. Appendix C lists further details of the estimates of livestock classes, number and water demand.

3.3 Water Demand

As indicated above, current consent records indicate that surface water resources are close to the allocable limit for the catchment. However, this determination is based on the calculated cumulative allocations and takes rates. The purpose of this section is to investigate the likely temporal variation in water use, and therefore the level of allocation efficiency. It is first presented separately by water use category and then in total.

3.3.1 Supply Networks

Figure 3 is a plot of the daily takes for the supply networks (total, rural and urban) on a monthly basis. The values presented on the plot are maximum daily rates (m^3/d) per month. They were calculated from actual water use records for the various networks from EW records and summaries supplied by the territorial authorities (TAs) over the five year period 1998-2003.

What is important about the plots is both the peak values i.e. less than 46,000 m^3/d (approximately 578 l/s), and the seasonal variation. The overall daily take is considerably lower than the cumulative consented takes and pending applications of 56,500 m^3/d (800 l/s). This may be due to trends in water use and seasonal variation; it may also be a factor in system design and operation, with high take rates required in case of unexpected system shutdown and the need for a buffer in take capacity.

The seasonal trend is similar for both rural and urban networks (and of similar magnitude), with a summer peak and a trough in demand in the winter months.

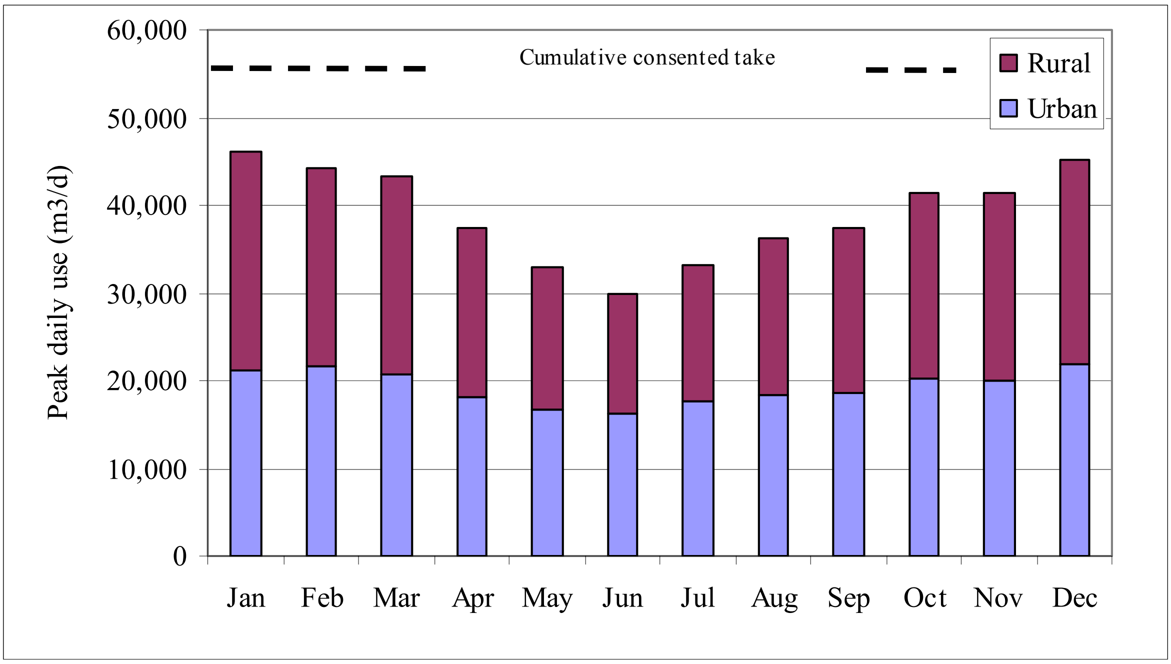

Figure 3: Seasonal water demand for supply networks (total, rural and urban)

3.3.2 Irrigation

Figure 4 is a plot of cumulative irrigation take volume (m^3/d) per month. It is calculated from modelled irrigation demand (1980-2003) and current irrigated area within the catchment. The plot includes mean and maximum values, to show the likely variation between seasons. It is interesting to note that the maximum take is close to the cumulative value (75,000 m^3/d). Most importantly it shows the seasonal nature of irrigation demand, starting in late October, peaking in January and tapering off in autumn, with maximum values of about 50,000 m^3/d in November and March.

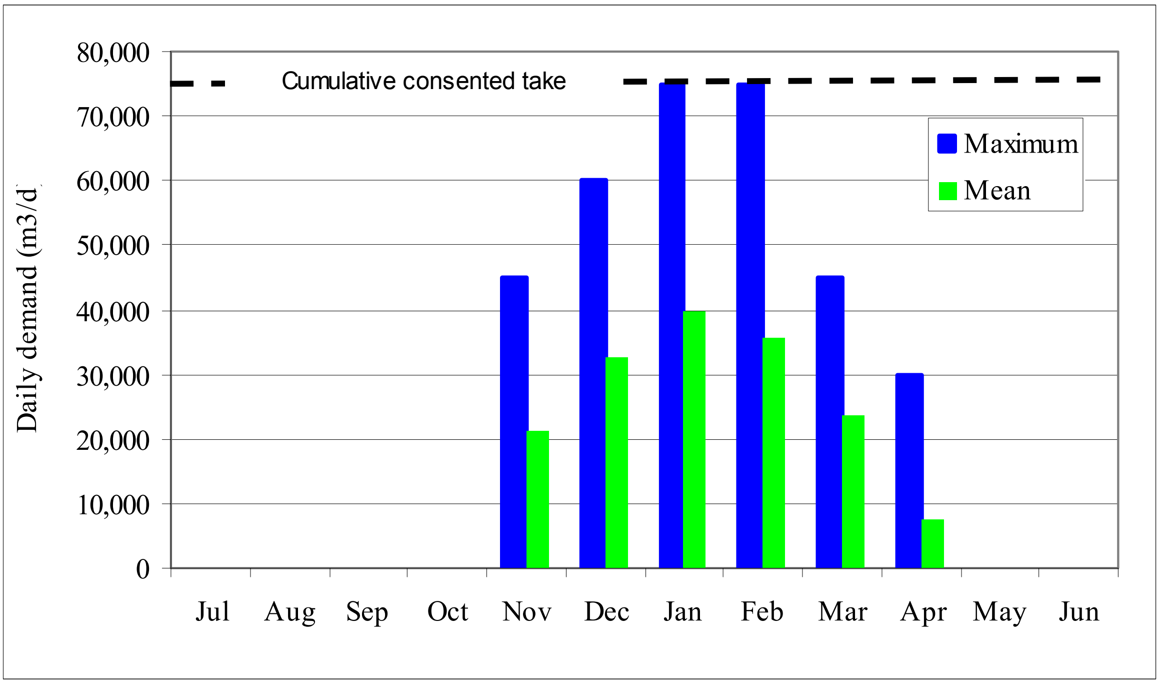

Figure 4: Seasonal cumulative irrigation demand (m^3/d)

3.3.3 Industry and Other

As indicated above, the most significant industrial use (outside the supply networks) is by the Anchor dairy factory at Tirau. Figure 5 is a plot of daily water use (maximum, average and minimum) per month for the factory over Dec 2001 to Mar 2004. The consented take rate for the factory is 20,000 m^3/d. Maximum use was approximately 15,000 m^3/d or 70% of the consented value. The pattern of use follows a distinct seasonal trend, high demand during the milking season (Aug-May) and low winter use.

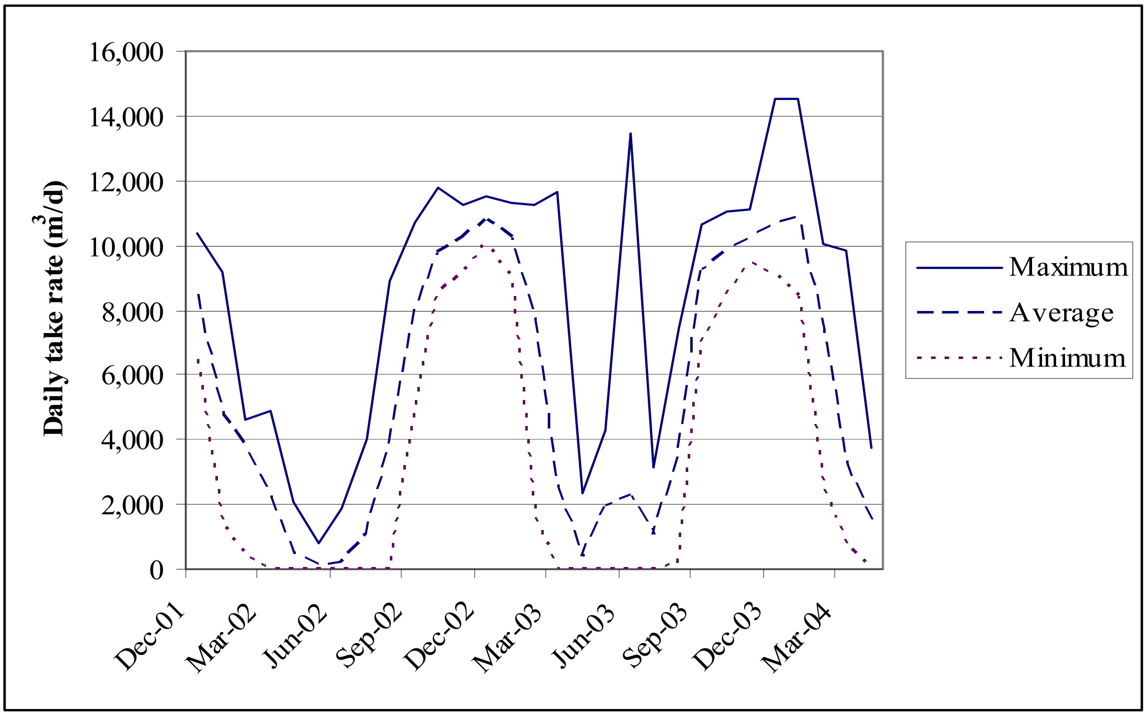

Figure 5: Water use at Anchor dairy factory, Tirau (Dec 2001 to Mar 2004)

3.3.4 Authorised and Permitted Takes

An evaluation of likely seasonal trends for permitted takes indicates that peak demand occurs during the summer months (Dec-Mar) due to the high livestock requirements and is lowest during winter. Cumulative daily take is estimated to range from a high in Jan-Feb of 25,000 m^3/d to less than 15,000 m^3/d in Jun-Jul.

3.3.5 Seasonal Trends

Figure 6 shows the cumulative take from surface water for consented and livestock (RMA authorised and permitted takes) as daily take (m^3/d) on a monthly basis. The total take peaks in January at just over 160,000 m^3/d, largely due to the combination of high irrigation and supply network use and declines to less than 40,000 m^3/d in May-June. Total allocable resources are the equivalent of approximately 207,000 m^3/d. The seasonal trend shows that at times of the year allocable surface water resources utilisation, at best, ranges from about 80% in summer to less than 30% in winter. Overall efficiency of use resource utilisation based on seasonal demand (assuming maximum irrigation demand) is in the order of 50%.

Table 4 shows the annual water demand (Mm^3/yr) for the above water uses. Total demand is just over 32 Mm^3/yr of which 44% is for supply networks, 31% for irrigation (assuming peak demand) and 10% for industry (excluding industries within supply networks). The livestock (RMA authorised and permitted) estimate is based on the assumption that 75% of demand is met from surface water (due to the high reliance on surface water for consented takes).

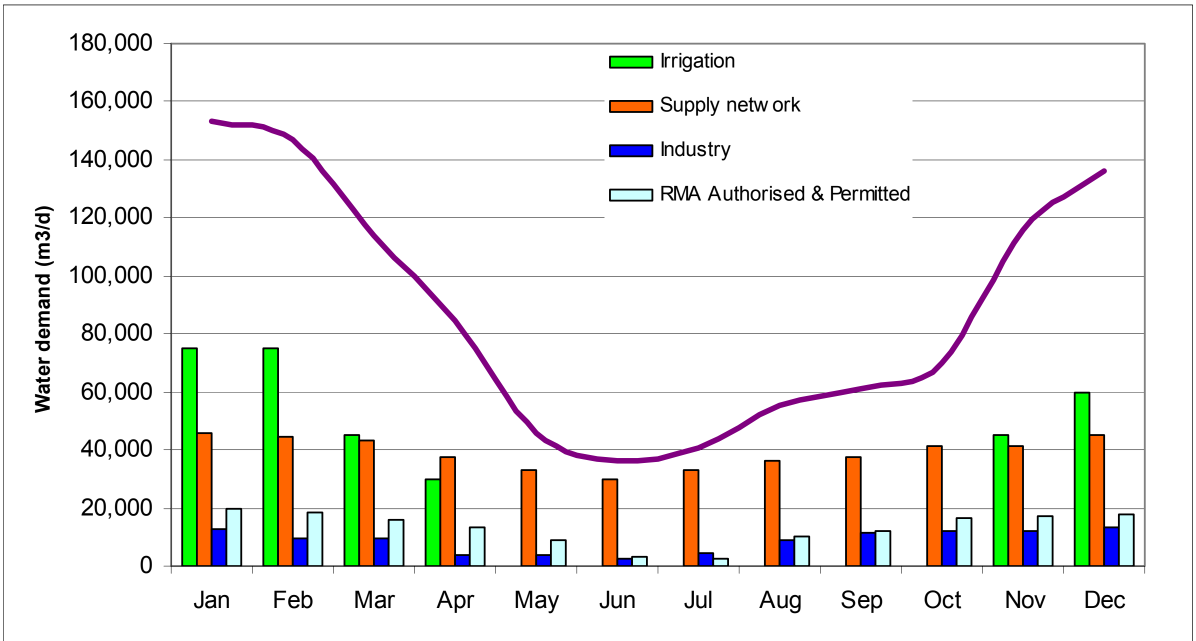

Figure 6: Seasonal trend in water demand

Table 4: Annual water demand from surface water by use category

Use Category	Water demand (Mm^3/yr)	Total demand (%)
Supply network	14.30	44
Irrigation	10.07	31
Industry	3.21	10
Livestock (RMA & permitted)(1)	4.73	15
Total	32.30	

(1) Based on 75% of demand supplied from surface water. Total demand is 6.3 Mm^3/yr

3.4 Key Issues

The key water allocation and management issues in the catchment are:

- Surface water is close to full allocation, and future demand will need to be met from discretionary takes or alternative sources.
- Take restrictions to protect water supply to the Hauraki Plains Scheme during high tide and low flow events.
- Accounting for non-consented water takes (authorised and permitted) in the determination of cumulative surface water takes.
- No mechanism established for restricting takes during low flow events, i.e. protection of minimum flow values.
- Current surface water allocation processes do not account for variations in seasonal demand.

4 Allocation Issues and Options

The evaluation of water availability and demand in the Waihou catchment, and discussion with EW staff, identified a number of issues related to water allocation. These are grouped according to categories of efficiency, protection of in-stream values and priority as listed in the following subsections. Most of the issues are related to surface water allocations, as this is the resource under the most pressure in terms of demand, and the resource most sensitive to demand peaks and low flow. While surface water is generally the most heavily developed in the Waikato Region, there are nevertheless a number of issues regarding groundwater, in terms of its relationship to surface water and longer term cumulative demand.

4.1 Allocation Efficiency

The efficiency of surface water allocations is constrained by current processes. While the catchment as a whole appears to be approaching the upper limit for allocations as a controlled activity, a closer examination of current consents and water use shows that a significant proportion of allocable resource is not utilized. For the purposes of this study, allocation efficiency is defined as the ratio of water use to allocable resources (10% of Q_5). The subsections below list a summary of the key elements and outcomes affecting allocation efficiency, and where relevant indicate the scope of inefficiency.

4.1.1 High Take Rates

The allocation of takes from run-of-river flows at rates greater than the equivalent 24 hour rate leads to over-estimation of cumulative effects. For example, for a take with a daily maximum volume of 3,500 m^3/d at a take rate of 80 l/s, the equivalent 24 hour rate is approximately 40 l/s. Under current allocation processes for estimation of cumulative effects, the take is recorded at 80 l/s, though in reality is only operational for a maximum of 12 hours per day.

For water users, there are sound and rational operational and financial reasons for requesting higher take rates, such as use of preference electricity tariffs i.e. night rates for irrigation and to meet daily demand peaks such as for domestic and rural water supplies. The resource management issue is that in areas where allocable limits are being reached this can lead to under-utilization of allocable resources, thereby reducing both allocation and economic efficiency.

In the Waihou catchment, if all surface water takes (run-of-river) were at an equivalent 24 hr rate the cumulative take rate would be approximately 1,778 l/s compared to the current cumulative rate of 2,544 l/s. The difference between the two values (766 l/s) is 30% of the total allocable surface water.

There are 31 takes (out of a total of 70) with rates significantly less than the 24 hour rate (i.e. less than the equivalent 20 hr rate). Table 5 shows the additional allocable water (column 3) and increase in allocation efficiency (column 4) for takes above three threshold rates: greater than 5 l/s, greater than 10 l/s and greater than 48 l/s. It shows that there is potential to increase allocable resources and efficiency through improved consent processes and compliance monitoring.

Table 5: Additional allocable resources

Options	No.	Allocable take (l/s)	Efficency increase(1) (%)
Takes greater than 5 l/s	21	733	30
Takes greater than 10 l/s	18	716	29
Top 10 takes (> 48 l/s)	10	612	25

(1) Proportion of the current under-utilized allocation

The key issue in improving the determination of cumulative take rates, in this case, is having an effective and accurate method of confirming the period and rate of daily takes (consistent with consent conditions and rates). One option is the electronic logging of water use for consented takes from surface water that are at a rate greater than an equivalent daily nominal value (20 hour day) and above a threshold level. For the Waihou, a threshold take rate of 10 litres per second could be a practical limit which would yield a relatively high proportion of the under-utilized resource. The logging would provide an accuracy of records to confirm that the take was consistent with the consented daily period and rates. The requirement for logging would be a consent condition, along with a standard of logging equipment comparable to EW standards for data collection, storage and transfer. The data records will provide confirmation of compliance with take conditions. In some critical areas where real time records are required, the conditions may be extended to EW telemetry access.

The cost of the logging equipment and associated installation could be borne by the consent applicant. Compared with the alternative option of a lower take rate and use of storage, the cost of logging is relatively low. For example, for the take above (3,500 m^3/d), if the take rate is reduced to 40 l/s the capital cost for storage would be in excess of $5,000. The cost of logging equipment is less than half this value.

An alternative option to electronic logging is the allocation of all takes from surface water on a 24 hour take rate basis. However, this is not recommended as it is unnecessary in areas where allocable limit is not reached, and will reduce the economic efficiency of water use. The above option provides a practical solution which still enables the principles of the RMA, regional policy and plan to apply i.e. first in line, and enable water users to find their optimum financial solution(s) and thus economic efficiency.

4.1.2 Seasonal Takes

Allocations for seasonal water take, such as irrigation, over-estimate cumulative take and annual volume. The current allocation process, while setting limits on number of take days per year for most seasonal takes (for example generally 120 take days for irrigation), it does not recognise the variability of seasonal demand and therefore can lead to under-utilization of surface water resources.

Irrigation demand varies between and within seasons, though allocations are based on a peak daily take rate for the annual take period. In the Waihou, cumulative annual allocation for irrigation takes is the equivalent of 9 Mm^3/yr (based on cumulative daily rate of 75,000 m^3/d for 120 days). But, as shown in Figure 4, daily demand while peaking in Jan-Feb is considerably lower on the margins of the season. The peak annual demand for the highest demand year is 7.6 Mm^3/yr, or 85% of the cumulative allocate annual volume (9 Mm^3/yr), while in an average season it is 5.8 Mm^3/yr or 65% of the cumulative allocation.

Table 6 shows the under-allocated surface water take during an irrigation season (Nov-Apr) of peak demand. It shows that outside the peak months there is an allocable resource not required for irrigation of 174 to 521 l/s (7% to 21% of allocable resources).

Table 6: Seasonal under-allocation

Month	Allocable resource	
	m^3/d	l/s
Nov	30,000	347
Dec	15,000	174
Jan	0	0
Feb	0	0
Mar	30,000	347
Apr	45,000	521

While allocation processes need to account for peak seasonal demand, they could be improved with better definition of seasonal takes, both in terms of period and variations in rates. The advantage would be reallocation of allocable resources to meet other complementary seasonal demand such as frost protection.

4.1.3 Water Use Accounting

Evaluation of water use indicates that actual water use is lower than cumulative takes. An example of this is shown in Figure 3 with cumulative take rates for supply networks. While the cumulative take rates for supply networks is approximately 800 l/s (56,500 m^3/d), actual water use based on water records shows a peak cumulative take in the order of 530 l/s (46,000 m^3/d). For this example, this is equivalent to approximately 10% of allocable surface water resources. There are a number of possible reasons for the difference, such as:

- variation in seasonal demand between networks (though as indicated in Figure 3, urban and rural networks appear to follow similar demand trends);
- consented take rates incorporating projected growth (within the consent duration);
- consented takes incorporating alternative supply options (such as with the Te Aroha water supply); and
- inaccuracy or completeness of water use records.

The allocation process could be improved with the integration of water use records to determine actual water use as part of the determination of actual peak cumulative demand. This information would enable periodic reviews of actual versus consented water use for major water users, and could form the basis for amendment of catchment cumulative take rates. The approach could also be accompanied by strategic planning of allocations to take into account projected changes in demand, both increases and decreases. Such an approach would reduce the need for applicants to over-estimate demand as a way of locking up allocable resource to meet future demand.

4.1.4 Consent Accounting (Takes and Discharges)

Estimates of cumulative take can be constrained by processes accounting for water discharges and in some cases for takes for flood protection. The issue in accounting for discharges relates to the determination of the quality and quantity of discharge water. Where the discharge is of a comparable or higher quality than the receiving water, it is contributing to allocable resource. This is relevant for non-consumptive uses such as hydro-power and use of water for cooling processes. The determination of allocable resource could be improved with amendment to current consent processes, with the specification of minimum daily discharge timing, rates and water quality.

To illustrate this point, Figure 7 shows daily water take (maximum) and discharges (minimum) for the Anchor dairy factory at Tirau. The two points to note are: i) peak water use is 70% of the consented take rate i.e. 15,000 m^3/d cf 20,000 m^3/d, and ii) during periods of peak demand discharges are up to 20% of take rate. If both the lower water use and contribution from discharge are taken into consideration, actual net water use during the spring-summer period is at best about 60%. In this case the under-utilized take is in the order of 90 litres per second, or 46% of the allocable resources at the take location.

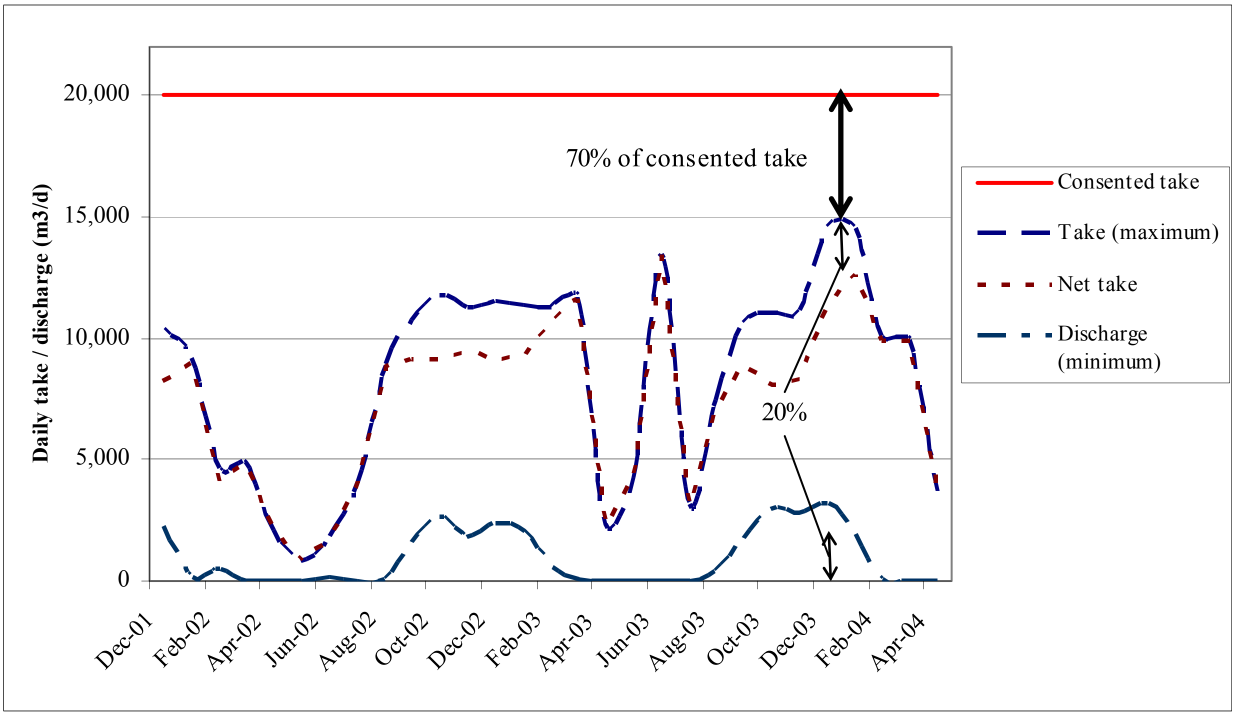

Figure 7: Water takes and discharges for Anchor dairy factory, Tirau

4.2 Economic Efficiency

The optimisation of economic benefits is one of the key water policy objectives. This can be constrained by limitations on allocation efficiency (when resources are fully allocated) as outlined above. It can also be constrained by other factors related to consent duration, resource availability and transferability, as discussed below.

4.2.1 Consent Duration

The consent duration may impact on economic efficiency by creating uncertainty of reliability of supply. To minimise risk in terms of surety of water availability, the duration should ideally be commensurate with the type and level of investment. Short term consent durations, while sometimes adopted due to uncertainty of resource availability or cumulative effects, can also constrain investment due to perceived higher risk of supply reliability.

The approach to consent duration may be based on:

- Duration related to type of water use (sector) (based on sector or industry guidelines)
- Level of certainty of resource availability.

The institutional requirements include technical assessment of consent durations for relevant sector or sub-sector of use and classification of water source assessment certainty (for surface water this may be based on whether reaches are gauged or not). In addition to optimising economic benefits, consent duration is also a mechanism to provide protection for priority water uses, such as for supply networks for domestic and livestock consumption. In this case the duration may reflect a need for long term surety of supply (within low flow restrictions as outlined below).

In the Waihou catchment the median duration is 10 years, but the range is from 3 to 30 years. For irrigation takes the average take duration is 10 years, with a range from 5 to 20 years (with the exception of 30 years consent for a golf course). For irrigation, 10 years would generally be regarded as acceptable period for payback on investment.

The average duration for town and rural water takes is 13 years with a range from 3 to 21 years. The duration for supply network takes would normally be in excess of 15 years, due to the high level of investment in infrastructure and the long term nature of demand.

The lag period between consent approval and the implementation of the take is an area which may also require further clarification. Where consented takes are not utilized, allocable resources are locked up until the expiry of the grace period (5 years).

4.2.2 Allocable Resources

There is considerable potential to increase availability of surface water for consumptive use with the harvesting of winter flows and/or allocation of takes above Q_5. This could be achieved with the allocation of a proportion of run-of-river flow above the Q_5 value, for a take either under a specified flow condition and/or period (typically during the period May to October). This will require the establishment of an additional category of surface water allocation under the current plan, along with the associated consent conditions on flow regime, take rate and take period.

While a more expensive supply option than direct run-of-river takes (due to the pumping and storage costs) in areas of high demand and fully allocated resources, it does offer the potential for additional allocable resources. In some cases this stored water may be complementary to run-of-river takes, to support demand during periods of restrictions, and in others be the primary water source. A recent study of the potential costs and benefits of water harvesting for irrigation in the Pukekohe area indicated for vegetable crops that water harvesting is financially feasible (ARL, 2004b).

In addition to the above resources there is also scope for the review of allocation criteria for surface water (i.e. percentage of Q_5), with the establishment of threshold allocation level at which in-stream values and flow criteria are reviewed, as outlined in Section 5.

4.2.3 High Priority Use

As identified in the Waihou catchment, there is a need to manage and protect access to water for high priority uses, such as for supply networks to urban and rural communities. While all water users should be expected to minimise usage during periods of prolonged shortage, the reality is that within these requirements there is a need to maintain a minimum level of supply for domestic, livestock and industrial consumption, in the interests of public health and social (employment) needs.

The approach to high priority use could include one or more of the following actions:
Application of differential restrictions for category of water uses; with high priority uses (domestic and livestock) being preceded in timing and extent of restrictions by lower priority uses (irrigation and industry).

- Consent duration; the issuing of longer term durations to provide a higher level of security of supply (with lower priority uses limited in duration).
- Strategic resource planning; the forecasting of water demand, and the coordination of consent durations to match predicted reallocation of water from lower to higher priority uses.

For rural towns, the security of water supply is a key element in encouraging economic development. This development is often dependent on attracting new industries, such as has recently occurred in Te Aroha, with the establishment of meat and poultry processing factories. The establishment of new industries created employment opportunities and therefore can improve the town’s economic outcome and the affordability of water services.

4.2.4 Water Transfers

Transfers of water takes in principle open up the opportunity to optimise both allocation and economic efficiencies. The PWRP makes provision for transfer of surface water takes (in full or part) (Section 3.4.4.4) on a temporary or permanent basis, within conditions of water management class and location. To date transfers appear to have been only used to a limited extent. They have been either associated with property sales (as recently occurred in the Waihou) or with temporary transfers between leasehold titles for vegetable production (as have occurred in the Pukekohe area). This limited use of transfers probably largely reflects the relatively high level of resource availability and low demand i.e. few catchments constrained by allocable resources (apart from several catchments around Pukekohe).

However, with increasing demand, restrictions on takes during low flows and changing environmental standards (both in terms of water quantity and quality), there is likely to be greater interest in the use of the transfer mechanism, to secure water and to optimise in water investment. This is largely to be of initial interest to high value water users (economic and social) such as for supply networks and industrial use. While the PWRP provide for transfers, what is not clear is the mechanism that appears between the consent holder and a third party. This is not regulated by the current plan, and is the subject of private negotiation.

5 Protection of In-stream Values

One of the key objectives of the allocation process is to ensure the protection of in-stream values (surface water and groundwater) from the effects of water takes. As discussed in Interim Reports, water takes within a catchment or area are a combination of consented takes (controlled and discretionary), permitted activities (permitted daily take volumes) and reasonable use under the RMA (domestic, livestock and fire-fighting). The current process includes metering conditions for verification of compliance with consented take rates and volumes, as well as conditions for restrictions on takes from surface water. The subsections below discuss methods for improving accounting for water use, application of restrictions and determining cumulative effects.

5.1.1 Accounting for RMA Reasonable and Permitted Activity Use

In some catchments, water use for non-consented activities, i.e. reasonable domestic and livestock use and permitted activities may be a significant proportion of total water use. This is particularly relevant in catchments or tributary catchments where livestock farming makes up a high proportion of total land use.

In the Waihou catchment as a whole, non-consented livestock use is estimated to be approximately 6.3 Mm^3/yr or 19% of total demand (supplied from surface water and groundwater). The peak daily demand is estimated to be in the order of 30,000 m^3/d. Based on the assumption that up to 75% of this demand is supplied from surface wate,r this is the equivalent of 260 l/s or the equivalent of 11% of allocable take rate (2,400 l/s).

Permitted takes are relatively low take rates (15 and 30 m^3/d from surface water and groundwater respectively) compared to many consented takes; they nevertheless may cumulatively be significant particularly from small tributary streams. These takes currently do not require registration with Environment Waikato, so are difficult to quantify in terms of numbers, volumes or rates.

Ideally, all non-consented water use should be taken into consideration in determining cumulative take effects, as it may be a critical factor in determining effects on river flows or groundwater levels. However, it is often a difficult use element to determine, due to the lack of information on the distribution and level of demand and water source.

One approach is that determination of reasonable livestock use levels based on land use classification. The classification from existing land cover databases would provide the identification of the proportion of a catchment or area for which there is likely to be non-consented consumptive water use. In the Waikato this is principally livestock farming, for which a demand level can be calculated based on livestock carrying capacity (i.e. stock unit per hectare (SU/ha)). While broad scale, this approach would provide a useful baseline for assessment of reasonable non-consented demand.

There is scope to further refine the approach, with the determination of demand levels from a review of supply rates (m^3/d) from rural water schemes. This would utilize existing water production values (such as for the Hauraki Plains Scheme) supplemented with information on stock numbers and types to determine unit area demand levels (seasonal and annual).

The accounting for permitted takes could be improved with the registration of take (non-consented) by location and water source. This approach has been adopted by some regional councils. Such information enables assessment of cumulative take rates and volumes to be included in consent and allocation processes.

5.1.2 Restrictions

To protect in-stream values (surface water and groundwater) there is a need to impose restrictions on takes during periods when flows and water levels are lower than minimum levels. The allocation criteria for surface water is based on a probabilistic occurrence of flow (i.e. Q_5), therefore there will be times when flow is less than minimum rates. To date restrictions on takes during low flows have seldom been enforced, due to limitations of current plan and management process i.e. lack of definition of minimum flow levels and mechanisms for enforcement of take restrictions.

Current processes could be improved with establishment of the following:

a) Minimum flow levels for protection of in-stream values. Under the current water allocation criteria, this should be the Q_5 value less the allocable resource (10 to 30% of Q_5 dependent on river/stream classification). The minimum flow forms the benchmark for imposition of take restriction regimes as listed below.
b) Trigger flow levels for implementation of restriction regimes. The practical approach is the adoption of Q_5 values as the trigger level, though an alternative for river/streams with low levels of allocation may be based on minimum flow plus cumulative take rate. This will reduce the frequency and duration of restricted takes without compromising in-stream values.
c) Regime(s) for reduction of takes at sustained flows less than Q_5 (or alternative critical flow i.e. $Q_{2.3}$ or IMFR etc.). This may vary from total cessation of take to incremental reductions. This may also be linked with electronic logging and possibly real time telemetry of high priority takes such as for supply networks etc. Where sites are actively monitored, and therefore reduced take rates can be verified, they may be entitled to maintain takes after non-verified sites are required to cease pumping. The benefit of such an approach would be to limit the probability of cessation of takes, by progressively reducing takes when lower flow limits are being reached.

Figures 8 and 9 illustrate the potential frequency and duration of restriction of takes on the Waihou River, based on flow measurements at Te Aroha (site 1122.34). Figure 8 shows the frequency when flow was less than Q_5 for irrigation seasons (Nov-Mar) in the period 1984-2003. Over this period flow was less than Q_5 for a total of 130 days. On the above criteria i.e. restrictions at less than Q_5 there would have been restrictions (full or partial) in 6 of the 19 seasons. The longest duration of restrictions would have occurred in the 1994-95 season, with a total of 26 days.

Figure 9 shows flow rates for the 1994-95 season (the season with longest period of restricted take) along with Q_5 and minimum flow levels. During the season there would have been three periods of restricted take during January, the longest of 11 days. It shows that with appropriate monitoring (telemetry), reduced takes (50% of allocation levels) could have been maintained during the period of restriction.

The lack of current restrictions on takes may have to some degree created a false understanding by consent holders about the reliability of water availability from rivers and streams. One of the challenges in development restriction regimes is to consult with user groups; i.e. irrigators and water supply managers, as to the nature of surface water reliability so that they understand and can plan for periods of low flow and reduced water availability.

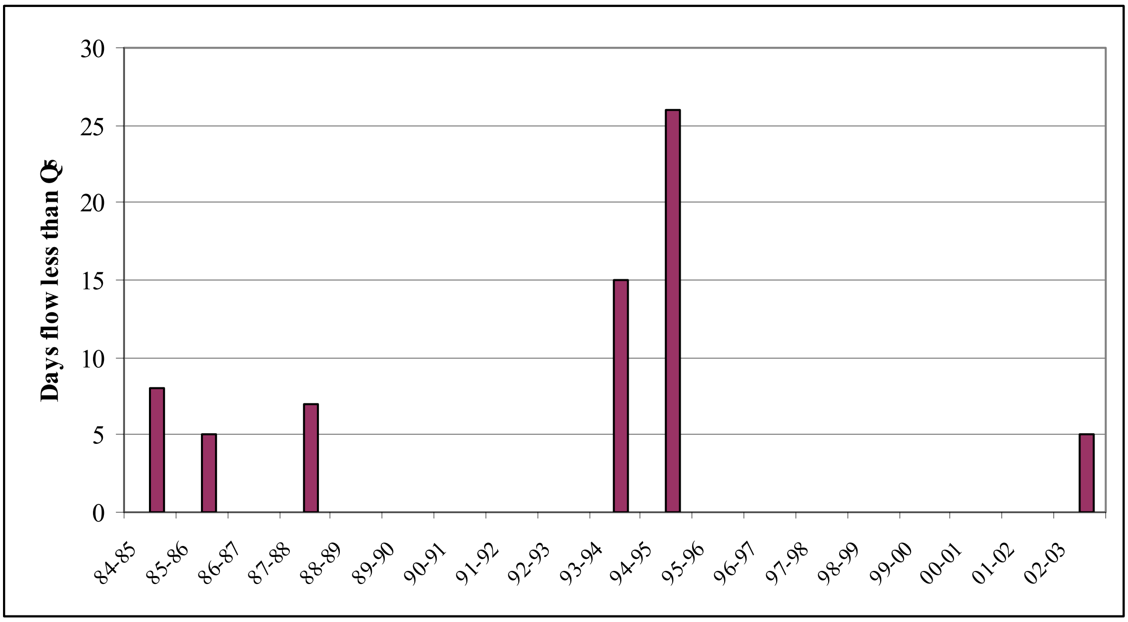

Figure 8: Periods of restricted take (days) for irrigation season from 1984-2003 (Te Aroha)

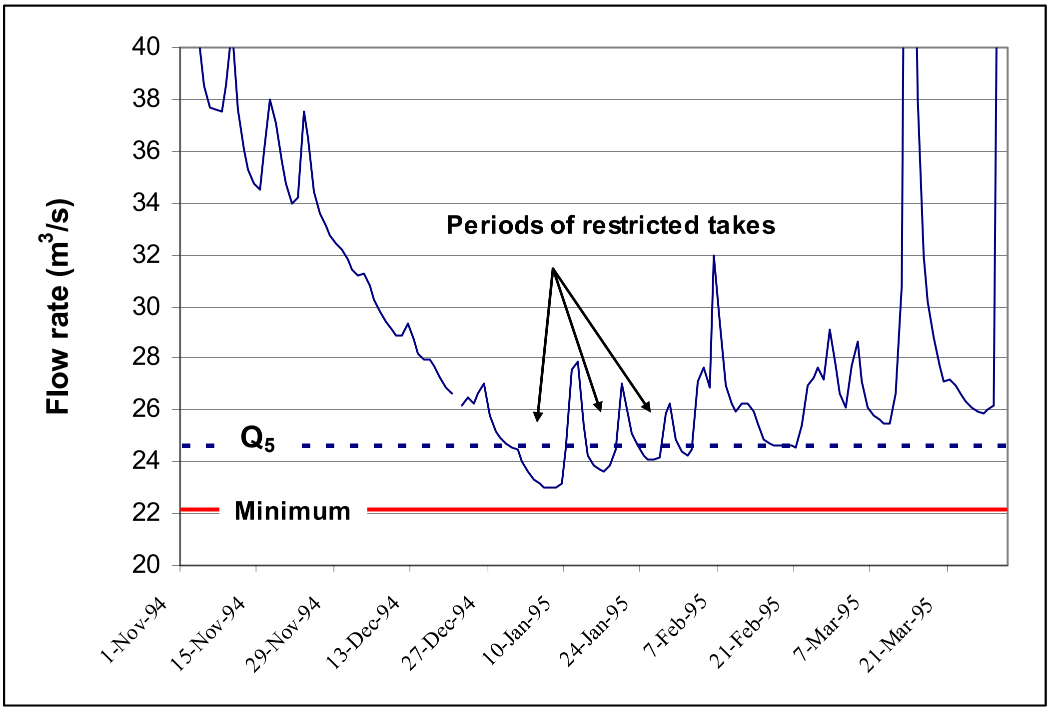

Figure 9: Flow at Te Aroha (1122.34) summer of 1994-95

5.1.3 Monitoring Use

Water use records provide the foundation for determination of compliance with consented rates and volumes. They also provide the potential for assessment of actual cumulative demand with consented values (and therefore reassessment of allocation and demand levels). However, as previously discussed there are a number of constraints on water use records, the primary one being the accuracy and reliability of records. In short, the current approach while a useful foundation could be improved, to provide a more complete and accurate records both in terms of time and volume of water use.

As indicated in the assessment of takes in the Waihou catchment, the approach could be focused on:

- Electronic logging of all takes above a threshold level. In the case of the Waihou, logging of takes greater than 20 l/s would account for more than 90% of the cumulative take rate. The issues and costs associated with logging are as per those outlined in Section 4.1.1
- Modify the current daily record requirements for low take rate consents to weekly records, with the intention of improving the reliability of meter reading.

The water use records need to be linked to consent databases for verification of compliance of take conditions. As with previous methods related to electronic logging, this requires the appropriate institutional resources and processes for data collection, quality control, processing and storage. It is assumed that these resources largely exist within EW.

5.1.4 Groundwater Cumulative Effects

Much of the preceding information and analysis has focused on issues associated with management of surface water allocations, as the predominant water use within the Waihou catchment (as indeed it is in much of the Waikato Region). However, there are significant groundwater resources, both freshwater and geothermal, within the region. The key allocation issues and risks for freshwater resources are local interference effects and those associated with cumulative effects and interaction with surface water (shallow groundwater), i.e., sustained lowering of water levels, stream depletion, spring flows and saltwater intrusion in coastal areas.

Allocations for consented groundwater takes are based on potential interference effects and cumulative take rate within a specified radius. The limits on cumulative take are based on best available assessment of sustainable yield, usually a percentage of local recharge. This is generally a conservative approach, which does not take into consideration recharge from through-flow and bedrock. However, the approach is usually dependent on assumptions for recharge and yield, which may lead to under- or over-allocation of resources. The sustainability of groundwater is dependent on medium to long term performance of the aquifer(s) (indicated by long term trends in water levels and water quality), and for shallow aquifers the effects on springs.

The current approach could be refined with greater understanding and quantification of groundwater systems as the basis for updating threshold levels for cumulative allocations (m^3/yr), above which allocations would be dependent on monitored trends for groundwater levels and spring flows.

5.2 Implementation of Options

To address the above issues and to improve allocation outcomes, there is a need to adopt changes in current consent processes and water management procedures. Table 7 presents a summary of the options for these changes, along with supporting institutional and financial requirements. It also where relevant lists the potential benefits, in terms of allocable resources and economic, to consent holders or the community in the Waihou catchment.

Key elements of implementation are:

- Changes to consent conditions including:
  - Specification of daily take period for high take rates i.e. greater than the nominal daily rate.
  - Specification of maximum take rates for irrigation takes i.e. m^3/d/mth.
  - Definition of the irrigation season i.e. Nov-Apr.
  - Definition of consent duration for principal water use categories i.e. 10 years for irrigation and 20 years for supply networks.
  - Specification of logging requirements for surface water takes greater than the nominal daily rate and greater than 10 l/s.
  - Weekly recording of water use for takes less than 10 l/s.
- Changes to water management procedures with:
  - Definition of minimum flows for surface water i.e. Q_5 less allocable resources.
  - Definition of threshold allocation levels i.e. 75% of allocable resources as the trigger for review of allocation criteria.
  - Establishment of multiple tier surface water allocations i.e. above Q_5.
  - Establishment of restriction regime(s) during low flow or water level periods.
- Institutional support is required for:
  - Accounting for discharge contributions (rate, time and quality) to allocable surface water.
  - Upgrading of water use monitoring for determination of actual cumulative demand.
  - Development of procedures for determination of non-consented takes in determination of cumulative demand
  - Downloading logged water use (annual) and associated systems for verification of compliance with consent conditions.
  - Provisional financial support for logging equipment, though this may be recovered through annual charges.

Table 7: Summary of options, implementation and benefits

Outcome & Issue	Action	Institutional / Financial requirements	Benefits (Waihou catchment)
Allocation efficiency: a) High take rate b) Seasonal take c) Consent accounting d) Discharge accounting	• Logging of selected takes (seasonal & high take rates) • Define period for seasonal takes • Specify monthly maximum volume for seasonal takes • Specific minimum daily discharge volumes (rate & time)	• Cost of logging – or alternative logging option (capital cost approx. $1,000 per site) • Amendment consent conditions with definition of daily take period and monthly rates • Linking of databases	• Increase allocation efficiency of surface water by 30-40% • Complementary water allocations e.g. irrigation & frost protection • Increase allocable resources (accounting for discharges)
Economic efficiency: a) Consent duration b) Priority use c) Allocable resources d) High priority uses e) Water transfers	• Consent duration α use and resource assessment reliability • Allocation of surface water takes for water harvesting • Differential restrictions between low and high priority uses • Longer consent durations for high priority uses • Strategic planning • Develop water trading mechanism/model	• Determination of consent duration for primary use categories • Definition of allocable water from water harvesting (% of mean winter flows) • Delegation of high and low priority uses • Determination of threshold levels for application of restrictions • Definition of consent duration for high priority uses • Demand forecasting	• Potential for improved returns to water through greater investment and mobility of water • Increased water utilization through higher water allocation (harvesting) • Establishment of a transparent approach to protection and prioritisation of high priority water use • Ensure reliability of supply for high priority use
Protection of values: a) PAs & RMAs takes b) Restrictions c) Monitoring use d) Cumulative effects	• Unit area demand assessment • Verification study(s) • Definition of allocation threshold • Incremental flow restrictions • Weekly reading for low take rates • Logging of take > 20 l/s • Weekly reading for low take rates	• Formalise non-consented water use as part of allocable resource assessment • Define flow thresholds (by catchment type) • Modify water use compliance based on take rate threshold values • Establish groundwater threshold rates	• Improve assessment of cumulative demand • Formalise criteria for restriction of takes • Increase resource allocation (based on improved assessment of water use patterns)

6 Conclusions

The key conclusions and recommendations for the study are summarised below.

Allocation issues and options

- The efficiency of allocation of surface water is constrained by consent and water management procedures. As demonstrated in the Waihou catchment, while surface water is close to the allocation limit (for controlled activities) of 10% of Q_5, allocation efficiency is less than 60%. The principal constraints are:
  - High take rates (greater than the nominal daily take rate) mainly for irrigation which lock up 30% of the allocable surface water resources.
  - Variations in irrigation water demand, with low rates on the margins of the season which could be allocated to alternative uses such as frost protection.
  - Cumulative water use is less than consented values. In the case of supply networks, actual use is about 80% of consented values.
  - Under-accounting for the contribution of discharges (of comparable water quality) to surface water which leads to under-estimation of allocable resources.

  In catchments at or near full allocation, there are large potential economic benefits for improving allocation processes. Improvements in the Waihou could increase surface water allocation in excess of 700 l/s, which if available for irrigation would have a cumulative financial benefit of $400,000 per year, and increase land values by $7 million. Alternatively it could be allocated to meet future demand from towns and rural water supplies.

- The potential economic benefits of water allocation is limited by:
  - Inconsistent consent durations, particularly short term durations which increase the supply risk for water users. For irrigation takes the minimum duration should be 10 years, while for supply networks it is 20 years.
  - Limitation of surface water availability. Currently surface water allocation is limited to run-of-river takes and dams. However, there is potential to significantly increase resource availability and therefore economic benefits with the development of water allocation based on criteria above Q_5. In the Waihou catchment, this is conservatively estimated to more than double surface water allocations (though at a higher cost and lower reliability).
  - As demonstrated, there is a need to have mechanisms for protection of high priority water use(s) such as community water supplies. The failure to do so could have negative economic impacts.

- Current allocation processes are limited in their ability to protect in-stream values. The constraints include:
  - Non-accounting for non-consented takes (authorised and permitted) which in the Waihou are approximately 20% of total water use.
  - Limitation of restrictions on takes during period of low flow or low water level.

Implementation

The improvement of water allocation requires changes to current consent conditions and management processes. Changes to consent conditions include specification of daily take period for high rate takes, irrigation season, maximum season demand (m^3/d/mth). The changes will need to be supported with improvements to verification of water use. It is proposed that electronic logging be a condition for high rate takes and takes greater than a threshold level (nominally 10 l/s). Supporting management procedures are those associated with improving assessment of contributions from surface water discharges and accounting for actual water use. These require the appropriate linkages between consent databases, some of which are currently being implemented by EW.

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Appendix A: Project objectives and scope

The project objectives and scope as presented in the proposal for services are listed below.

Objectives

The objective of the study is to identify and recommend options for improvements in the processes and practices for water resource allocation and management in the Waikato Region.

The study specific objectives include:

- Determine key issues and constraints of current management processes
- Develop alternative management options
- Assessment of implementation methods for option(s).

Approach

The approach to the study will be based on a case study of the Waihou catchment as an example of the type and range of water allocation issues common to the region. It will draw on information and data from the catchment for the identification of key issues and constraints and to demonstrate the potential impacts and benefits of alternative management options.

While the approach will primarily be based on the Waihou catchment, it will also take into consideration where relevant the application of the study findings to other areas of the region.

The following subsections outline the approach to the three main study elements.

1. Key issues and constraints

Environment Waikato has identified a number of deficiencies in the implementation of current plan methods and rules. The first study element is therefore an assessment of the current management processes to determine key issues and constraints. This assessment will include:

- Review of current management policies and plans to establish the context under which water is managed in the region. This is not a review of issues and policies, but an outline of the framework for current methods and allocation rules.
- Determination of improvements to water allocation mechanisms. While the plan defines allocable resources (surface and groundwater) (which is not a part of this study), there is potential to improve decision processes in allocating water for consumptive use. These improvements may include establishment of threshold allocation levels beyond which additional criteria may apply for water takes and resource monitoring.
- Review of current consent processes to identify constraints and improvements. The study will assess how well current processes match water allocation to demand, whether these processes could be changed to improve water allocation and use efficiency.
- Determine spatial and temporal water demand by water use category (based on permitted and consented water take). There is considerable variation in demand for water between users. Domestic demand is relatively constant throughout the year, while irrigation is seasonal and highly variable. Current allocation processes are based on combined peak demand, which leads to under-utilization of available resource for much of the year. The process could be improved with the establishment of time dependent allocations based on demand period.
- Identify key issues and constraints to water management and identify opportunities for improvement.

Output: The results and findings will be presented as a section of the Draft Final report for review by and discussion with EW. The output of this process will be integrated into the Draft Final report.

2. Management options

There are a number of options or approaches that may be adopted to improve the water management outcomes. The purpose of this element is to identify and evaluate a range of catchment-based management options. This will utilise above information on allocable resources and water demand as the basis for optimising allocation efficiency, use priority, reliability of supply, restrictions etc. Options will include adaptive management, which takes into consideration level of water demand, information needs and allocation mechanisms.

Output: A summary of the option(s) impact and benefits will be presented in a task memorandum for review by and discussion with EW, the output of which will be integrated into the final report.

3. Implementation methods

The purpose of this element is to evaluate the practical steps to implementation methods for proposed water management options (above). This will look at institutional, environmental, financial and social issues and constraints, and recommend a practical approach to overcoming these constraints.

Output: The recommendations will be presented as a task memorandum for EW consultation; the output of this process will be presented in the final report.

Appendix B: Summary of consented water takes – Waihou catchment

The table below is a summary of water consents and consent applications for surface and groundwater by number and daily rate (m^3/d).

Water resource	No.	Rate m^3/d
Surface water		
Consented takes	58	135,411
Current applications	11	26,210
Subtotal	**69**	**161,621**
Groundwater		
Consented takes	32	4,250
Current applications	3	1,470
Subtotal	**35**	**5,720**

The table below is a summary of surface water consented takes and consent applications allocations by principal use categories.

Surface water	No.	Rate	
		m^3/d	l/s
Consented takes			
Irrigation	30	73,838	1,456
Public supply	12	39,487	601
Industry	8	21,511	267
Other	8	575	11
Subtotal	**58**	**135,411**	**2,334**
Current applications			
Irrigation	1	1,260	15
Public supply	10	24,950	288
Industry			
Other			
Subtotal	**11**	**26,210**	**303**
Takes & Applications			
Irrigation	31	75,098	1,471
Public supply	22	64,437	889
Industry	8	21,511	267
Other	8	575	11
Total	**69**	**161,621**	**2,637**

The table below is a summary of groundwater consented takes and consent applications by principal use categories.

Groundwater	No.	Rate m^3/d
Consented takes		
Irrigation	6	2,100
Public supply	6	971
Industry	4	275
Other	16	904
Subtotal	**35**	**4,250**
Applications		
Irrigation	2	1,470
Industry		
Supply		
Other	1	
Subtotal	**3**	**1,470**
Takes & Applications		
Irrigation	8	3,570
Industry	6	971
Supply	4	275
Other	17	904
Total	**35**	**5,720**

Appendix C: Waihou catchment water demand

The table below is a summary of water supply schemes listing supply population and consented take daily rate (m^3/d).

Summary supply networks in the Waihou catchment

Water Supply	Type	District	Population	Take (m^3/d)
Hikutaia	Rural	Hauraki	200	1,000
Hinuera	Domestic	Matamata-Piako		
Hauraki Plains	Rural	Hauraki	9,935	15,000
Kaimanawa	Rural	Hauraki		1,211
Mackaytown	Domestic	Hauraki	140	100
Matamata	Urban	Matamata-Piako	6,234	4,400
Ohinemuri	Rural	Hauraki	600	2,000
Omahu	Rural	Thames Valley		3,409
Paeroa	Urban	Hauraki	4,000	6,870
Puriri	Rural	Hauraki	150	4,200
Putaruru	Urban	South Waikato	4,500	4,000
Te Poi	Domestic	Matamata-Piako	100	100
Te Aroha	Urban/Industry	Matamata-Piako	3,465	7,000(1)
Tirau	Urban	South Waikato	700	2,000
Waihi	Urban	Hauraki	4,450	4,900
Waikino	Domestic	Hauraki	340	250
		Total	**35,089**	**56,640**

(1) Excludes additional backup consent application of 8,000 m^3/d from Waihou River

The table below is a summary of water demand for the Hauraki Plains Scheme.

Summary of water demand for the Hauraki Plains Scheme

Category	No.	l/h/d	Other	Unaccounted	ADD m^3/d	PDD m^3/d	Annual Mm^3/yr
Population	10,000	300	0%	0%	3,000	4,500	1.10
Dairy cattle	**No**		**ADD**	**PDD**	**ADD m^3/d**	**PDD m^3/d**	**Annual Mm^3/yr**
Total	100,000						
Cows	80,000		35	70	8,400	11,200	3.066
Others	20,000		25	50	500	1,000	0.183
				Subtotal	8,900	12,200	3.249
				Total	**11,900**	**16,700**	**4.344**

Approximately 60% taken from within Waihou – at Kerepehi and Apakura Stream, balance supplied from adjacent catchments.

The table below is a summary of average daily demand (ADD), peak daily demand (PDD) and annual demand for drinking and shed cleaning requirements for livestock outside rural water supply schemes.

Livestock drinking and shed cleaning requirements

Stock	Nos	ADD l/h/d	PDD l/h/d	ADD m3/d	PDD m3/d	Annual Mm3/yr
Dairy cattle						
Cows	176,000	35	70	6,160	12,320	2.248
Shed washdown		60	70	10,560	12,320	3.326
Others	44,000	25	50	1,100	2,200	0.402
			Subtotal	17,820	26,840	5.976
Beef cattle						
Cows	29,920	30	60	898	1,795	0.328
Others	7,480	20	40	150	299	0.055
			Subtotal	1,047	2,094	0.382
Sheep						
Ewes	117,920	2	4	236	472	0.086
Others	29,480	1.5	3	44	88	0.016
			Subtotal	280	560	0.102
Deer						
Hinds	5,280	2	4	11	21	0.004
Others	1,320	1.5	3	2	4	0.001
			Subtotal	13	25	0.005
Goats						
Nannies	4,400	2	4	9	18	0.003
Others	1,100	1.5	3	2	3	0.001
			Subtotal	10	21	0.004
			TOTAL	19,170	29,541	
			l/s	222	342	

The table below is a summary of irrigation takes (number, allocation and area) and annual demand (average, maximum and minimum) by water source and in total.

Summary of irrigation takes and demand

Element	Water source		Total
	Groundwater	Surface Water	
Take (no)	7	32	39
Allocation (m3/d)	2,350	74,616	76,966
Area (ha)	47	1,463	1,510
Annual (Mm^3/yr)			
Average	0.14	4.24	4.38
Maximum	0.16	5.12	5.28
Miniumum	0.12	3.66	3.77

Appendix D: Summary of average daily and total demand from surface water

The table below presents a summary of average daily demand (ADD) per month and total annual demand for water use categories.

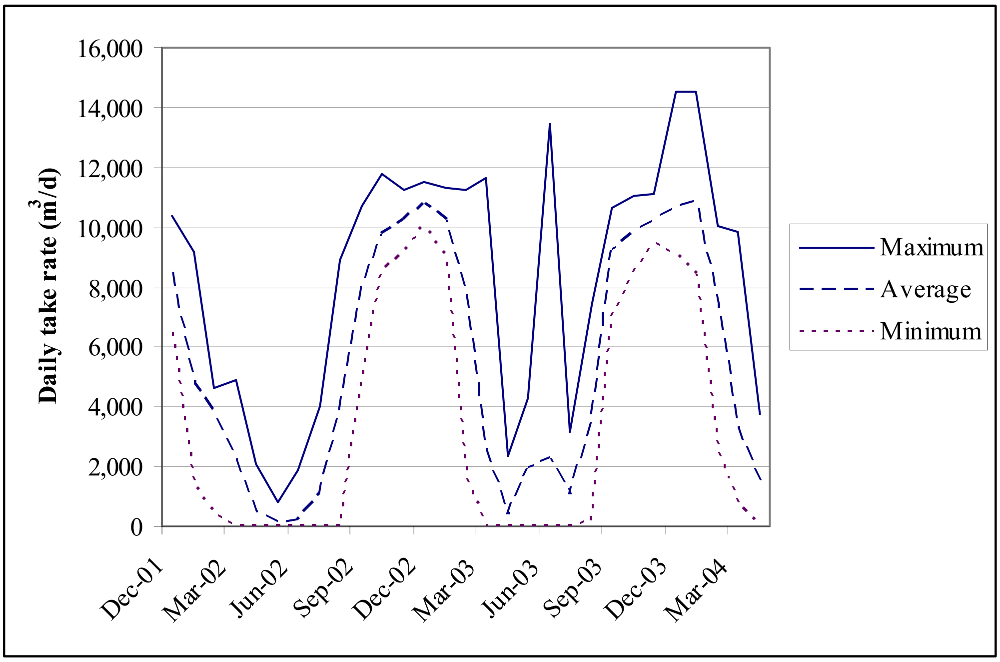
Use Category	Average daily demand (m^3/d)												Total	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mm^3/y	%
Supply network	46,049	44,272	43,206	37,303	33,005	29,999	33,232	36,205	37,448	41,439	41,410	45,229	14.30	14
Irrigation	75,000	75,000	45,000	30,000							45,000	60,000	10.07	10
Industry	12,677	9,639	9,811	3,713	3,532	2,850	4,586	9,175	11,663	12,393	12,177	13,158	3.21	3
Livestock(1)	19,572	18,186	15,787	13,388	9,140	3,229	2,583	10,159	11,912	16,343	16,989	17,635	4.73	5
Total	153,299	147,097	113,803	84,403	45,677	36,077	40,400	55,539	61,024	70,175	115,576	136,022	32.30	32
% utilized(2)	74	71	55	41	22	17	19	27	29	34	56	66	43	

(1) Livestock use from RMA authorised use and permitted takes, assumed to be 75% supplied from surface water
(2) Percent utilization based on cumulative allocable surface water of 207,000 m^3/d

Appendix E: Daily water take and discharge for Anchor dairy factory at Tirau

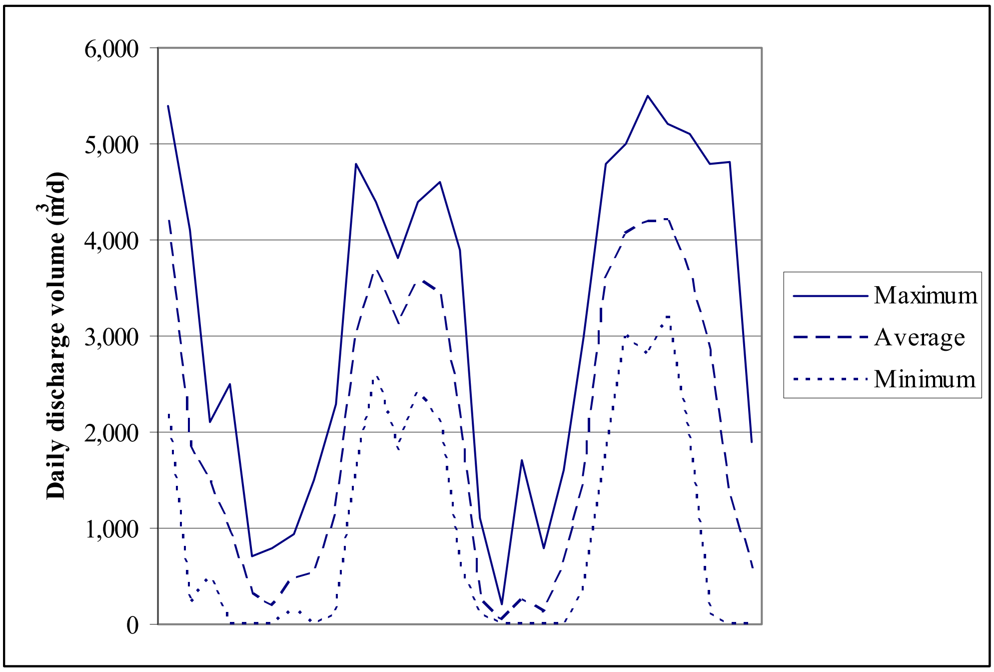
The Anchor dairy factory is the largest consented industrial water take within the catchment (though there are a number of meat processors supplied from supply networks i.e. Richmonds and Inghams). The factory has one consented water take for 20,000 m^3/d (230 l/s) and three consented discharges: 12,000 m^3/d (180 l/s) for cooling water, 8,000 m^3/d (92.6 l/s) for treated wastewater and 30,000 m^3/d for stormwater (1,900 l/s). EW supplied daily water use and discharge volume records for the period Dec 2001 to Mar 2004. This data was used to determine the levels of water use and contribution of discharge to allocable resources.

The figure below is a plot of the daily (maximum, average and minimum) water take (m^3/d) per month. The point to note is the seasonal trend (average), low winter demand and high summer demand commensurate with dairy production.



The figure below is a plot of the daily (maximum, average and minimum) discharge volumes (m^3/d) per month. The points to note are that discharge volumes are lower than the above take rates and the seasonal trend (as would be expected).

To determine the reliable contribution to allocable resource (assuming discharge water quality is consistent with receiving water quality), the maximum take rate was combined with minimum daily discharge volume. The figure presented in the main text (Figure 5) shows that discharges reduced gross water demand by about 20%. It was also noted that maximum daily use was 70% of the consented take.



Daily discharge volume (m³/d)
6,000
5,000
4,000
3,000
2,000
1,000
0
Maximum
Average
Minimum