

Potential for Transfer and Trade of Freshwater Permits

Prepared for

Ministry for the Environment

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Executive Summary

Background

The transferability of water permits (for extraction or discharge) can provide a mechanism for water to be allocated to those that value it most. Transfer or trading independently of transfers of land ownership is enabled by the Resource Management Act (RMA), and some trading is occurring currently. This has the potential to yield net benefits, but in a number of locations there is current over-allocation of water, in which permitted extractions are more than available supplies, defined with reference to ecological or other limits. There is a concern that transfers or trading, while allocating water to high value users, may lead to over-extraction unless there are limits to trading, or the underlying permitted amounts are addressed.

In this context, the work under this project examines:

- the extent to which transfers are (or are not) occurring currently, under existing legislation;
- the necessary conditions for trades to occur and for the benefits of trades to be achieved, including physical/geographical attributes and institutional arrangements;
- what could be done within existing legislation to facilitate trading and/or the achievement of the benefits of trading.

Potential Demand for Trading

The theoretical benefits from water trading have been widely discussed. These are more likely to be realised as levels of demand for water increase and more catchments experience demand in excess of supply. Trading is possible under existing institutional arrangements and the majority of activity to date has occurred in Canterbury. In total, 137 site-to-site transfers of water take permits have been accepted through Canterbury Regional Council since 2007, comprising consented volumes of 35.5million m³ per year (of the 4,991million m³ per year consented in the region).¹ In general, the number of trades and the volume of water traded have increased every year.

Barriers to Trading

A wide range of barriers to the development of a system of tradable water rights have been noted:

- Transaction costs—the current system in which a transfer requires the involvement and approval of the consenting authority, with all the associated costs.

¹ Ignoring water allocated to non-consumptive hydroelectric generation.

- Limited demand—to date there have been relatively few catchments in which demand exceeds supply, but the number is changing over time and demand for trading will increase. This is evidenced by a 33% increase in national weekly water allocation and an 82% increase in land irrigated by consented water takes between 1999 and 2010.² As catchments approach their allocation limits (see Figure 4), new entrants must seek a permit transfer in lieu of a new consent.
- Fears that trading will lead to overuse of water as it releases current permits in catchments which have been over-allocated, ie consented volume is greater than current use;
- The bundling of take and use elements where the environmental risks are different across time, location and in their characteristics;
- Uncertainty over future availability of permits. There are concerns over possible irreversibility of transfers—sellers have no confidence that there will be permits available if they need to acquire them in the future. This leads to more comfort with temporary rather than permanent transfer. This concern has been exacerbated by approaches where the council has “taxed” transfers by removing some allocation amounts at the same time as a resource consent is transferred (to a new site).
- Objections to the strengthening of private property rights in water, particularly from the perspective of Maori.
- Protecting the interests of landowners who have paid for land at a price which includes the value of water rights (some approaches to introducing trading may reduce these existing rights).

Many of these can be overcome through the design of a trading system.

Where Trading Can Work

Trading systems can best work when:³

1. The resource is fully allocated, with demand exceeding supply.
2. There is sufficient knowledge of resource availability and the environmental effects of its use to enable the council to set effective constraints on transfer, and permit holders have certainty as to how those constraints will affect them.
3. Permits are enforceable and monitored, so that permit holders know unauthorised use will be prevented and that those transgressing permit

² Aqualinc (2010) Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes. Prepared for Ministry for the Environment.

³ MfE (1997) Case Study 1: A Case Study of the Oroua Catchment Plan. In: MAF (ed) Transferable Water Permits: Two Case Studies of the Issues. MAF Policy Technical Paper 97/12.

conditions will be detected and penalised.

4. The market for transfer is not constrained and is sufficiently diverse to allow flexibility in transferring permits.⁴

Key Design Elements

Table ES1 summarises the key suggested design elements of trading systems for water quantity and quality.

Table ES1 Summary of Design Elements

Design Element	Quantity Trading	Quality Trading
Definition of rights that define the traded commodity	The right to take water from a water body	The right to discharge a pollutant into a water body
The commodity traded	Groundwater: right to take 1 m ³ per year from a specified groundwater zone Lakes: as for groundwater Rivers, streams: right to take 1 litre/second ^(a)	Groundwater/lakes: right to discharge 1 kg of pollutant per year Rivers & streams: right to discharge a pollutant
Initial allocation	Grandparented on the basis of existing take permits (for duration of current permits) Additional amounts via auction or sale	Grandparented on the basis of existing discharges or discharge permits
New entrants ^(b)	Auction or sale	Auction or sale
Participation	Anyone can hold permits ^(c)	Anyone can hold permits ^(c)
Trading platforms	No need for council or government involvement	No need for council or government involvement
Monitoring and penalties	Metering/monitoring required to protect the value of the permit. Penalties should be higher than the estimated cost of a permit divided by the probability of being caught	Metering/monitoring required to protect the value of the permit. Penalties should be higher than the estimated cost of a permit divided by the probability of being caught

Notes: ^(a) Many rivers and streams have total daily use limits, but it is not clear that this is necessary in addition to a flow limit; ^(b) New entrants can either obtain permits in the market or purchase from the council at a market price. ^(c) This is not a vital component of a design but would tend to increase efficiency.

The Australian experience has suggested that trading for quantity is best limited to systems with high degrees of storage that provide greatest certainty to water flows. In New Zealand groundwater systems appear to provide a greater level of volume certainty and appear to be the most suitable for trading.

Take and Use Unbundling

Bundling take and use components of water permits can unnecessarily complicate transfers where the impacts are widely separated in time, space or characteristics, eg in-

⁴ Diverse in this sense refers to a range of buyers and sellers looking to trade permits. A broad range of uses for water, and a cross-section of farms with competing water requirements represent a diverse marketplace for water in New Zealand.

stream impacts related to volume reductions compared with water quality impacts of non-point discharges following use. In some instances the level of impact of one part of the take-use combination can be insignificant compared to the other. However, bundling these elements is not required under the RMA; it is more a historical practice or habit that has not been sufficiently challenged.

Separating use from take allows the different impacts to be managed separately, including through separate rules setting bounds on tradability or for the use portion to be broadly permitted for environmentally safe uses, and consent given for controlled uses. Such a division yields greater flexibility for the transfer of the take permit within a groundwater zone or a defined river catchment area.

We believe that the separation of take and use components, and the development of trading of take permits, offers the most promise.

Use permits are not so much rights to use water as rights to produce a set of effects related to water use. These might be developed as separately tradable commodities within limited geographical areas.

For quality trading, the successful development of trading systems already in New Zealand suggests that this has considerable promise also. Because these systems are dominated by non-point discharges they rely on modelling of discharges.

Government Involvement

The US experience with the development of trading systems for NO_x, and most recently for multiple pollutants, is that of the national (federal) government producing model rules that States can adopt or modify to implement trading systems. This appears to be a useful role for the government in the development of water trading; a point that is also raised by Hawke.⁵ There are formal approaches for achieving this, such as via a National Policy Statement (NPS) but this is not necessary. It can remain a guidance document.

Particular issues that might be covered by such a document would include:

- the definition of the traded commodity or commodities. This could include advice relating to
 - the division of permits into take and use;
 - the divisibility of permits over time and volume;
- advice on approaches to initial allocation and renewals.

The nature of such a document would be a discussion of issues and examples of how regional rules might be written.

⁵ Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09.

There is often a tendency for governments to over-design trading systems and to provide elements or rules where these can be provided more efficiently and effectively by the private sector, eg the development of trading platforms. Systems are developing currently via HydroTrader and local estate agents. In addition, because trades are local rather than national in scope, ie they are geographically highly limited, a national register is not likely to be a suitable level at which to aggregate information.

1 Introduction

1.1 Background

The transferability of water permits (for extraction or discharge) enables water to be used by those that value it most. Transfer or trading independently of transfers of land ownership is enabled by the Resource Management Act (RMA), and some trading is occurring currently. This has the potential to yield net benefits, but in a number of locations there is current over-allocation of water, in which permitted extractions are more than available supplies, defined with reference to ecological and other limits. Transfers or trading, while allocating water to high value users, may lead to over-extraction unless there are limits to trading, or the underlying permitted amounts are addressed.

In this context, the work under this project examines:

- the extent to which transfers are (or are not) occurring currently, under existing legislation;
- the necessary conditions for trades to occur and for the benefits of trades to be achieved, including physical/geographical attributes and institutional arrangements;
- what could be done within existing legislation to facilitate trading and/or the achievement of the benefits of trading.

In this report we use transfer and trading of water reasonably interchangeably. It refers simply to the ability to shift the ownership of a water permit from one person to another. There is a separate issue of the extent to which councils are involved in approving such transfers/trades, but this can be on somewhat of a continuum from those in which it is reasonably automatic (pre-approved) to those for which the council must approve all aspects of the transfer.

1.2 Context

The recently produced national policy statement on freshwater management⁶ notes the importance of fresh water to New Zealand's economic, environmental, cultural and social well-being. It notes New Zealand's comparative advantage in primary production, tourism, and energy generation as a result of the levels of supply of fresh water, alongside its importance to recreation, biodiversity, natural and cultural heritage.

In this context, the efficient allocation of water is a key objective so that well-being is maximised to the extent possible under resource constraints. This is achieved through water being allocated to its highest value uses. Water trading has an important potential role in achieving this.

⁶ New Zealand Government. National Policy Statement Freshwater Management 2011. Issued by notice in the Gazette on 12 May 2011.

2 Water Allocation and Gains from Trade

2.1 The Issues Covered

In this section we:

- provide data on levels of allocation and use of water in different regions;
- examine theoretical issues to do with efficient allocation and the potential gains from trade;
- review the value of water use in different activities as a basis for estimating the expected trading price and the potential gains from trade.

2.2 Current Water Allocation Levels

There are a number of difficulties in summarising the use of water in New Zealand:

- more data are available on consents for water than for actual consumption, largely because of the absence of metering in many applications prior to the introduction of metering regulations;⁷
- hydro-electricity is a significant user of water but generally it neither consumes nor degrades the water;⁸
- percentage use rates differ between daily, weekly and annual cycles.

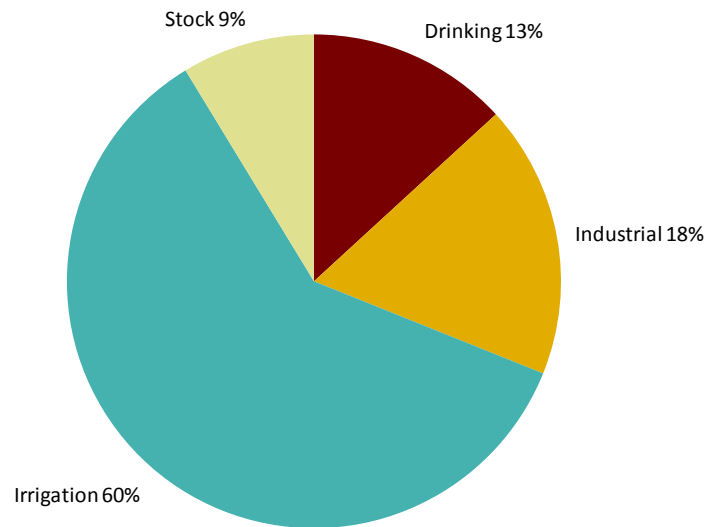
2.2.1 Uses of Water

In Figure 1 we show the annual percentage of consumption by different consented uses apart from hydro electricity on the basis of estimates of actual use. The major uses by volume are irrigation, industrial, drinking water (a category that includes all domestic use, eg including washing, gardening etc) and drinking water for livestock farming (stock).

⁷ Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

⁸ According to Aqualinc (2010) one hydro scheme in Southland uses it and then diverts the water directly to the sea, effectively making it unavailable.

Figure 1 Distribution of Non-Hydro Consumptive Allocation

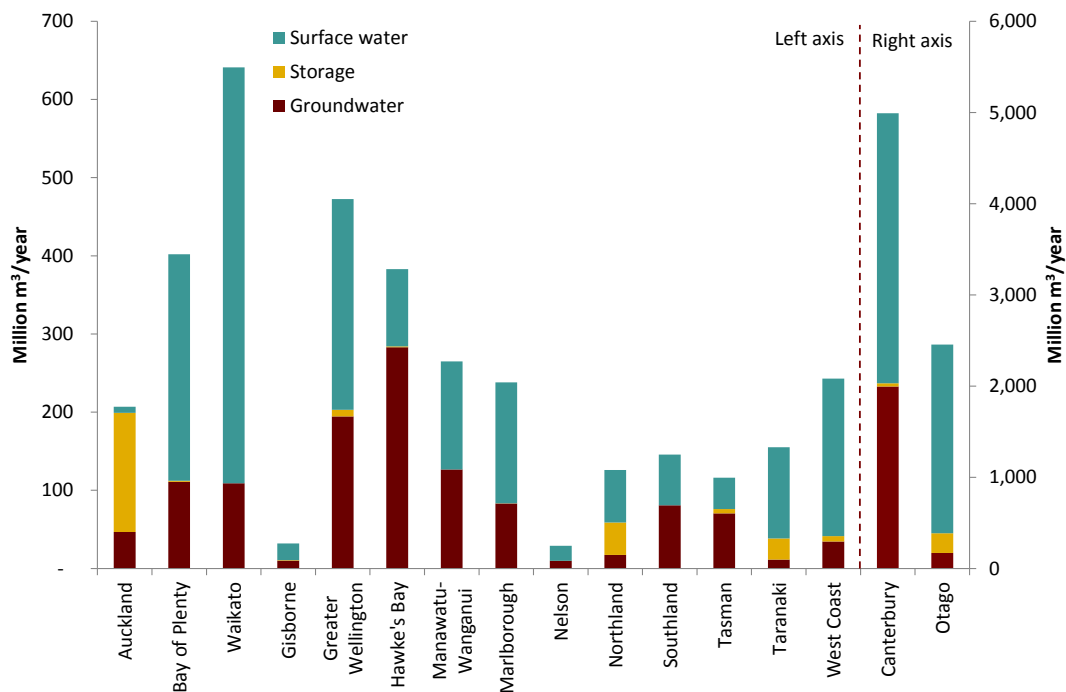


Source: Data from Aqualinc (2010) Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes 2009–10

2.2.2 Where it is Used

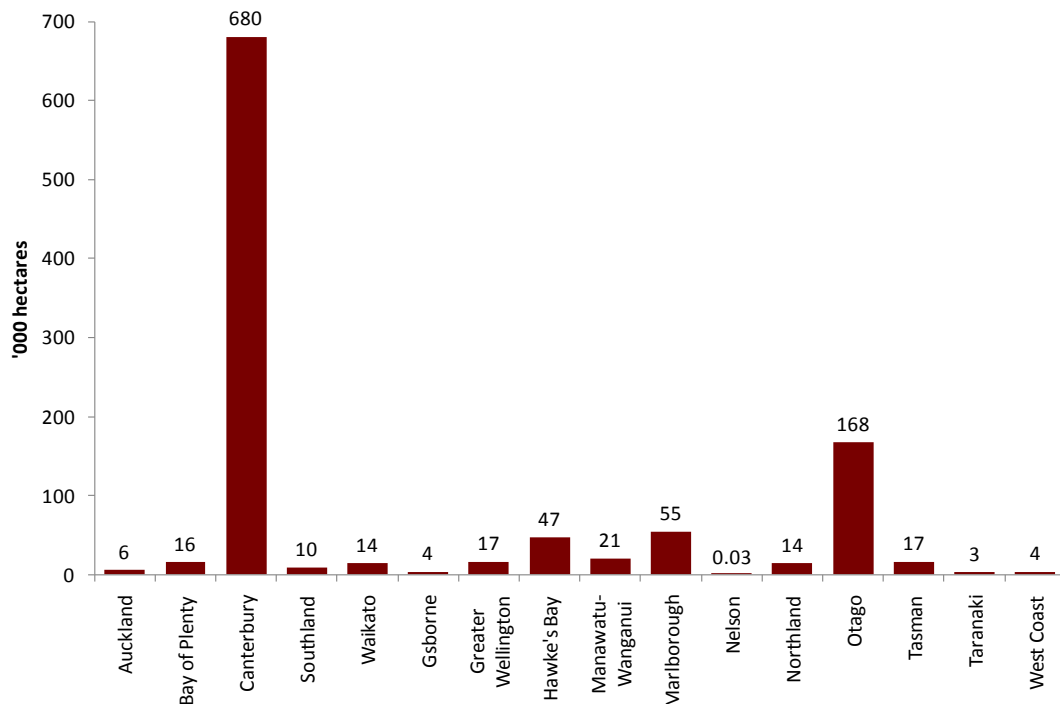
Levels of use vary widely by region as illustrated in Figure 2. Very large volumes are used in Canterbury and Otago, particularly because of the sizes of the areas that are irrigated (Figure 3).

Figure 2 Annual Water Allocation for Non-Hydro Consumptive Use by Region and Source



Source: Aqualinc (op cit)

Figure 3 Area Consented for Irrigation by Region



Source: Aqualinc (op cit)

2.3 Levels of Over-Allocation

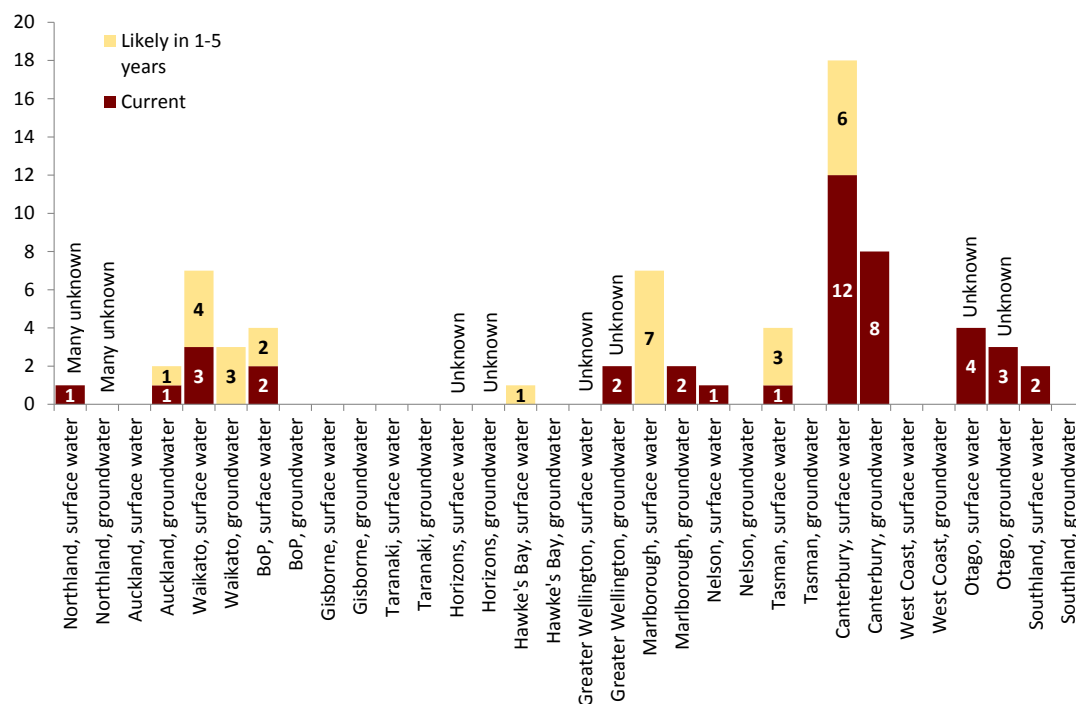
Figure 4 provides some estimates of the extent of over-allocation currently or in the near future. The text additions (“many unknown” and “unknown”) refer to over-allocations in 1-5 years time. The data and estimates are at the catchment level. Aqualinc define a catchment as fully allocated when all of the water that has been set aside for taking has been allocated to persons through:

- (a) the granting of consents to take water; and/or
- (b) conferring permitted activity status on water takes through plan rules.⁹

This is somewhat of a simplification as it is not clear that the latter will inevitably result in overuse and it will not result in new entrants not being able to take water. It has been a pragmatic approach in the absence of more detailed information on use.

⁹ Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

Figure 4 Fully- or over-allocated catchments (number of catchments)



Source: Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development

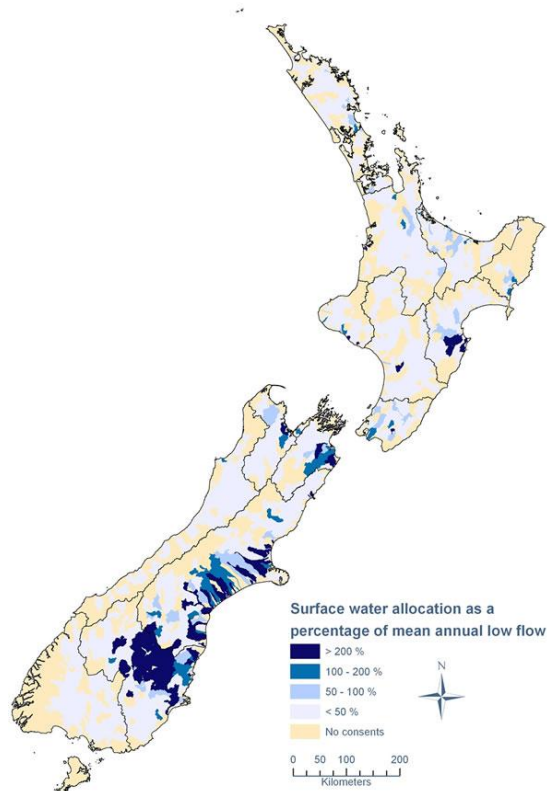
Canterbury is the area with most fully or over-allocated catchments, both for surface and groundwater. The other most significant regions are Marlborough, Otago, Tasman and Waikato. These are all regions in which there is emerging interest in trading schemes.

The other point illustrated by the graph is that the extent of full or over-allocation is increasing. It suggests that there will be more catchments over time in which demand for water exceeds supply and in which there will be potential benefits from trading (see below).

Figure 5 and Figure 6 show the degree of allocation for surface and groundwater respectively, noting the major catchments that are fully allocated, and those greater and less than 75% allocated (the groundwater chart shows only those over 75% allocated).

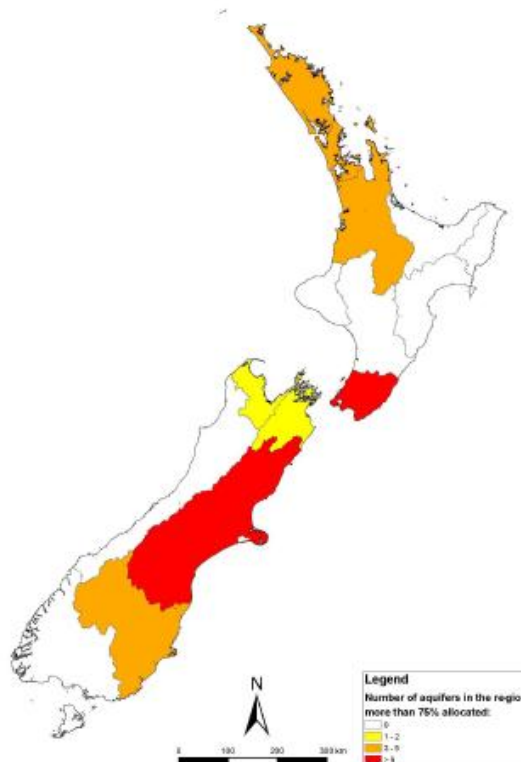
Currently, in areas where there is over-allocation, consent conditions enable Councils to ration available supplies during times of drought. The approach adopted may be to scale back the level of allowed takes on a proportional basis or reflecting some local (planning) priorities rather than relative value (willingness to pay).

Figure 5 Surface water allocation (consented) pressure by major catchment



Source: Ministry for the Environment (www.mfe.govt.nz/environmental-reporting/freshwater/demand/resource.html)

Figure 6 Groundwater allocation by region



Source: Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development

2.4 Theory – Efficient Allocation

2.4.1 Efficiency as Maximising Well-being

Economic theory suggests that competitive market transactions can result in efficient allocation of resources. As with other uses of the term “efficiency”, the meaning in economics is of there being no waste. Efficient allocation of a resource means that it is allocated to those that value it most. When we are examining this from a societal perspective we mean that it is allocated to the uses that provide the greatest well-being to society as a whole. Well-being refers to the total benefits that people obtain from all that they value, including but not limited to consumption of goods and services, participation in individual or communal activities, their environment, health and overall contentment with their life and actions; it includes economic, social environmental and cultural values. Waste would occur where the allocation resulted in the loss to society of some potentially available well-being, but efficient allocation occurs when water is producing the greatest possible well-being.

Competitive markets can produce an efficient allocation of a resource because market participants express the extent to which they value the resource through bid prices. Thus, in some theoretically competitive market for water, all potential users of water could express their willingness to pay for water across all time periods and the highest bidders would be allocated the water for extractive or in-stream use (including to discharge into). Below we explore: (1) the definitions of efficiency and (2) the significance of the potentially missing market participants.

2.4.2 Types of Efficiency

Economists define economic efficiency in different forms. Of key interest here is:

- **allocative efficiency** under which all resources are allocated to their highest value uses, ie those that produce the most well-being, as discussed above. Trading would allow this to occur to some extent, although it is limited to those users that would be able to participate in a market (see Section 2.4.3 below);
- **productive efficiency**, ie that resources are used efficiently in productive processes. The ability to trade water permits would provide incentives for productive efficiency because increasing water efficiency could allow users to sell excess permits or reduce their requirement to purchase them. In this way, water use has an opportunity cost – by using water, permit holders lose the opportunity to sell water permits;
- **dynamic efficiency** — consumption and investment patterns maximise total well-being over time. This introduces a time dimension to the consideration of efficiency and may have implications for the duration of allocations and their specification.

- Where the highest value requires investment in infrastructure, eg pipes and pumps, users will require some certainty of access to the resource into the future; and
- Where available water is variable with time, the quantity allocated to any user may need to vary over time also.

The theory is relatively clear: well-defined rights and the ability to trade can increase all forms of efficiency (qualified by the limitations that include those to the achievement of allocative efficiency as discussed above). In this report we focus on practical aspects of achieving these efficiency gains.

2.4.3 Non-market values

We discuss the different values associated with the use of water in Section 2.6 below. This includes non-market values, ie those that are not expressed in a market or cannot readily be estimated using market values. Currently allocation of water to produce these values is achieved largely through limits to extraction of water or to discharge; these limits protect the quantity and quality of water in a water body. Water trading systems, particularly those relating to quantities of takes, can achieve more efficient allocation of the excess water above these limits. However, they are limited to finding the highest value users amongst those expressing a market value of water and do not enable additional allocation to those that have values not readily expressed in a market.

- The environmental limits do not define the total non-market value that can be obtained from the resource (more water might produce more value).
- Having environmental limits does not suggest that the non-market values that they protect are greater (produce more well-being) than the market values of water that might be obtained if the limits were breached.

Thus water trading is limited in its ability to achieve optimal allocation of water in the sense of maximising potential well-being. However, it can improve efficiency within the constraints of the system of environmental limits.

MfE and MAF¹⁰ make a similar point, noting that transfer or trade may facilitate the achievement of the most valued economic uses but might not lead to the highest total value, ie taking account of the social, cultural and environmental values.¹¹

Aqualinc suggests that councils take a risk-avoidance approach to managing the environmental effect of taking water and in the setting of limits on take.¹² They suggest this may not be appropriate for a fully allocated catchment where there is a clear trade-off between economic uses of water and in-stream values protected by the limits. They also note the disadvantage of bundling up all the in-stream values under an

¹⁰ Now the Ministry for Primary Industries (MPI).

¹¹ Ministry for the Environment and Ministry of Agriculture and Forestry (2004) Water Programme of Action. Water Allocation and Use. Technical Working Paper.

¹² Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

‘environment’ label, rather than recognising quite significant differences and the potential for some (eg water recreation) to be more readily traded-off with other potential uses of water than others (eg protection of aquatic ecosystems).

These issues are relevant to the definition of limits rather than to trading per se, but they do provide some constraints on the extent to which trading can achieve efficiency gains.

2.5 Requirements for Achieving Efficiency Gains

For there to be an efficiency gain from the development of a market, there has to be excess demand for water in a catchment. If a resource is not priced (or has a zero price) and demand for that resource is less than available supplies, that resource is not scarce. Establishing a market would not improve efficiency where currently a potential user can obtain additional supplies without reducing the amount available to others.

Aqualinc has noted that current water allocation management results in low allocation efficiency, because “much of the water allocated for taking is not used, and potential new users are not able to access this water”.¹³ Thus in some catchments there may be excess supply but some users or potential users of additional water are unable to obtain additional supplies because of institutional barriers.

In Table 1 we summarise four options made up of combinations of the balance between demand and supply, and between allocation and supply. It notes the potential benefits from trading.

Table 1 Demand-Supply Options and the Benefits of Trading

	Allocation ≥ Supply	Allocation < Supply
	(1)	(2)
Demand > Supply	Trading can increase efficiency by enabling redistribution of consents	Trading can increase efficiency by: (i) enabling redistribution of current consents and (ii) ensuring new consents are allocated to those that value them most
	(3)	(4)
Demand < Supply	Trading can increase efficiency by enabling redistribution of consents. But regulatory solutions can work also.	No benefits from trading.

Trading can improve efficiency when **demand for water exceeds available supply**, but there are two possible cases:

1. **Allocation may exceed or equal supply.** In these circumstances a new entrant with a high value use of water cannot obtain a water use consent, unless it waits until the end of the existing consent period, and even then they are unlikely to obtain a permit unless the current holder does not reapply. Trading might allow new entrants to purchase consents from those that value water less.

There is a risk that trading can lead to the realisation of the problem of demand

¹³ Aqualinc (op cit).

exceeding supply that might be masked by current over-allocation. For example, total demand may exceed supply, but incumbent permit holders may have more permits than they need such that actual consumption is less than available supply. We explore this issue in more detail in Section 4.4.

2. Where **allocation is currently less than supply** but there is excess demand, eg as a result of new entrants, new parties can obtain consents from council. However, in the absence of trading this is likely to be on the basis of first-come-first-served rather than on the basis of who values the water most. Trading systems (or water markets) can be used to ensure that water is allocated to:
 - the highest value new entrants by using auction systems or by placing consents into an exchange or other market; or
 - the highest value new and existing users by making all permits readily tradable.

Sometimes trading can improve efficiency with which water is allocated, even when **demand is less than supply**:

3. Where **water is fully allocated** but those with allocations use less water than they have consents for, making permits tradable can enable efficiency gains through redistribution of existing consents. This enables productive use of water that is currently not being used, despite consents for take and use. However, there are non-trading options that can also improve efficiency, eg through clawing back unused allocations.
4. Where **available supplies of water are not all allocated** and total demand is less than supply there is no allocation problem and trading systems will have no benefits. The benefits are only realised when allocation reaches a level at which there is insufficient available supply to meet the requirements of the next person wanting a water permit.

Thus there are two potential issues that are relevant to defining the benefits of trading:

- Physical – levels of demand (at zero price) compared with available supply; and
- Institutional – levels of allocation compared with total demand and available supply. We note Aqualinc’s analysis that only 30-80% of water use allowed in consents is actually used.¹⁴ This will reflect a number of issues, including seasonal demand and over-allocation, but it can mean that a user with one pattern of seasonal demand might have surplus when another potential user with a different seasonal pattern cannot obtain supplies. Aqualinc also notes that the Australian (and Chile and US) experience in water trading was that much of the early gain from trading was the uptake of water that was previously allocated but not used.

¹⁴ Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

The benefits of trading need to be considered in the light of both of these issues.

2.6 Value of Water in Different Uses

The potential gains from trade depend on the relative value of water in different uses, including non-use (eg where a potential user cannot obtain a permit despite there being excess supply). Where there are large differentials in value the potential gains from trade are large also. In this section we examine the values associated with water use.

The National Policy Statement (NPS) for Freshwater Management defines direct uses of water (Table 2) that include extractive and in-stream uses, and other values of water (Table 3). Current institutional arrangements protect many in-stream values of water using low-flow limits or minimum water levels. Allocation of water to users is restricted to surplus amounts.

Table 2 Uses of Water

• Domestic drinking and washing water • Animal drinking water • Community water supply • Fire fighting • Electricity generation • Commercial and industrial processes	• Irrigation • Recreational activities (including waka ama) • Food production and harvesting eg, fish farms and mahinga kai • Transport and access (including tauranga waka) • Cleaning, dilution and disposal of waste
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Source: National Policy Statement for Freshwater Management 2011

Table 3 Examples of Other Values of Water

• The interdependency of the elements of the freshwater cycle; • The natural form, character, functioning and natural processes of water bodies and margins, including natural flows, velocities, levels, variability and connections; • The natural conditions of fresh water, free from biological or chemical alterations resulting from human activity, so that it is fit for all aspects of its intrinsic values;	• Healthy ecosystem processes functioning naturally; • Healthy ecosystems supporting the diversity of indigenous species in sustainable populations; • Cultural and traditional relationships of Maori with fresh water; • Historic heritage associations with fresh water; • Providing a sense of place for people and communities
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Source: National Policy Statement for Freshwater Management 2011

To ensure that the in-stream values of water are protected, the NPS requires regional councils to “establish freshwater objectives and set environmental flows and/or levels”. Environmental flows and/or levels are defined as “a type of limit which describes the amount of water in a body of fresh water ... which is required to meet freshwater objectives”. They must include an allocation limit and for rivers and streams, a minimum flow (or other flow/s), and for other water bodies a minimum water level (or other level/s). Water must then be allocated efficiently within these limits.

In a similar way, to protect water quality, regional councils must set limits, and the NPS directs regional councils to impose conditions in discharge permits to ensure the water quality limits and targets can be met.

As a result of these requirements, the potential for water transfers and trading is limited to the available supply of water that is not required to meet quantity and quality limits and to protect the values set out in Table 3. This means that the potential for

improvements in allocation efficiency are limited largely to extractive uses of water quantities and to discharges. However, there will be an impact on in-stream values when transfers and trading leads to additional out-of-stream use of water for resources that are currently allocated but not used. This is an important potential consequence of trading. We address it specifically in Section 4.4.

2.7 In-stream values

Table 3 above noted a number of in-stream values of water, plus there are other in-stream uses of water that include fishing and navigation. Despite environmental limits, in the form of low-flow limits and minimum water levels, being used to protect these values, in many instances there will be additional water (and water quality) in rivers that is beyond that required to protect these values. In these instances, allocation of this water to extractive uses reduces the extent to which water contributes to these in-stream values. In other words, total in-stream values can increase with more water in the river.

Recent analysis of existing monetary data for these non-market values¹⁵ suggests that there is a range of monetary data available but not in a form that can be readily compared with the data for extractive uses. For a range of uses (irrigation, stock water etc) we have defined values per m³ but the non-market data are expressed in terms that include the value of a day's fishing or of being able to swim, but not in a way that attributes value to an additional cubic metre of water in a river. It may be that, above some low level at which these values obtain, there is little marginal value for additional volumes. However, this appears not to be well-researched. Thus, current values cannot be used to define the cost (reduction in in-stream values) of allocating additional water to extractive uses.

2.8 Potential Gains from Trade

In Annex 1 we bring together data on the value of water in different uses as an input to a discussion on the potential gains from trade. Table 4 presents headline results from the analysis. We use these values below in a discussion of expected trading prices and potential gains from trade.

Table 4 Summary of estimated values of water in different uses

Use	Value (\$/m ³)
Irrigation	0.1 - 1
Stock water	10 - 25
Hydro electricity	0.002 - 0.05
Industry	1 - 100

Using these numbers to estimate the potential price of water permits would suggest that, given the importance of irrigation to total water use and that this is likely to dominate any water market, prices would be in the range of water values for irrigation, ie \$0.10-1/m³ reflecting differences in location and type of agriculture.

¹⁵ Covec (2011) Gap Analysis of Freshwater Economic Valuation Information. Report to Ministry for the Environment.

The actual value of trade depends on what would have happened otherwise, ie the counter-factual. Transfers or trade might result in changes in:

- **Use**, including
 - transferring water that would otherwise be supporting in-stream values to some extractive use (or hydro electricity);
 - changing the extractive use, eg from stock water to irrigation or industrial use;
- **Location**, eg from one farm to another;

There is value in changing water from no use to use, or from one specific use to another. There will be value also in transfers between landowners using water for the same thing, eg one kiwifruit orchard to another. In these circumstances the value of the trade will be some proportion of the water price.¹⁶

As noted above, irrigation use is dominating the trading of water permits, and we would expect that the values of water in irrigation will set the price of water use permits. We understand that the average value of permits sold by Hydrotrader in Canterbury is approximately \$0.90/m³/year, equivalent to approximately \$0.08/m³,¹⁷ similar to an estimate of \$0.07-0.08/m³ for entitlements in the Mackenzie Basin.¹⁸

2.9 Maori Values in Water

Under Section 6 of the RMA the relationship of Maori with water is noted as a matter of national importance that should be recognised and provided for “by all persons exercising functions and powers under the Act, in relation to managing the use, development, and protection of natural and physical resources”.

MfE and MAF published a report in 2005 of the results of consultation with iwi and hapu groups, in addition to individual Maori, as an input to the Sustainable Water Programme of Action.¹⁹ The feedback suggests that there are distinct values pertaining to water (eg as noted in Table 3 above). However, of specific concern relating to water transfers and trading:

- The concerns of Maori are with process, not just outcome—there is a desire to be involved in decision making with respect to water management. This could lead to friction in water trading markets if Maori involvement extends to decisions on

¹⁶ To the extent that trade in water leads to an increase in total economic output, there will be additional consumer and producer surplus in some other markets. For example, if trading allows more output of milk, the sales of milk will generate income for farmers and, in turn, additional consumption. This will have associated consumer surpluses (benefits from the consumption may be more than the price paid) and producer surpluses (the costs of production may be less than the price received if they are not marginal producers).

¹⁷ Over 30 years at an 8% discount rate.

¹⁸ Ian Brown Consulting and Harris Consulting (2005) Environmental, Economic and Social Impacts of Irrigation in the Mackenzie Basin. Report to the Ministry for the Environment.

¹⁹ Ministry for the Environment (2005) Wai Ora: Report of the Sustainable Water Programme of Action Consultation Hui.

individual transfers as opposed to wider policy relating to trading markets and/or to the definition of limits that define the tradable amount.

- There is concern if the establishment of trading markets leads to the strengthening of property rights in water, ie if it edges towards private ownership of water as opposed to possession of entitlements to use water for a limited period. We examine below whether developing a trading system requires the strengthening of rights.

3 Institutional Arrangements for Allocation and Transfers

3.1 Current Allocation Arrangements

3.1.1 Water Use Must be Permitted

The RMA states that it is not possible to own the underlying resource (water) but that the Crown asserts the rights to manage the resource on behalf of everyone.²⁰ This is reinforced by the creation of offences under Section 14 to take, use, dam or divert water (other than coastal water) unless it is expressly allowed by:

- a national environmental standard;
- a rule in a regional plan or in a proposed regional plan; or
- a resource consent.

According to Section 14(3) (b) this does not apply if it is being taken or used for an individual's reasonable domestic needs or the reasonable needs of an individual's animals for drinking water, and the taking or use does not, or is not likely to, have an adverse effect on the environment.

Typically water, beyond environmental baselines, is allocated to users by the consent process. Section 122 states that water and discharge permits are neither real nor personal property. Despite this, resource consents define some rights pertaining to the use of water; a water permit confers a right to take, use, dam and/or divert water, subject to its availability. It does not constitute ownership of the resource and does not provide a guarantee that water is available.²¹ Consents are individual permits with conditions attached that grant their holder a personal right to use water.²²

3.1.2 Allocation on First-Come-First-Served Basis

Permits tend to be allocated on a first-come-first-served basis, although this is more a result of case law with courts inferring a Parliamentary intention to proceed on a “first-come-first-served” basis.²³ McGregor notes that the “‘first-in-first-served’ line of authority has continued to be applied and developed by the Courts to situations of competing applications for a limited or finite resource”.

MfE and MAF have noted that “when the amount of water already allocated from a catchment comes close to the allocation limit, then there is the potential for ‘goldrush’ situations which exacerbate the problems with first-in first-served.”²⁴

²⁰ Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09.

²¹ Ministry for the Environment and Ministry of Agriculture and Forestry (2004) Water Programme of Action. Water Allocation and Use. Technical Working Paper.

²² McGregor D (undated) Water Allocation and Trading – A New Zealand Perspective. Bell Gully.

²³ McGregor D (op cit).

²⁴ Ministry for the Environment and Ministry of Agriculture and Forestry (2004) Water Programme of Action. Water Allocation and Use. Technical Working Paper.

The 2005 amendments to the RMA confirmed that Councils can preferentially allocate water to activities via regional plans, but this begs questions of how this is done, especially when balancing economic values expressed in a market with non-market values.

3.1.3 Permit Renewal

There is no right of renewal for a consent, so on expiry a new resource consent must be applied for unless a condition in the plan or resource consent states otherwise. Section 124 provides some protection for the holder of a consent that is due to expire during the process of applying for a resource consent. Although there is no guarantee for the renewal of a water permit, to date it has been customary for this to occur.²⁵

Section 104(2A) notes that, for applications for permit renewal, the council as consent authority must have regard to the value of the investment of the existing consent holder. In making such an assessment, the council must consider, *inter alia*, the efficiency of the person's use of the resource (Section 124B) unless they state in a regional plan that these provisions do not apply, or if they create an allocation plan for the resource (Section 124A). This implies that there is a requirement to consider whether the existing user requires all of the water allocated.

3.1.4 Cancellation for Non-Use

Permits can be cancelled by a regional council if not exercised for a continuous period of five or more years (RMA Section 126).

3.1.5 Over-allocation and Drought

There are different problems relating to water shortages in the short and long terms. Over-allocation is a long-term problem where the amount of water allocated to extractive use is greater than average quantities available if meeting environmental limits. These problems last for the duration of existing consents. In contrast, there may be short-term problems relating to droughts.

Where water is over-allocated with respect to environmental limits, councils must reduce allocated amounts. Allocated take volumes can be reviewed upon renewal of consents through a condition of the permit, or during the process of transferring permits. For example, the proposed Draft Canterbury Land and Water Regional Plan includes a rule that transferral of permits in over-allocated catchments must include a surrender of a proportion of the allocated water.²⁶ This introduces a cost to transfers and thus a barrier to trading; it can limit the potential net benefits of establishing a trading system.

In comparison, low rainfall levels can lead to more transitory stress on available volumes of water. Environment Waikato assesses the risk of drought defined as an

²⁵ Beech K (2006) The Use of Tradeable Water Rights in New Zealand. A dissertation submitted in partial fulfilment of the requirements of the degree of Bachelor of Laws (Honours) Faculty of Law University of Otago, Dunedin.

²⁶ Environment Canterbury (2012) Draft Canterbury Land and Water Regional Plan. Section 4.70.

above average rainfall deficit.²⁷ Although consented abstractions may be within formal limits, low rainfall can lead to a supply shortage because of low flows. Councils can scale back water takes in the short term through minimum flow conditions in consents, or regional level restrictions (consents often contain a clause regarding compliance with regional rules).

Rationing can be used during periods in which water flows fall close to environmental limits.²⁸

We examine the issue of over-allocation more in Section 4.4.

3.2 Transfers

3.2.1 Water Quantity

Water rights are not tied to land titles in any legal sense. They belong to a person or other entity independent of land ownership. However, the usual way in which transfers occur is at the same time as changes in land ownership; the permit is transferred to the new owner of the property. When this happens the value of the water right is capitalised in the value of the land.

Under Section 136 of the RMA, rights to take, use, dam or divert water can be transferred separately from the land. The restrictions are shown in Table 5.

- Consents to take or use water can be transferred in whole or part to a new owner or occupier of the current site;
- Consents to dam or divert water can only be transferred as whole permits to the new owner or occupier of the site and not to a different site.

Table 5 Transfers Allowed under the Resource Management Act, Section 136

	New owner or occupier of same site	Person on another site
Taking or Using	Whole or part	Whole or part
Damming or Diverting	Whole only	Not allowed

The different activities are not defined in the RMA but are generally taken to mean:

- Take = abstraction or removing of water from a water body;
- Use = the final action taken with the water following its removal, eg irrigation or use as stock water;
- Dam = impounding surface water with any structure, although this does not include tanks or drains;
- Divert = altering the natural course of water flows or natural flow patterns.

²⁷ Environment Waikato (2000) Water Shortage Risk Mitigation Plan. Policy Series 2000/31.

²⁸ Ministry for the Environment and Ministry of Agriculture and Forestry (2004) Water Programme of Action. Water Allocation and Use. Technical Working Paper.

Transfers of take or use permits can only be transferred to another site if both sites are within the same catchment, aquifer, or geothermal field. The transfer can happen if it:

- (i) is expressly allowed by a regional plan; or
- (ii) has been approved by the consent authority that granted the permit, taking account of matters set out in Section 104 including the effects on the environment.

Amendments to the RMA in 2005 introduced a clause that allows for transfers to be for a limited period only.

The impacts on the environment include localised effects relating to ground water takes which might affect any shift in location, and impacts on surface water, particularly associated with shifting the take location upstream. The impacts of water use are separated in space and time from the impacts of take, and this has led to discussion over the separation of the two components.

3.2.2 Water Quality

Section 15 of the RMA prohibits the discharge²⁹ of any contaminant into water unless expressly allowed by a National Environmental Standard (NES), regional plan, or discharge permit. The transfer of discharge permits is controlled under Section 137.

Transfers can be:

- of whole or parts of a permit;
- to a new owner or occupier of the current site or to a new site.

Transfers to a new site can happen where a regional plan:

- allows the transfer; or
- allows the holder to apply to the consent authority that granted the permit to be allowed to make the transfer.

However, a transfer can only happen if:

- it does not worsen the actual or potential effect of any discharges on the environment;
- it does not result in any discharges that contravene a national environmental standard; and
- both sites are in the same catchment.

3.2.3 Regional Plans

Permit transfers which are not explicitly sanctioned by the RMA can only take place if they are permitted by a rule in the local regional plan, or otherwise approved by the regional council. The National Policy Statement (NPS) for Freshwater Management 2011 requires consent authorities considering applications for permit changes to have regard to adverse effects on the life-supporting capacity of the ecosystem³⁰.

²⁹ Defined under Section 2 of the RMA to include: emit, deposit, and allow to escape.

³⁰ Ministry for the Environment (2011) National Policy Statement for Freshwater Management 2011. Policy B7.

Where a transfer does not comply with a regional rule, or there is no such rule, it is subject to the full resource consent process. This process requires an assessment of environmental effects, involves larger fees, and can be subject to public notification or a hearing. Factors considered in deciding whether to allow a transfer include:

- Efficiency of the proposed take;
- Priority levels during water shortages;
- Measures to mitigate adverse effects of water takes and intake structures;
- Effects of the activity on tangata whenua and taonga;
- Effects on existing users, including generation;
- Regard to appropriate regional policy, rules and standards.

Consenting authorities with a regional rule expressly permitting the transfer of water permits are:³¹

- **Bay of Plenty Regional Council:** Transfers are allowed, but there must be no increase in the rate or volume of water taken from upstream of the Hydroelectric Power Schemes as a result of the trade. Water may be used on another property, provided this activity complies with the conditions of the consent, and permission is given by the permit holder,³²
- **Hawke's Bay Regional Council:** Transfers of take permits are permitted if they are for a lake and are to another location in the same lake. Within the same aquifer or stream management zone, transfers are a controlled activity provided there is no adverse effect on lawfully established users or reduction in flows/recharge.³³
- **Horizons Regional Council:** Established the Oroua Catchment Water Allocation and River Flows Regional Plan (OCWA) which contains rules to allow the transfer of water permits in the Oroua River and Kiwitea Stream during period of low flow, alongside other requirements to apportion limited flows, restrict and suspend abstractions.³⁴
- **Taranaki Regional Council:** Policy 6.1.9 allows the transfer of the whole or any part of a permit to take water, to any owner or occupier of any property provided that "(a) the transfer occurs within the same catchment; (b) the transfer is consistent with the objectives and policies of this Plan; (c) the transfer does not result in a flow that is below any prescribed minimum flow; (d) there are no significant adverse environmental effects from the transfer."³⁵

³¹ Permitted activities may be carried out so long as they comply with the RMA.

³² Bay of Plenty Regional Council (2011) Regional Water and Land Plan, Chapter 5: Table 14 & Method 160.

³³ Hawke's Bay Regional Council (2006) Regional Resource Management Plan. Chapter 6: Regional Rules, Rule 6.7.3.

³⁴ Horizons Regional Council (2003) Land and Water Regional Plan. 3.2 Oroua Catchment Water Allocation and River Flows Regional Plan.

³⁵ Taranaki Regional Council (2001) Regional Fresh Water Plan. 6. Resource issues in the Taranaki region.

- **Waikato Regional Council:** Transfer of surface and groundwater take permits is permitted, subject to usual conditions.³⁶
- **West Coast Regional Council:** Transfers downstream within the same river are permitted.³⁷

Some of the resulting transfers and transfer mechanisms are described in more detail below (Section 3.3).

The Freshwater NPS requires regional councils to state criteria for approval of transfers of water take permits “to improve and maximise the efficient allocation of water”,³⁸ some regions have not yet notified plans with such rules (reflecting the short time period that the NPS has been in place). Regions where the transfer of water permits is a controlled or discretionary activity, or which do not contain explicit rules are:

- **Auckland Council;**
- **Canterbury Regional Council** classifies the transfer of water permits as a controlled activity³⁹, contingent on the transfer being within hydraulically connected sites within the same transfer zone and allocation block;⁴⁰
- **Gisborne District Council;**
- **Marlborough District Council:** Discretionary activity⁴¹ within the same catchment for both Marlborough Sounds⁴² and Wairau/Awatere;⁴³
- **Northland Regional Council;**
- **Otago Regional Council** has no specific rule, but has a policy to approve applications to transfer consents where the volume taken does not increase as a result of the trade;⁴⁴
- **Tasman District Council:** Site-to-site transfer of water take in the Wai-iti Dam Service Zone is a controlled activity, and a restricted discretionary activity⁴⁵ elsewhere.⁴⁶
- **Southland Regional Council:** an application to transfer will be considered if this is consistent with minimum flow and allocation regimes;⁴⁷
- **Wellington Regional Council:** Transfer of permits to another site is a discretionary activity, and requires application for consent. However; Policy

³⁶ Waikato Regional Council (2007) Waikato Regional Plan. Rule 3.4.4.

³⁷ The West Coast Regional Council (2012) Proposed Regional Land and Water Plan. Rule 40.

³⁸ Ministry for the Environment (2011) National Policy Statement for Freshwater Management 2011. Policy B3.

³⁹ Controlled activities require a consent, but with limited conditions in keeping with regional rules.

⁴⁰ Environment Canterbury (2011) Natural Resources Regional Plan Chapter 5: Water Quantity. Rule WQN19.

⁴¹ Full discretion exercised over whether to grant consent.

⁴² Marlborough District Council (2003) Marlborough Sounds Resource Management Plan. Rule 26.1.2.

⁴³ Marlborough District Council (2009) Wairau/Awatere Resource Management Plan. Rule 27.1.3.

⁴⁴ Otago Regional Council (2012) Regional Plan: Water for Otago. Policy 6.4.17.

⁴⁵ Restricted discretionary activities require discretionary consent by the regional council. Discretion is restricted to issues identified in the regional plan.

⁴⁶ Tasman District Council (2011) Tasman Resource Management Plan. Rules 31.1.7.1 and 31.1.7.2.

⁴⁷ Environment Southland (2010) Regional Water Plan for Southland. Policy 20.

6.2.10 encourages permitting transfers where there are no adverse effects caused.⁴⁸

3.3 Current Transfers and Trades in NZ—Quantity Trading

Elements of water trading markets already exist under the RMA framework. This section considers markets for water quantity and quality, before comparison to foreign similar schemes.

3.3.1 Canterbury

Rules in Canterbury's current Natural Resources Regional Plan (NRRP)⁴⁹ specify that Environment Canterbury (ECan) can allocate groundwater takes based on estimates of 50% of land-surface recharge,⁵⁰ or 15% of average annual rainfall.⁵¹

High demands for groundwater abstractions for irrigation in Canterbury have led to many management zones being identified as 'red zones,' where over 100% of potentially allocable water takes are under permit.

The NRRP acknowledges the importance of efficient allocation of water resources, but "does not want to be involved in trying to pick winners in terms of allocative efficiency".⁵² Rather, policy WQN17 enables the transfer of take permits within the same catchment which can "improve the economic efficiency of water use".⁵³

As water resources have become scarce, a market for water permits has developed. In addition to simple bilateral trades, they have been facilitated by brokerage HydroTrader and by real estate agents. They provide a matching service, while the trades themselves still require council approval. In total, 137 site-to-site transfers of water take permits have been accepted through Canterbury Regional Council since 2007, comprising consented volumes of 35.5million m³ per year (of the 4,991million m³ per year consented in the region).⁵⁴ Figure 7 shows the number of transfers of groundwater permits, and the volume of groundwater takes transferred since 2006. Volumes are measured both in terms of consent allocations and as full EAVs (effective annual volumes); in general the number and volume of trades has increased every year.

⁴⁸ Wellington Regional Council (2012) Regional Freshwater Plan for the Wellington Region. Rule 16 and Policy 6.2.10.

⁴⁹ The Proposed Canterbury Land & Water Regional Plan was publicly notified on 11 August 2012, and will supersede the existing NRRP. Rule 5.96 in the proposed plan restrict water allocation to 20% of the 7-day mean annual low flow.

⁵⁰ Environment Canterbury (2011) Natural Resources Regional Plan. Ch5: Schedule WQN4.

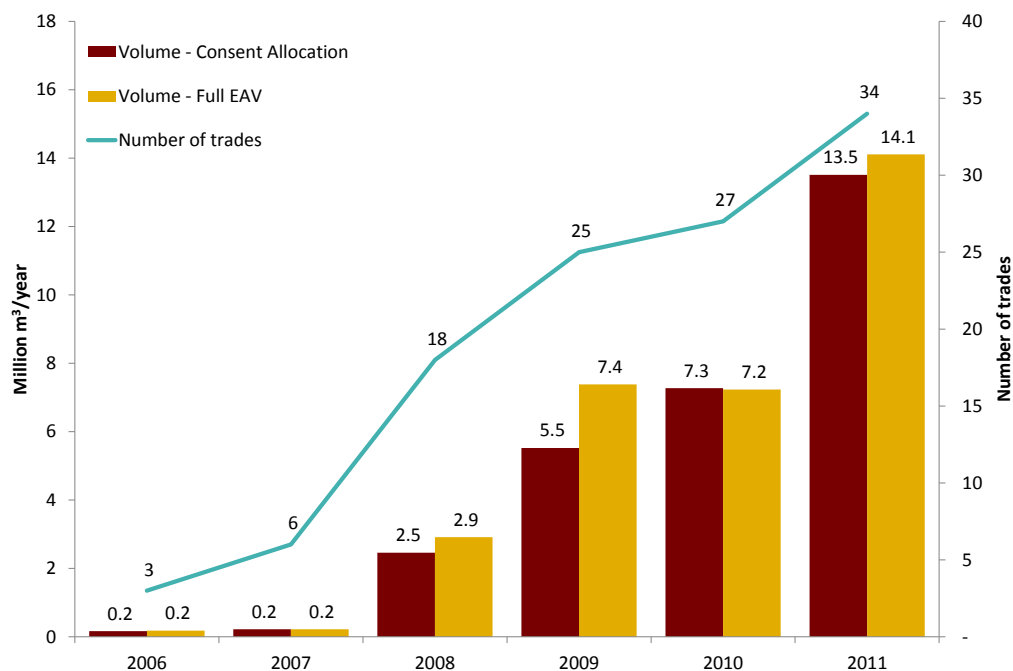
⁵¹ Environment Canterbury (2004) Groundwater Allocation Limits. Chapter 6.

⁵² Environment Canterbury (2011) Natural Resources Regional Plan, Ch5: Objective WQN5.

⁵³ Canterbury NRRP, Ch5, Policy WQN17.

⁵⁴ Ignoring water allocated to non-consumptive hydroelectric generation.

Figure 7 Number and volume of groundwater trades in Canterbury



Source: Environment Canterbury

The majority (89%) of trades in Canterbury have been of groundwater permits. Surface water trades are specified in terms of flow rates and trades have varied from 3 l/s to 1,720 l/s.

A survey of water users and others conducted to better understand attitudes and barriers to water transfer concluded that, although users and regional councils generally support the concept of water transfer, only 4-10% of water is likely to change hands.⁵⁵ Based on these conclusions, Aqualinc estimates that the potential demand for transfers in Canterbury might be 5% of total consents, or approximately 300 per year.⁵⁶

3.3.2 Manawatu-Wanganui

The Manawatu-Wanganui (Horizons) Regional Council has developed the Oroua Catchment Water Allocation and River Flows Plan (OCWA) to manage high demand for water quality and water abstractions in the region. The OCWA allows the limited transfer of water permits without requiring consent. Instead, transfers become effective as soon as the council receives written notice, provided that the following requirements are met:⁵⁷

- Both parties extract water for the purpose of irrigation.
- Permits for abstractions downstream of the Mangoirā confluence remain so.
- Permits for abstractions from the Kiwitea catchment remain so.

⁵⁵ Robb C, Morgan M & Harris S (2001) Attitudes and Barriers to Water Transfer. Prepared for Ministry for the Environment. Lincoln Environmental Report No 4464/1

⁵⁶ Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

⁵⁷ Horizons Regional Council (2003) Oroua Catchment Water Allocation and River Flows Regional Plan (Change 1). OCWA Rule 10 Transferring Water Permits.

- Such a transfer only applies during periods of water restriction (as specified in the plan).
- In no case shall the transfer exceed the maximum low flow abstractions allowed by the permit.

A case study description of the Oroua Catchment trading system noted a number of reasons why trading had been implemented:⁵⁸

- A clear potential for efficiency gain because of;
 - full allocation during periods of low flow; and
 - diversity of agricultural use within the catchment (dairy and sheep farms, and potato, cereal, pea and carrot crops), all with differing irrigation requirements, and requiring water at different times of the year.
- The catchment is geographically small with a good record of hydrological information.
- The relatively small number of individual users made it reasonably easy to monitor water use.
- An existing voluntary agreement (between the council and major water permit holders to limit abstractions at times of low flow) had already laid the foundations for a transferable system which would rely on some cooperation between permit holders.

A number of potential difficulties were identified in the development of the system:

- **Potential market power**—irrigators were suspicious of the proposed system and feared that large urban abstracters (namely the Manawatu District Council which takes water for the Fielding water supply) would exert an influence and be able to purchase most water permits.
- **Loss of existing rights**—irrigators considered that the rights of existing permit holders should be protected in some way, without precluding potential new entrants into the area who might wish to abstract water (land prices paid by existing farmers in the area to some extent incorporated a "price" for water).
- **Administrative and monitoring** challenges for the council.

To address these potential problems, a number of provisions were adopted:

- Limited participation—the ability to transfer permits is limited to the agricultural irrigators, to avoid fears that larger interests might have been able to "buy out" permits. Abstraction limits for large non-agricultural abstracters, such as the Manawatu beefpackers plant and the Manawatu District Council town water supply, were negotiated separately.

⁵⁸ MAF (1997) Transferable Water Permits: Two Case Studies of the Issues. MAF Policy Technical Paper 97/12.

- Transfers can only occur once the river flow is below a threshold point (see Table 6). When water is scarce, the market for transfers ensures that permits are held by those who value them most highly.
- There are two permit categories giving different rights to current (as of start of scheme) and new (new entrants and those wishing to increase their allocation) permit holders. Existing permit holders are given *category a* permits which can be traded but their use must be limited during low flows by a rostering system. New entrants (*category b*) permit holders can purchase *category a* permits, but otherwise must suspend abstractions during low flows. Written notice of any transfer must be sent to the council.

Table 6 Thresholds and permit categories in the Oroua Catchment trading system

Threshold ^a	Existing (Category A) permit holders	New (Category B) permit holders
30% of mean monthly flow	• Must limit take within total budget of 120 l/s. ^b • Roster of takes amongst permit holders • Transfers allowed	• Must suspend abstractions • Can purchase Category A permits
1-in-5-year expected 7-day mean flow	• Must limit take within total budget of 50 l/s • Roster of takes amongst permit holders • Transfers allowed	• Must suspend abstractions • Can purchase Category A permits

Notes: ^a When river flows fall below the threshold level, transfers are permitted subject to the restrictions. ^b Maximum total abstractions (for the purpose of irrigation) from the Oroua River must be within this budget.

The system is thus a mixture of a rationing system and a trading system and the voluntary agreement is at the heart of it. It is a limited trading system in which transfer is possible only during periods of low flow, and only between irrigators.

One of the reasons for giving different rights to existing permit holders is that, for them, the value of the water right has been incorporated into the land price that they have already paid, whereas the development of a trading market can lead to the separation of land and water right values.

Despite the detailed system developed, we understand that there have been few trades to date and that the major element that is used in practice is the system of rationing of flows under the voluntary agreement.

3.3.3 Tasman

Water trading is not included in the Tasman District Regional Plan although the Tasman District Council (TDC) has approved enhanced transferability in the Wai-iti catchment, where insufficient and variable water supplies are to be augmented via a storage

scheme.⁵⁹ For the Wai-iti Dam Service Zone the council has introduced a controlled activity for site-to-site transfers of points of take to enable users to move points of take closer to the river to establish a more reliable supply of water.⁶⁰ No permanent transfers of water permits has taken place in Wai-iti as yet, however there have been short term transfers (3 years) of water take permits for market gardening and fruit growing operations.⁶¹

The Regional Plan states that in a number of specific areas⁶² it will decline any application for site-to-site transfer of water permits, or parts of water permits, in circumstances that result in an increase in irrigated areas.

The plan sets out that the council will regularly review permits to ensure the allocation authorised by the permit reflects what is actually needed by:

- encouraging permit holders to relinquish permits or, if relevant, to transfer the point at which water is taken, and/or lease or permanently transfer permits wholly or in part to another person if the water allocated is no longer being used, except in over-allocated zones where the transfer is likely to lead to an increase in irrigated area or amount of water used; or
- reducing allocations to reflect bona fide use. This is part of a ‘use it or lose it’ policy in which water permits (or parts thereof) that are not being used are cancelled, thus allowing their take-up by others.

3.3.4 Waikato

Variation No. 6 to the Waikato Regional Plan has the following rules to improve efficient allocation of water:

- the use of water for crop and pasture irrigation is in general a permitted activity, provided that:⁶³
 - The water is not applied in a way or at a rate that causes the water holding capacity of the soil within the plant root zone (rhizosphere) to be exceeded.
 - The rate of irrigation does not exceed the infiltration rate of soil and any run-off or ponding of irrigated water shall be minimised.
 - The amount of irrigation water applied does not exceed the irrigation demand by more than 20%.
 - The activity shall not result in any direct application of contaminants to any water body.
 - The activity shall not result in the contamination of land.

⁵⁹ Beech K (2006) The Use of Tradeable Water Rights in New Zealand. A dissertation submitted in partial fulfillment of the requirements of the degree of Bachelor of Laws (Honours) Faculty of Law University of Otago, Dunedin.

⁶⁰ Tasman Resource Management Plan Chapter 30: Taking, Using, Damming and Diverting Water.

⁶¹ Personal Communication with Neil Tyson of Tasman District Council, July 2012.

⁶² the Upper Catchment, Reservoir, Waimea West, Golden Hills, Delta and Upper Confined Aquifer zones.

⁶³ Waikato Regional Council (2011) Waikato Regional Plan – Variation No. 6. Rule 3.4.5.6.

- Users wishing to use water for controlled or discretionary activities can apply to the Council for a permit to use water. The transfer of the take portion of water permits has also become a permitted activity, provided that the recipient holds a permit for the intended use of water, or whose intended use is permitted by a rule in the plan.⁶⁴

Waikato Regional Council has also introduced the option of using multiple site permits.⁶⁵ These are similar to the approaches applying to irrigation schemes (see below). Applicants for the take and use of water may consider applying for:

- A single take consent that may cover multiple locations. This may be used either by an individual or a group of individuals;
- A transfer consent so that water can be taken at multiple locations.
- A single use consent where more than one site is being utilised by the consent holder, where a use consent is required.
- For the avoidance of doubt, when separate applications are made for either a take consent, use consent, or transfer consent, the separate applications retain their relevant rule provisions for each consent, rather than a bundling of the applications

No trades have taken place as yet under the new rules.

3.3.5 Irrigation Schemes

By applying for resource consent collectively as part of an irrigation scheme, farmers can facilitate easy transfer of permits on a micro level. Several such schemes are in operation in New Zealand. The second-largest of these, the Ashburton-Lyndhurst Irrigation Scheme, serves as an appropriate example.

Ashburton-Lyndhurst

The Ashburton-Lyndhurst Irrigation Scheme has 50,000 shares covering 25,000ha.⁶⁶ The consents held are to:

- Take up to 114 litres per second of water from Spring Creek, for the use of irrigation of up to 267 hectares. (CRC990718.1)
- Use water for powering turbines to drive pumps. (CRC093800)
- Take groundwater of up to 2 litres per second for use in irrigating crops and pasture. (CRC040441.1)
- Dam up to 50,000m³ of water on the corner of Dromore Methven Road and Mitcham Road, Ashburton. (CRC063728)

⁶⁴ Waikato Regional Council (2011) Waikato Regional Plan – Variation No. 6. Rule 3.4.4.3.

⁶⁵ Waikato Regional Council (2012) Waikato Regional Plan. Ch3 Water Module – 3.4.4 Implementation methods – transfer of water take permits.

⁶⁶ Ashburton Lyndhurst Irrigation Limited (2011) Scheme Info.

Rangitata Diversion Race Management Limited is contracted to allocate 12.0m³/s to the scheme during the irrigation season 10th September to 9th May, under several consents to take surface water⁶⁷.

Local farmers purchase two shares for each hectare of land, and agree to a Supply Contract with the company. Standards include rights to vary supply during low flows; compliance with resource consent conditions, acts, regulations and laws; and standards of best practise for the utilisation of water.⁶⁸

Transfer between members of this scheme is achieved through sales of shares, rather than any variations to consents.

Irrigation in Australia

A review of water trading in Australia⁶⁹ suggested that irrigation scheme participants should hold actual (tradable) permits (entitlements) rather than shares. Holding entitlements would allow them to participate more broadly in the entire water market, trading with all permit holders rather than just within the irrigation scheme. Participants could still hold shares in the infrastructure assets of the scheme. It is not clear that water markets are, or will be, sufficiently developed or that catchments are sufficiently large in New Zealand to justify a similar conclusion here.

3.4 Current Transfers and Trades in NZ —Water Quality Trading

3.4.1 Lake Taupo Nitrogen Trading

Regional Plan Variation 5 (RPV5)⁷⁰ became operative in July 2011 and includes a nutrient trading programme to reduce the nitrogen discharge to Lake Taupo from rural land and wastewater.⁷¹ The approach appears to be widely applicable to areas where limits to pollutant discharge are required at least cost.

Overall Objectives

The overall objectives are to achieve targeted levels of:

- water quality—total Nitrogen of 70.3mg/m³ by 2080; and
- load—a 20% reduction to the current load to the lake of 1,200 tonnes of nitrogen per year.

The Traded Commodity

The trading system has defined a commodity in the form of a nitrogen discharge allowance (NDA). Permits to discharge can be traded by exchanging any quantity of the allocated NDA.

⁶⁷ Rangitata Diversion Race Management Limited website.

⁶⁸ Ashburton Lyndhurst Irrigation Limited (2011) Constitution 2011.

⁶⁹ PWC (2006) National Water Initiative Water trading study Final Report. The Department of the Prime Minister and Cabinet.

⁷⁰ Waikato Regional Council (2011) Waikato Regional Plan – Variation No. 5.

⁷¹ Ministry for the Environment (2004) Lake Taupo - The Ministry for the Environment's perspective

The Obligation

An owner of a pastoral farm must hold NDAs equal in number to the estimated discharge from their property; the estimate is made using the OVERSEER nutrient budgeting model⁷². The requirement to cover nitrogen discharges produces a demand for NDAs.

Initial Allocation

Initial NDAs are allocated on the basis of OVERSEER estimates of the highest leaching year on each property between 2001 and 2005, specified in kg of N/ha/yr, and an accompanying Total Allowable Nitrogen Discharge (TAND) in total kg of N/yr.⁷³ The Lake Taupo Protection Trust currently funds the benchmarking process by which initial NDA allocations are determined.⁷⁴

Market Mechanism

Waikato Regional Council maintains a central notice board advertising nitrogen allocations available or wanted for sale⁷⁵. Once a price, quantity and dates are agreed, both parties to the sale prepare a Nitrogen Management Plan (NMP) through OVERSEER showing how each will operate under their new cap. Approval of the consent is given by Waikato Regional Council, upon submission of application⁷⁶ each party's NMP, and an initial deposit of \$500 each (additional fees may be required as per the usual consent process).⁷⁷

Lake Taupo Protection Trust (LTPT)

In addition to assisting with the initial allocation process and supporting nitrogen reduction research, the LTPT works to reduce nitrogen levels in Lake Taupo. The LTPT has been granted \$81.5m over 15 years⁷⁸ by the government (45%), Waikato Regional Council (33%), and Taupo District Council (22%) with the objective of reducing nitrogen levels by 20%.⁷⁹ This is done both by purchasing NDAs and by converting pastoral farming land to forestry, resulting in reductions in the overall nitrogen discharge levels.⁸⁰

Historically the LTPT pays farmers \$300-\$400 per kg of nitrogen reduction, under longstanding (999 year) agreements.⁸¹ Rather than setting the cap at environmental targets and regulate reductions in discharge, the regional council allocates nitrogen based on current levels, and finances LTPT to purchase the reduction of nitrogen from the market. This method provides funding to those reducing their discharges. The trust has been active in this trading system, having achieved a total reduction of 84 tonnes towards the target of 153 tonne reduction in nitrogen leakage. Most recently, the

⁷² OVERSEER® Nutrient budget model.

⁷³ Waikato Regional Council (2011) Nitrogen sourcing and trading in the Lake Taupo catchment.

⁷⁴ Waikato Regional Council (2011) Nitrogen management in the Lake Taupo catchment.

⁷⁵ Waikato Regional Council website. Services > Nitrogen Trading.

⁷⁶ Waikato Regional Council (2012) Consent application forms.

⁷⁷ Waikato Regional Council (2011) Nitrogen management in the Lake Taupo Catchment.

⁷⁸ Lake Taupo Protection Trust (2009) Funding Deed.

⁷⁹ Lake Taupo Protection Trust (2011) About Us.

⁸⁰ Lake Taupo Protection Trust (2011) Our Role.

⁸¹ Conversation with Graham Fleming at Lake Taupo Protection Trust.

trust purchased 17 tonnes of NDA from the Waihi Pukawa Ahu Whenua Trust, a farming entity committing to implement nitrogen management improvements on farms and transfer 284ha of pastoral land into forestry.⁸²

3.4.2 Lake Rotorua (Proposed)

A similar scheme is currently in development for nutrient trading in the Lake Rotorua catchment. The Bay of Plenty Regional Council published the Lakes Rotorua and Rotoiti Action Plan in 2009⁸³ which sets a target for nitrogen input of 435 tonnes/year to Lake Rotorua. To facilitate this, the goal is to reduce total exports 250 tN/y of the current total 746 tN/y by 2017.⁸⁴ The draft action plan aims for a 170tN/y reduction in export from improved management of farmland. Specifics of the allocation method have not been agreed, but are likely to be based upon historical leaching rates.

Participants

As modelling of nutrient loss requires significant data, Motu Economic and Public Policy Research (Motu) notes the significant compliance costs which outweigh the benefits of small sources participating in a trading programme⁸⁵. Potential rules for participation based on land use and property size are as shown in Table 7.

Table 7 Rules for Participation in Lake Rotorua Trading Regime

Land Use	Nitrogen loss coefficient (kg/ha/yr)	Land use area threshold (ha)
Horticulture and cropping	60	8.3
Dairy	50	10
Non-Dairy Pastoral farming	19	26
Native bush	4	125
Exotic forestry	3	167

Source: Lock, K & Kerr, S (2008) Nutrient Trading in Lake Rotorua: Choosing the Scope of a Nutrient Trading System

Market Mechanism

OVERSEER[®] is used to model nutrient loss from farms.⁸⁶ For use in designing the trading scheme, the NIWA computer model N-Trader is being used to simulate the nutrient trading market.⁸⁷ N-Trader can econometrically predict the likely market price for nitrogen, the impacts of transaction costs, and how trading might affect land-use. To encourage early initial reductions in nitrogen leaching, it has been suggested that participants be allowed to bank allocations, effectively trading with their future self.

⁸² Lake Taupo Protection Trust (2010) News & Events 16 December 2010.

⁸³ Bay of Plenty Regional Council (2009) Lake Rotoiti Action Plan.

⁸⁴ Motu (2007) Nutrient Trading in Lake Rotorua: Goals and Trading Caps.

⁸⁵ Lock, K & Kerr, S (2008) Nutrient Trading in Lake Rotorua: Choosing the Scope of a Nutrient Trading System. Motu.

⁸⁶ See OVERSEER[®] online at <http://www.overseer.org.nz/>

⁸⁷ NIWA (2009) Water and Atmosphere: Nutrient Trading to Improve and Preserve Water Quality (17)1.

Changes to the Regional Plan

The regional plan would require changes to facilitate the framework of such a trading scheme. A report by Chapman Tripp highlights the necessary plan changes⁸⁸:

- Identify and control the activities which discharge nitrogen, including a threshold for participation in the scheme.
- Set a 'cap' on nutrient discharges, a method of allocating credits, and a process for modelling discharge.
- Specify governance for facilitating trades and monitoring.

3.5 Lessons from Other Countries

A review of water trading systems in other countries is included in Annex 2. We bring out a number of key issues below.

3.5.1 Quantity Trading

Water quantity trading has been particularly active in Australia, both in terms of the number of trades and the policy development activity. However, the water systems are different. Trading has focussed on water bodies with significant storage such that volumes can be controlled. This provides much greater certainty to quantities of water available and to the development of commodities (rights to water) that provide owners with certainty.

This has meant that trading is limited even amongst groundwater systems.

Where there is reasonable certainty, trading has been shifting towards greater levels of unbundling of the water rights into component parts, some of which are tradable and some which are not. South Australia has taken this the furthest, unbundling rights into the following components that can be traded:

- **Water Access Entitlement**—the ongoing right to a specified share of the water resource, expressed in unit shares;
- **Water Allocation**—the actual volume of water you are able to take in a water use year (it may vary from year to year depending on availability);
- **Delivery Capacity Entitlement**—the right to access a proportion of the capacity of a water distribution system.

And other elements that cannot:

- **Water Resource Works Approval**—a permission to construct, operate and maintain works (such as a pump, meter, well or dam) to take water at a particular location in a particular way; and

⁸⁸ Chapman Tripp (2010) Nutrient trading programme: Incorporation into Environment Bay of Plenty regional plan.

- **Site Use Approval**—a permission to use the water at a particular location in a particular way.

It is not clear that this degree of unbundling is necessary in the New Zealand system, particularly as water infrastructure is more limited in scale, reducing the value of rights to distribution systems. In addition, as discussed elsewhere, it is not clear that some of these rights (or tradable commodities) need to be defined through regulation.

3.5.2 Water Quality Trading

Water quality trading systems include baseline & credit and cap & trade systems (see explanation below in 3.6.1).

The complexity for water quality trading is over the importance of non-point sources and how best to include them. Typically this has been achieved, as for New Zealand, through modelling discharges.

The specific pollutants included will differ reflecting local environmental priorities.

3.6 Lessons from Other Trading Systems

Markets have been defined as a way to address resource allocation in a number of other natural resource and environmental markets. We include a discussion of a number of different trading systems in Annex 3:

- The NZ Emissions Trading Scheme (NZ ETS);
- SO₂ trading in the US;
- NO_x trading in the US;
- Fishing Quota Management in New Zealand;
- Biodiversity Offsets;
- The UK Renewables Obligation;
- UK Packaging Recovery Notes.

We draw out a number of lessons from this experience below.

3.6.1 Basic Design

Trading systems come in a variety of forms and are often classified under the following headings:⁸⁹

- **Cap and trade** systems in which there is some quantified limit to the availability of the traded commodity, eg a total number of available emission allowances. Demand for these units is established through a regulated obligation, eg every emitter of a specific pollutant must hold one emission allowance for each defined quantity of emissions. Allowances are initially distributed either through free allocation or sale and then must be held (or surrendered) by the obligated parties. Examples include the sulphur trading under the US acid rain

⁸⁹ See for example: Ministry for the Environment (2006) Discussion paper on measures to Reduce Greenhouse Gas Emissions in New Zealand Post-2012.

programme.

- **Baseline and credit** systems in which trading is of “unders” and “overs”. For specified activities a baseline of emissions or other resource use is defined. If a participant uses less of the resource (fewer emissions) the surplus can be sold as an allowance to participants that have exceeded their specified baseline. In practice the systems are very similar — a baseline and credit system is functionally equivalent to a cap and trade system in which a participant has an initial gift of allowances equal to the baseline.
- **Offset systems** require participants (those with obligations) to offset their impacts (total emissions or emissions above a specified limit) through actions that will have a positive effect elsewhere. These positive actions might be in a different location or sector. For example, the Biodiversity Offsets Programme requires developers to offset adverse biodiversity impacts of a project by generating credits from enhancing biodiversity offsite.⁹⁰

3.6.2 A defined commodity

The systems have a clear definition of a commodity. Generally these include:

- A defined right, eg to emit a unit of a pollutant or to catch a specified volume of a fish species.
- A variant to this is the UK Renewables Obligation and the Packaging Recovery Note (PRN) system where the commodity is an obligation fulfilled;
- A time period over which this right or obligation applies, eg a right to emit in a specified time period.

The commodity can be specified in absolute terms (eg 1 tonne of CO₂-equivalent) or as a rate (eg kg/m³ as might apply to discharges to rivers). New Zealand Quota Management System (QMS) for fishery management is based on a system in which a Total Allowable Commercial Catch (TACC) is defined by the government on an annual basis and tradable quota provide rights to a percentage of this TACC. Such a system might be relevant to water trading where there is annual variability in available volumes for trading, particularly of surface water quantities.

3.6.3 The Obligation

Trading systems have a legal obligation that, combined with penalties, defines the value of the commodity. Thus under the NZ emissions trading scheme (NZ ETS) there is an obligation to surrender emission units at the end of specified compliance periods. The equivalent for water might be the obligation to hold a permit when taking or using water.

3.6.4 Compliance Period

The compliance period is the period over which the tradable commodity meets the requirements of the obligation. This can be annual (eg Sulphur), multi-year (eg NZ ETS) or overlapping (eg RECLAIM – see Annex 3).

⁹⁰ Department of Conservation (2010) Biodiversity Offsets Programme Factsheet.

3.6.5 Distribution or Allocation of Tradable Commodities

There is a range of approaches to the initial distribution of allowances and other tradable commodities. This includes:

- historical grandparenting—gifts of allowances on the basis of historical levels of activity or resource use. The most extreme case is the sulphur trading in the US where historical activity (energy input) is used to define the level of gifts of allowances in perpetuity;
- auction—sales to the highest bidder with no free gifts;
- grandparenting with updating—gifts of allowances each year based on recent activity, ie the historical time period changes over time;
- averaging—an example of this is the gift of emission units to New Zealand foresters owning mature (pre-1990) forests that would be liable to an emissions surrender obligation on felling. An equal number of NZUs was given per hectare of forest owned.

3.6.6 Treatment of New Entrants

An issue for trading systems that include gifts of allowances on the basis of historical activity is how to treat new entrants, ie new firms that have a demand for allowances. Designs differ in whether there is a set-aside of allowances for these firms or if they are required to purchase their allowance requirements on the market.

3.6.7 Banking

Banking of allowances involves unused allowances from one time period being transferred to another future time period. This is most effective for allowances relating to cumulative environmental effects where shifting emission reductions forward in time may be beneficial. In addition, it can result in costs being smoothed over time.⁹¹

Consideration has been given to borrowing approaches also; these involve greater emissions in the current time period, compensated by more significant emission reductions in the future. Such approaches are generally regarded as introducing high risks, especially where there is the potential for avoiding obligations.

3.6.8 Government Involvement in Trading Platforms

In trading systems, the mechanism for exchanging commodities is usually left to the market rather than being provided by the government (at national or regional/local) level. Generally mechanisms:

- develop over time, eg they start with bilateral trades assisted by brokers and develop towards exchange-based mechanisms when markets are more mature;

⁹¹ This was the result with the SO₂ trading market in the US where the cap was introduced in steps. Allowing banking allowed prices to be smoothed over time, rather than jumping at the time of a new step change in the size of the cap.

- differ depending on the number of trades—when there are few trades bilateral trading systems are more likely to persist.

The information from these different systems is used in our exploration of the key market requirements for water trading in the next section.

4 Barriers to Trading and Possible Solutions

4.1 Existing Barriers

A wide range of barriers have been noted to the development of a system of tradable water rights.⁹² A review of literature and discussion with a range of stakeholders has identified the following issues:

- Transaction costs—currently a transfer requires the involvement and approval of the consenting authority, with all the associated costs.
- Limited demand—to date there have been relatively few catchments in which demand exceeds supply, but the number is changing over time and demand for trading will increase. This is evidenced by a 33% increase in national weekly water allocation and an 82% increase in land irrigated by consented water takes between 1999 and 2010.⁹³ As catchments approach their allocation limits (see Figure 4), new entrants must seek a permit transfer in lieu of a new consent.
- Fears that trading will lead to overuse of water as it releases current permits in catchments which have been over-allocated, ie consented volume is greater than current use;
- The bundling of take and use elements where the environmental risks are different across time, location and in their characteristics;
- Uncertainty over future availability of permits. There are concerns over possible irreversibility of transfers—sellers have no confidence that there will be permits available if they need to acquire them in the future. This leads to more comfort with temporary rather than permanent transfer. This concern has been exacerbated by approaches where the council has “taxed” transfers by removing some allocation amounts at the same time as a resource consent is transferred (to a new site).
- Objections to the strengthening of private property rights in water, particularly from the perspective of Maori.
- Protecting the interests of landowners who have paid for land at a price which includes the value of water entitlements (some approaches to introducing

⁹² See for example: Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development ; Ministry for the Environment and Ministry of Agriculture and Forestry (2004) Water Programme of Action. Water Allocation and Use. Technical Working Paper; Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09.

⁹³ Aqualinc (2010) Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes. Prepared for Ministry for the Environment.

trading may reduce these existing entitlements).⁹⁴

Protecting the interests of landowners who have paid for land at a price which includes the value of water entitlements (some approaches to introducing trading may reduce these existing entitlements).

We address these issues in turn below. We identify potential solutions in the next section.

4.2 Transaction Costs

Currently, in most regions, transfers are equivalent to applications for a new consent. Aqualinc suggests that the time taken is the most significant element of costs and that straightforward applications for water take consents take about three months in Canterbury and more involved applications take several years.⁹⁵ This renders temporary transfers impractical in many instances.

The administrative costs are associated with the re-permitting process because of the need to assess the environmental effects of a transfer. This is reduced where transfers are treated as permitted activities under rules included in regional plans. Councils will need to examine the extent to which administrative costs can be reduced by establishing clear regional rules permitting transfers where the environmental impacts are likely to be minimal. Administrative costs might also be simplified by the unbundling of permits into different components as is being pursued in Australia and the Waikato.

In addition to the administration costs associated with a transfer, there are costs associated with finding permits for sale. The development of Hydrotrader and real estate agents partially addresses this problem. And we might expect that, if there is greater demand for trading, and the administrative costs of trading could be resolved, brokerages for trading would be more active, making it easier to find permits and permit buyers. It is not clear that there is a requirement for government involvement in this process. Transfers are local, by their nature, and the requirement is really for a matching service for buyers and sellers. There are transaction costs involved and these are unlikely to be lower if the government is doing the work. Under private provision, costs are likely to be recovered through a charge on trades; this is appropriate and equitable, compared with taxpayers being charged.

4.3 Limited Demand and Thin Markets

Limited demand is a constraint to the development of a trading system but only in the sense that it is a measure of the absence of a problem. In other words, water trading is a solution only if there is a problem of excess water demand.

⁹⁴ The issue is highlighted by the introduction of the Emissions Trading Scheme in which owners of forests planted prior to 1990 faced a new liability associated with felling trees that was only partially compensated.

⁹⁵ Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

A more pressing problem for the development of a trading market is that markets may be thin. Catchments may have relatively few potential buyers and sellers resulting in a relatively illiquid market in which those wanting permits may have difficulty in finding permits for sale and those with surpluses may not be able to find purchasers. These issues may relate to:

- difficulties of transferring parts of permits rather than whole permits. Enabling permits to be broken into component parts would help to increase potential supply and demand;
- undeveloped transfer or trading platforms. This appears to be a relatively minor problem. In a currently thin market, mechanisms are developing, including Hydrotrader and real estate agents using their traditional advertising approaches. In all cases these are run by businesses that have other activities. In a similar way, TradeMe has entered the carbon trading market, although specialised brokers have developed more sophisticated platforms.

MfE and MAF note the small size of many New Zealand catchments limiting the potential net benefits in terms of gains from better use of water as compared to the transaction costs involved in facilitating increased transferability. This is best tackled through reducing transaction costs to the extent that this can be achieved without increasing environmental risks.

4.4 Will Trading Lead to Over-Use?

The issue of potential overuse is raised as an objection to the introduction of trading. This is an issue where there is a combination of the following:

- Total demand currently exceeds total available supply – new entrants cannot obtain permits;
- Currently, some water users hold consents for a greater level of take than they have a practical demand for. National use of water was estimated to be 65% of consented volumes in 2010;⁹⁶
- The current consents do not have conditions requiring them to restrict takes at times when environmental limits will be compromised.

The Australian experience was of increased water use when markets were first established, but the conclusions are that the establishment of a trading system needs to be accompanied by institutional arrangements (eg allocation limits) that prevent over-use from occurring.⁹⁷

⁹⁶ Aqualinc (2010) Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes. Prepared for Ministry for the Environment.

⁹⁷ Young M. The effects of Water Markets, Water Institutions and Prices on the adoption of irrigation technology

Reducing barriers to trade might result in those with excess permits realising the value of the permits by transferring them to those that will use them.

This is a problem regardless of trading. In this context, the National Policy Statement on Freshwater requires councils to:⁹⁸

- ensure that no decision will be likely to result in future over-allocation – including managing fresh water so that the aggregate of all amounts of fresh water in a water body that are authorised to be taken, used, dammed or diverted – does not over-allocate the water in the water body; and
- set a defined timeframe and methods in regional plans by which over-allocation must be phased out, including by reviewing water permits and consents to help ensure the total amount of water allocated in the water body is reduced to the levels set via freshwater objectives, environmental flows and/or levels.

In the interim period prior to the introduction of rules in Regional Plans that will address this problem, there is a risk that trading could lead to some over-use. However, councils will often have means to tackle this, either through persuading voluntary scaling back of use or through requiring permit holders to reduce takes or discharges.

4.5 Bundling Take and Use

4.5.1 The Issues

Water that is to be used is initially taken out of a water body which may be running water, stored water (a lake) or groundwater. The effects of take are to reduce the water available in-stream, the cumulative effects on the groundwater aquifer as a whole and/or the localised effects relating to the take of groundwater that include saltwater intrusion. The effects are related to the volume of water abstracted.

The effects of water take will change with the location of the take. In some circumstances the effects of shifting take location will be minor, eg shifting where water is abstracted from in a lake. But in other instances, eg shifting the take up-stream in a river, the effects may be significant. The acceptable circumstances for transfers might be definable in a set of rules in a plan.

The adverse effects of use are largely the discharges of nutrients and other potential pollutants of water bodies. Application of water to land increases the flow of these substances. For these reasons, permits will often limit the extent of use (or the effects of use) or its location. The nature and location of the effects will often be separated geographically and temporally from those associated with the take of water.

Bundling take and use components of water permits requires the environmental impacts of both components to be considered together. This can unnecessarily limit trading. Bundling these elements is not required under the RMA; it is more a historical practice or habit that has not been sufficiently challenged. And unbundling facilitates trading,

⁹⁸ New Zealand Government (2011) National Policy Statement Freshwater Management 2011 Issued by notice in the Gazette on 12 May 2011.

particularly when one element is relatively unchanged (eg the location of take changes but not use) or is minor (eg the use does not result in discharges).

Via Variation No. 6 to its regional plan in April 2012, Waikato Regional Council has separated take from use components. Permits are required for takes, but permission to use is either granted by a rule or a separate consent.

In Australia there is a shift towards even greater unbundling of rights. In South Australia this includes components relating to abstraction volume, abstraction infrastructure, water volume, access to the water distribution system and use. There is a definite logic to this approach; the water right is broken down into a series of individual rights with quite different impacts. This appears to be a way to reduce the potential impacts of trading on the environment, can reduce the level of management of low-risk activities, and may also have benefits in terms of the strengthening of property rights. The negative aspect of this approach is that it might be introducing a level of complexity that is not required, leading to water users requiring five permits whereas previously they only required one.

Separation is recommended by a number of analysts, including Sinner and Fenemor.⁹⁹ They suggest two approaches, either unbundling permits into:

- take and use components – where the separation is based on abstraction of water (take) and transport and application of water (use); or into
- take and site components – where *take* is the volume of abstraction but *site* includes both the site specific components of the take and of use.

They picked up particularly on the Australian experience, noting that the key lesson to be learned is that transferability is best catered for by making the water entitlement (the take component of a water permit) as simple as possible, and addressing site-specific issues separately. The key benefit of unbundling water rights is that each component can be managed independently. However, they note that separating take and site may require legislative change.

4.5.2 Application

To explore this approach further, we examine a number of hypothetical cases:

Changing land use on a single site

The land owner might want to change land use in a way that changes the requirement for water. This may be a seasonal change in water demand and/or a change in total volume. In reconsidering the permit there is a need to examine the effect of changes in the volume and timing of water abstraction. This will differ between surface water (where there is likely to be a concern with flow rate) and groundwater (where the main concern is with annual/seasonal total take). The land use activity itself might be

⁹⁹ Sinner J and Fenemor A (2007) Opportunities for separating the take and use of water in planning frameworks and resource consents. A Report for the Sustainable Water Programme of Action.

specified in the permit and is of interest to the extent that it affects the characteristics of take and total discharges.

Superficially, under these circumstances, there is little advantage in unbundling. The change requires consideration of the environmental effects of the new volumes and timings both with respect to take and use. However, if we consider how a tradable permit regime might work, unbundling appears more useful.

Making a permit tradable requires that the specification of the take component includes flow rate, volume and timing components. For example, if abstracting from groundwater the farmer may need to increase the total annual volume take. Tradable take permits could readily be specified in that way ($\times \text{m}^3/\text{annum}$) under a total cap for a specific location. For surface water the permit specification may be different, and probably more complicated, eg a maximum flow rate for a specified time period.

Use permits could restrict total discharges, and their separation from take provides incentives for the farmer to use the water efficiently to minimise discharges and thus the requirement for permits. Where there is little impact associated with use, the use element can be a permitted activity.

Despite the change in land use having implications for take volumes and timings, separating the take and use components better enables the development of an effective and efficient market in take permits.

Shifting water to a different site but not changing the take

A farmer may provide (sell) water (or access to water) to a neighbouring farm. Here, councils generally require a new consent to be issued for the change in use, with site-specific take conditions included in the new permit. The old permit would also need to change to reflect the alterations.

Here there is clear value in separating out the take and use component. There may be no need for a change in take, only management of the use component. This might be achieved through the permit covering the take conditions, but having generic conditions in the consent that allowed flexibility in use; alternatively this could be achieved via regional rules relating to use conditions.

Alternatively, each farmer may hold a specific use permit controlling the effects of uses of water on that property, eg leaching of nutrients due to irrigation. This would facilitate the transfer of water provided the intended use complied with the local permit.

The farmer may require compensation from the neighbour for the water, representing the opportunity cost of losing access to water and/or the cost of transfer. However, this transaction can be a purely private arrangement. The permits deal only with the effects of transfer. Risks of such transfers are managed by the requirement that both parties be operating within their site-specific use conditions.

Shifting take but not changing use

If a farmer wishes to change the location of the take point but not the use, the effects of the change in take need to be taken into account. If a trading system was in place, the farmer could either buy water at a different site, or follow the consent process to obtain a permit for a different location/change the location of the existing permit. As above, the permits are more easily tradable to the extent that there are no use conditions attached.

Shifting both take and use location

If both the point of take is shifted, and the use location, there is a need to consider a range of effects. Again this is possible under a trading system through having take permits that are bound to a location specified as widely as possible.

4.5.3 Workability

One issue for consideration is how to define the required level of take for a permit if there is no associated use component. For example, imagine a competitive market for use permits in a catchment with limited water available and multiple potential users of water who might be supplied from separate take points. Under these circumstances an applicant for a take permit might attempt to monopolise the market by obtaining more than are currently required.

The central issue is whether take permits should be placed on the market equal to the available supply, ie an estimate of available volume (or flow), less the amount required to meet ecological limits, or if the volume placed on the market is based on current demand for use of water. There are arguments for both approaches:

- placing all on the market immediately reduces the transaction costs of dealing with the council in estimating the impacts of take; but
- it introduces the risk of the exercise of market power by the first applicant.

Ways around this are to ensure that, following unbundling, any new permits are placed on the market in one of the following ways:

- using auctions;
- using a charge paid to the council that is an estimate of the expected market price; or
- distributed equitably amongst landowners, eg on a per hectare basis.

In the presence of transaction costs of trading, the latter approach is unlikely to be the best solution. It may require a lot of effort for some land owners to compile sufficient permits to continue their existing activities.

If the initial allocation is based on current demand only, and the permits have market value, the initial estimate of demand becomes a crucial element of the permitting process. This may increase transaction costs significantly if there is a requirement for detailed modelling. Our preference is for an approach in which auctions are used for

initial allocations, as this ensures allocations are distributed to those who value them most highly and it means that applicants are unlikely to purchase more than they need.

4.5.4 Take Infrastructure

There are additional effects associated with the infrastructure required for abstraction that will have localised environmental effects. The extent of these will vary significantly and these might be appropriately included with other aspects of take. However, to do so reduces the scope for creating take permits as tradable commodities. Effects relating to take infrastructure are normally considered via land use consents.

4.6 Strengthening of Property Rights

The concerns over strengthening of property rights are in two directions. On the one hand, one of the requirements for an effective trading market in water rights is that there are strong (clearly understood and enforceable) rights associated with the traded commodity. The RMA explicitly states that permits are neither real nor personal property.¹⁰⁰ They do not represent ownership of water itself, but rights to abstract or to use water. The strength of these rights determines the value of the traded commodity. We explore these issues below.

On the other hand, strengthening the rights is of particular concern to Maori in the context of on-going discussions over water resource ownership in light of customary Maori rights, described by the Waitangi Tribunal as “full and unrestricted use and control of the waters”.¹⁰¹ These issues extend beyond Maori, however, into a potential concern over the sale and alienation of rights to a community resource.

4.6.1 Need for Stronger Rights

Richard Hawke (MED) suggests that “there is almost universal agreement that the property rights associated with water lack adequate specification”.¹⁰² He notes the work of Guerin at NZ Treasury¹⁰³ and ACIL Tasman¹⁰⁴ that set out the requirements for effective property rights (Box 1).

¹⁰⁰ Resource Management Act (1991) Section 122.

¹⁰¹ Chen M (2012) Govt faced with uncomfortable water precedents. New Zealand Herald 19 July 2012.

¹⁰² Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09.

¹⁰³ Guerin K (2003) Property Rights and Environmental Policy: A New Zealand Perspective. New Zealand Treasury Working Paper 03/02.

¹⁰⁴ ACIL Tasman (2003) Water Trading in Australia: Current and Prospective Products. Current trends & prospective instruments to improve water market function. Prepared for the Water Reform Working Group.

Flexibility and divisibility. Can the right holder transform the right; eg can the right holder lease all or part of the right for less than its full term?

Exclusivity. Do the direct benefits and the costs associated with the use of the right accrue solely to the holder; ie is it possible to exclude others from use of the right?

Quality of title. The right should be clearly specified so that owners and potential holders understand exactly what benefits and obligations the right brings. For example, the right may be to an absolute amount of resources or to a proportional share of a pool. In the case of water rights a secure title does not mean that the access to the water should be secure, but that the access rights should be. Nor does a secure title require that the rights cannot be attenuated, but attenuation should be on the basis of well-understood and recognized principles.

Enforceable and enforced. It must be possible to determine, including information requirements, when the rights have been infringed and to have legally binding ways of preventing this or providing redress.

Duration. What is the duration of the right? Is it permanent? What is the basis for reallocation and whether the right holder would have any preference for future allocations?

Transferability. What is the basis for initial vesting of the right and are there any limits on transferability; eg, to who, at what price, how often.

Source: Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09

Flexibility and divisibility

A water right has greatest value if it can be divided into component parts, eg if a permit to take 100m³ can be divided into 100 permits to take 1m³. In addition there is greatest value where there is complete flexibility over use, eg if the water right is not limited to be used for irrigating a particular crop but could be used to allow use of water for stock drinking water.

Hawke notes that currently some water use consents state that water can be used for a particular use, “even down to specifying the exact area and land use practice”.¹⁰⁵ Tradability is enhanced through flexibility, ie through not limiting the uses to which water can be put, either in space or land use type.

He also suggests that the variability in consents reduces their tradability; consents may be specified in terms of actual volume of water, per second, over a week, a season and/or over a year and they may also specify a maximum rate of take. The number of options reduces the flexibility, ie they are not specified in a way that translates easily into a single commodity.

Exclusivity

The issue of exclusivity is over whether holding a permit provides benefits that are not available to those without a permit. This would appear to be achieved through the combination of water use permits with the penalties for using water without a permit (Section 14 of the RMA). However, the other issue is whether new permits can continue to be issued once a resource is allocated, potentially diminishing the value of existing permits by reducing the certainty of water availability.

¹⁰⁵ Hawke (op cit) p16.

McGregor¹⁰⁶ notes that the 2005 case of *Aoraki Water Trust v Meridian Energy Ltd* addressed whether further consents could be issued to a number of parties for irrigation purposes when the resource, Lake Tekapo, was already fully allocated to a power company for electricity generation. The Court decided that granting any further consents would reduce the amount available to the first consent holder, Meridian Energy. McGregor goes on to note that by refusing to allow any further claim to the water, the Court effectively confirmed the principle that the right granted by consent to take and use a resource really amounts to an allocation of that resource.¹⁰⁷

This is also consistent with the requirements in the new NPS for councils not to over-allocate and to phase out existing over-allocations, as discussed in Section 4.4.

Quality of title

Quality of title refers to the extent to which owners and potential owners understand the benefits and obligations that the right brings. Water rights do not provide certainty of access to water, but the circumstances under which rights to water are attenuated are reasonably well understood.

Aqualinc, in its assessment of alternative institutional arrangements for water management, suggested an approach that allocates water to different “bands” reflecting reliability; they suggest this would provide greater transparency to the availability of water, helping to strengthen a water market. An example of the bands for the Waimakariri River is given in Table 8. It includes splitting in-stream requirements into those supporting aquatic ecosystems and those supporting recreational activities. In addition, they note that some of the ecological requirement for water is related to extreme flows (R5) that are particularly important in maintaining in-stream habitat and river form (which require the occasional high flow).

Table 8 Possible Water Reliability Bands - Waimakariri River

Band	Flow Rate	% of time above this flow rate	Assigned to:
R1	41 m ³ /s	97-100%	Aquatic ecosystems (require reliable water)
R2	63 m ³ /s	80-97%	Consented use
R3	84 m ³ /s	60-80%	In-stream public use
R4	111 m ³ /s	40-60%	Consumptive use (often into storage due to unreliability)
R5	>111 m ³ /s	<40%	Aquatic ecosystems (in-stream habitat and river form)

Source: Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development

The quality of the title is possibly reduced through problems with enforceability (see below).

¹⁰⁶ McGregor D (undated) Water Allocation and Trading – A New Zealand Perspective. Bell Gully.

¹⁰⁷ Appleyard J (2007) “Has the Resource Management Act Replaced the Property Law Act?” NZLS Intensive Resource Management 49, 60 In: McGregor D (undated) Water Allocation and Trading – A New Zealand Perspective. Bell Gully.

Enforceable and enforced

It is not always possible to determine when rights have been infringed, largely as a result of inadequate monitoring systems in many areas. This means that, for any possessor of a water right within a fully-allocated catchment in which demand exceeds supply of water, the extent to which other permit-holders maintain use to permitted amounts will affect whether the council needs to implement measures to limit aggregate use.

The lack of ability to properly enforce may reduce the quality of the title because other participants can affect its value by their behaviour.

Duration

The duration of the water right determines its value, with longer rights having greater value.

Transferability

Transferability increases the quality of the title as it is part of the flexibility of the right.

4.6.2 Need to Limit Property Right

The above discussion focussed on strengthening the property right. As noted above also, from another perspective, property rights might be too strong.

The chief concern appears to be that of introducing rights of ownership in water itself as opposed to ownership of access rights, especially those that are time limited. The concern is particularly that the establishment of rights in water may cut across and not recognise existing customary rights. The resolution of these issues is not the subject of this analysis.

4.7 Protecting the Interests of Landowners

Introducing separate rights for water that are tradable means that the value of the water right is associated with the water right directly, rather than with the land. Land that sells with the water right at the same time should retain its value as before.

The difficulties arise during the allocation of initial water rights; a move away from historical grandparenting of rights can affect land values which include these rights. If the allocation approach removes existing rights, or expectations of future rights (ie assumed roll-over of permits), existing land values will be affected. This is not an undesirable outcome, but one that may require careful management during the allocation phase. This is not necessarily related to trading, but the introduction of a trading system makes it more likely that alternative approaches to initial allocation will be used, particularly because the market value of permits means any free allocation results in a wealth transfer to recipients.

5 Addressing the Barriers – A Workable System

In this section we address the barriers noted above by describing how a tradable water rights system might operate.

5.1 The nature of rights

5.1.1 Take or use

The starting point for defining a tradable permit system is generally the definition of the commodity that is traded. Here a prior decision relates to the scope of the rights and specifically whether they are covering rights to take and/or use.

The discussion in Section 4 above suggests that the impacts relating to take and use can be very different in terms of location and characteristics. Takes reduce volumes of water in groundwater systems or flow rates in surface water systems. Use of water can reduce the net effect of takes and result in discharges, particularly of nutrients to water bodies.

Effects of take need to be addressed via specifications on the level, rate and timing of take.

Use permits are not so much rights to use water as rights to produce a set of effects related to water use. In some instances these effects can be covered by rules included in a regional plan; Sinner and Fenemor¹⁰⁸ make the point that site-specific impacts distant from the take point might be tackled via land use permits rather than water permits. Water use permits can be tradable to the extent that the effects can be clearly associated with a level of use of water in a geographically-defined location.

We agree that separation of take and use is an important component of the development of a trading system.

5.1.2 Water availability

The water availability issues are that, because of natural fluctuations, available water for allocation will vary over time. In the context of a trading system this means the certainty of being able to obtain a volume (or flow) allocation, or to exercise the right to discharge, will change over time. There are different ways to deal with water availability issues:

1. Scale back the allocations consistent with water availability, eg if only 50% is available, all consent holders are scaled back by the same amount. If permits remain tradable, this affects all rights equally, and retains the potential efficiency gains from trading, provided that trading has low transaction costs;

¹⁰⁸ Sinner J and Fenemor A (2007) Opportunities for separating the take and use of water in planning frameworks and resource consents. A Report for the Sustainable Water Programme of Action.

2. Defining commodities as percentages of an available resource rather than in absolute amounts. This is effectively what the first approach is achieving. This simply gets there via a different approach. It is the approach used in the specification of fishing quota in New Zealand.
3. Defining commodities with different levels of certainty, eg different bands of permits which will be more or less interruptible. The same outcome can be achieved through the above approaches, provided that there is an efficient short-term market in permits, eg where there is limited demand, those with highest value uses can purchase all available supplies. The advantage of having bands of permits is that it allows high value users to signal in advance their willingness to pay for not being interrupted and it reduces their uncertainty about the efficiency of a short-term market.

5.2 The commodity

A clearly defined tradable commodity is required. The specifications will differ between groundwater and surface water, and between quantity and quality markets.

5.2.1 Groundwater Takes

Groundwater take permits might be defined in terms of a maximum volume of consumption per annum from a given groundwater zone. This would be specified in m³/annum. These could be divisible down to, say 1 m³/annum.

Permits can either be specified with a vintage, eg 1m³ from groundwater zone x in 2012, or they might be specified as permanent or for a number of years. The obligation might differ between these approaches.

- With the permit vintage approach, the obligation might be:
 - to hold a permit for the specific year; or
 - to surrender permits to cover the level of take over the previous year, in a similar way to that for the NZETS.
- With the multi-year permit approach, the user would need to hold a permit for the specific year.

The advantage of the vintage approach is that a holder can sell these without fear of losing access to permits in later years, although this might also be achieved through temporary sale and/or lease arrangements, such as those which have taken place through Hydrotrader.

5.2.2 Rivers and Stream Takes

Takes from rivers and streams will require a defined flow rate, eg in litres per second. Permits sometimes have a maximum total volume attached to them as well, although it is unclear why this is the case. Because users may require water at different times of year, flow rate permits might be defined either with a season/month to which they apply (with potentially different amounts in different seasons) or they might be

specified to apply at all times. For the transfer of durations less than the full consent, trades would need to include the potential for leasing arrangements/temporary trades.

5.2.3 Lake takes

Lakes are broadly similar to groundwater systems. Depending on the local circumstances, permits might be defined in a similar way.

5.2.4 Discharge permits

Regional authorities manage water quality by considering the environmental effects of granting discharge permits. Consent is required in NZ for discharge of effluent, leachate, stormwater, contaminated water, and for a range of other activities such as spray painting.

Discharge permits are most readily defined either as:

- a rate (or concentration) of discharge of a specified pollutant or its effect (eg as biological oxygen demand or chemical oxygen demand);
- a total volume (load) of discharge.

For example, a permit to discharge dairy effluent might specify “the volume of undiluted effluent discharged shall not exceed 4,590 litres per day”.¹⁰⁹

Quality trading markets target more specifically the actual pollutant run-off from a property into nearby water bodies. The commodity traded in these schemes is the discharge right, in kilograms of pollutant leached per year. Non-point sources use modelling techniques to estimate pollutant run-off, whereas point sources can monitor at the point of discharge.

The most applicable method will differ with the specific water body and trading system in place.

5.2.5 Divisibility

Ideally, all permits should be divisible into any volume and any duration (and potentially other measures such as reliability).

5.3 Initial Allocations

Water permits will have a value. This means that someone with no permits will need to pay a price for permits equal to the opportunity cost of their use. Many current permit holders will have paid for the rights to water in the value of their land and making these land owners purchase these rights again is likely to be seen as inequitable. Some form of grandparenting (giving permits to current holders) is likely to be an acceptable approach. Most simply this would continue for the life of the existing permits.

However, as discussed earlier, although there is no guarantee of the renewal of water permits, generally this occurs. Thus current land prices may include an expectation that

¹⁰⁹ For example, see Environment Canterbury consent CRC001170 “Discharge of Dairy Effluent”.

water rights will continue to be associated with ownership of a specific piece of land, rather than lapsing with the possibility of no renewal, at the end of the existing permit. There is thus a debate to be had over whether grandparenting should be for a long time (permanent even) or only for the duration of the current permits.

If the council offers permits at a price less than their market value, all take permits might be acquired so that the initial purchaser can obtain a profit on sale. If the wealth transfer impacts are of concern, ways around this include setting up arrangements for auctions of permits, or to require those acquiring permits initially from the council (as opposed to purchasing in the market), to demonstrate use requirements. As noted above, our preference is for an auction-based approach or one that involves payment of a market price estimate, as this can result in a more efficient initial allocation (allocation to those that value rights the most).

5.4 New Entrants

There are different ways to treat new entrants and the way in which they are treated depends on the extent of current allocation.

- If the water rights are fully allocated, then new entrants would need to purchase rights from existing holders of rights;
- If the rights are not fully allocated, new entrants will need to obtain permits from the council directly. As noted above, the options are either to do so through a demonstration of use or through a pricing arrangement. Pricing (eg auction or sale at an estimated market price) reduces the transaction costs for the council (and ultimately the applicant) of demonstrating use.

5.5 Participation

The more participants in a market, the more “liquid” it will be, ie the more readily that buyers can find the commodities they wish to purchase and sellers can find a purchaser for their surpluses.¹¹⁰ Liquidity is an important element of the design of any market as it makes it more likely that trading will lead to an efficiency improvement in which permits are held by those that value them most.

The challenge for water trading will be over the number of potential traders. Ideally participation in the market should be widely available, including to those that wish to purchase rights but do not necessarily wish to use the water. Although the perceived risk is that speculators will enter to push up prices, in general the more participants, the more likely it is that efficient trading platforms will develop in which trading becomes simpler and prices become more transparent.

As transportation of water can be costly, transfer of water is most likely to take place between users located closely to one another. However this does not preclude the

¹¹⁰ Other elements that improve liquidity are low transaction costs (eg brokerage fees), transparent prices and clearly specified commodities

liquidity benefits of open market participation; the more potential buyers and sellers, the more likely it is that trades will improve efficiency.

5.6 Trading Platforms

In most trading systems governments have not needed to establish trading platforms. These have been developed and provided by private participants. The same is happening with water trading and we see little need for government or council involvement. If the commodity is clearly defined and trading facilitated by the legal framework, private platforms will develop where required by the market. This can happen rapidly, especially where there are existing firms that have established platforms for trading similar items. This includes HydroTrader, real estate agents and TradeMe.¹¹¹

5.7 Monitoring and Penalties

When water take or discharge permits have a market value, effective monitoring systems will be an important component of the system to maintain that value. The rights have value where there is certainty that not having a right, or not having sufficient rights, will be penalised. Thus monitoring and metering systems need to be developed alongside trading systems.

The general rule is that illegal activities are not worthwhile if the penalty is larger than the expected benefit (value of the activity multiplied by the probability of being caught).¹¹² To discourage taking water without a permit, penalties should be larger than the cost of a permit divided by the probability of being caught without a permit, ie if the cost of a permit is \$0.50/m³ and the probability of being caught is only 5%, then the penalty should be more than \$10/m³. Penalties should increase with the amount of non-compliance, ie a penalty should apply per permit that the person is short of that required.

¹¹¹ TradeMe, for example, has facilitated trades of voluntary carbon credits.

¹¹² Becker GS (1968) Crime and Punishment: An Economic Analysis. *Journal of Political Economy* 76(2): 169-217. This is also discussed in: Hargrave T, Kerr S, Helme N and Denne T (2000) Treaty Compliance as Background for an Effective Trading Program. Chapter 3 in: Kerr S (Ed) Global Emissions Trading. Key Issues for Industrialized Countries. New Horizons in Environmental Economics. Edward Elgar. pp: 43-83.

6 Conclusions

6.1 Where Trading Can Work

The points made by MfE on the circumstances under which trading systems for water permits can best work, provided as input to a 1997 review, remain valid. Trading systems can best work when:¹¹³

1. The resource is fully allocated, with demand exceeding supply.
2. There is sufficient knowledge of resource availability and the environmental effects of its use to enable the council to set effective constraints on transfer, and permit holders have certainty as to how those constraints will affect them.
3. Permits are enforceable and monitored, so that permit holders know unauthorised use will be prevented and that those transgressing permit conditions will be detected and penalised.
4. The market for transfer is not constrained and is sufficiently diverse to allow flexibility in transferring permits.¹¹⁴

These conditions are exemplified by water trading in Canterbury and Otago, particularly where catchments are over-allocated (1 above); management of the effects of nitrogen discharge through trading in Lake Taupo (2); and the early experiences of less constrained markets for transfer under the framework established by Waikato Regional Plan Variation 6 (4).

MfE also suggested that “private and community benefits exceed transaction (and other) costs”, taking account of:

- the administrative and legal costs of establishment;
- transaction costs in conducting trade; and
- enforcement and management costs in maintaining the system.¹¹⁵

Analysis of the full costs and benefits of trading is beyond the scope of this study but it is likely that a trading market can be developed at reasonably low cost from the current permit system. The current legal framework established by the RMA provides sufficient flexibility for the development of an effective trading system at a regional level.

Improvements could include the unbundling of water entitlements (take and use) which does not require legislative change. A national policy statement (NPS) might be used to provide guidelines for regional councils to establish effective markets, and more broadly

¹¹³ MfE (1997) Case Study 1: A Case Study of the Oroua Catchment Plan. In: MAF (ed) Transferable Water Permits: Two Case Studies of the Issues. MAF Policy Technical Paper 97/12.

¹¹⁴ Diverse in this sense refers to a range of buyers and sellers looking to trade permits. A broad range of uses for water, and a cross-section of farms with competing water requirements represent a diverse marketplace for water in New Zealand.

¹¹⁵ They also note that the less obvious costs of wasting water or losses in production which occur under a non-transferable system should be weighed against these transaction costs.

permitted activities relating to water use. However, it is likely that this can also be undertaken in a less formal way targeted at specific regional councils for which trading will be more effective and efficient. Policy requiring explicit criteria for the transfer of water permits in the National Freshwater Policy Statement 2011 is a useful first step.¹¹⁶

6.2 Key Design Elements

Building on the discussion in Section 5 above, Table 9 summarises the key design elements of trading systems for quantity and quality.

Table 9 Summary of Design Elements

Design Element	Quantity Trading	Quality Trading
Definition of rights that define the traded commodity	The right to take water from a water body	The right to discharge a pollutant into a water body
The commodity traded	Groundwater: right to take 1 m ³ per year from a specified groundwater zone Lakes: as for groundwater Rivers, streams: right to take 1 litre/second ^(a)	Groundwater/lakes: right to discharge 1 kg of pollutant per year Rivers & streams: right to discharge a pollutant
Initial allocation	Grandparented on the basis of existing take permits (for duration of current permits) Additional amounts via auction or sale	Grandparented on the basis of existing discharges or discharge permits
New entrants ^(b)	Auction or sale	Auction or sale
Participation	Anyone can hold permits ^(c)	Anyone can hold permits ^(c)
Trading platforms	No need for council or government involvement	No need for council or government involvement
Monitoring and penalties	Metering/monitoring required to protect the value of the permit. Penalties should be higher than the estimated cost of a permit divided by the probability of being caught	Metering/monitoring required to protect the value of the permit. Penalties should be higher than the estimated cost of a permit divided by the probability of being caught

Notes: ^(a) Many rivers and streams have total daily use limits, but it is not clear that this is necessary in addition to a flow limit; ^(b) New entrants can either obtain permits in the market or purchase from the council at a market price. ^(c) This is not a vital component of a design but would tend to increase efficiency.

The Australian experience has suggested that trading for quantity is best limited to systems with high degrees of storage that provide greatest certainty to water flows. In New Zealand groundwater systems appear to provide a greater level of volume certainty and as a result have experienced the majority of trading.

We believe that the separation of take and use components, and the development of trading of take permits, offers the most promise.

Maximum divisibility of permits increases the potential efficiency of a tradable system of water rights. Ideally permits would be divisible in a way that enables a permit holder

¹¹⁶ National Freshwater Policy Statement (2011) Policy B3.

to obtain and use water for short periods, particularly where two or more users have requirements that fall in separate time periods. Where the take point does not shift, this would not require any trading of take permits. What is changing is the person who is using the water and having (volume and quality) impacts. Divisibility of permits requires a detailed and effective permit register, and we discuss this in more detail below. It would need to record who had a permit and the time period over which they had a permit. Whether this is termed a temporary sale, a lease or the sale of a part of a permit is somewhat semantic. What is required to make it effective is that the register records the time period over which a person possessed the rights and the extent of those rights (volumes).

For quality trading, the successful development of trading systems already in New Zealand suggests that this has considerable promise also. Because these systems are dominated by non-point discharges they rely on modelling of discharges.

6.3 Participation

The discussion of trading in this review has focussed on consumptive uses, and specifically in agriculture (irrigation, stockwater), rather than temporary, non-consumptive uses such as hydro electricity. These are very different uses of water.

6.3.1 Hydro Electric Power

Hydro electric use of water may reduce the availability of water for on-farm use over certain stretches. To this extent, requiring generators to purchase take permits from current holders may be a useful approach that serves to internalise some costs of hydro electricity and provides compensation to current permit holders. However, this will not always be suitable. For example, there will be instances where hydro electric use of water might have some effects on existing irrigation schemes but might be addressed through changing the location of take rather than requiring a reduction in take.

Most suitably these issues and options would be considered during the consenting process for a new hydro electric plant. The introduction of a system of tradable water permits will not remove the need for such a consenting process. In this context, purchase of tradable permits by generators might be used in some circumstances to address these local effects on farmers.

6.3.2 Treatment of Domestic Water Requirements

The specification of section 14 (3) (b) adds some complexity to the trading system, in that water can always be taken for an individual's reasonable domestic needs, or for the reasonable needs of an individual's animals for drinking water. Thus rights to water might be reduced as a result of requirements for these other uses. There are different possible responses.

- Additional household use of water may remain as a risk to all extractive users of water. This would result in some reduction in value in areas where there was a perceived risk.

- Requiring household uses (most likely the council) to obtain (purchase) permits where using additional water would reduce the amounts available to current permit holders.

The choice of approach depends on decisions relating to where the risk should appropriately fall. Requiring councils to purchase permits where required maximises the value of permits and the trading system.

6.3.3 Regional Participation

If trading is to develop, it is most likely to occur in regions that have the greatest expected supply shortfall. These are those identified in Figure 4, ie Canterbury, Otago, Marlborough and Tasman in the South Island, and the Waikato and Bay of Plenty (and potentially Auckland), in the North Island.

6.4 Government Involvement

6.4.1 Guidance

The US experience with the development of trading systems for NO_x, and most recently for multiple pollutants, is that of the national (federal) government producing model rules that States can adopt or modify to implement trading systems. This appears to be a useful role for the government in the development of water trading; a point that is also raised by Hawke.¹¹⁷ There are formal approaches for achieving this, such as via a National Policy Statement (NPS) but this is not necessary. It can remain a guidance document.

Particular issues that might be covered by such a document would include:

- the definition of the traded commodity or commodities. This could include advice relating to
 - the division of permits into take and use;
 - the divisibility of permits over time and volume;
- advice on approaches to initial allocation and renewals.

The nature of such a document would be a discussion of issues and examples of how regional rules might be written.

6.4.2 Trading Platform

There is often a tendency for governments to over-design trading systems and to provide elements or rules where these can be provided more efficiently and effectively

¹¹⁷ Hawke R (2006) Improving the Water Allocation Framework in New Zealand: Enhanced Transfer. Ministry of Economic Development Occasional Paper 06/09.

by the private sector,¹¹⁸ eg the development of trading platforms. Systems are developing currently via HydroTrader and local estate agents.

6.4.3 Register

There will be a requirement for a permit register in which current permit holders are clearly identified. Transfers over time can be recorded also. Because trades are local rather than national in scope, ie they are geographically highly limited, a national register is not required. However, the government might facilitate the development of registers that can be used by local governments.

A register would need to record the initial holder of the permit, the permit's duration and volumes (or discharge quantities) associated with it. When there is a trade, the register would need to record:

- the new owner;
- the permit number so that it can be linked back to the original holder;
- the volume and time period to which the trade applies

6.4.4 Legislation

It is unlikely that new legislation is required to establish a system of tradable rights in water. The RMA allows take and use elements of permits to be separated, and this is already being pursued by the Waikato Regional Council. Other legislation relating to commerce and trade would apply also, eg the Fair Trading Act 1986 and the Commerce Act 1986.

¹¹⁸ This is a point that has previously been emphasised to the primary author by US officials involved in the design and introduction of trading for SO₂ and NO_x.

Annex 1 Market Values of Water

A1.1 Irrigation

Aqualinc¹¹⁹ uses MAF values¹²⁰ on the GDP benefits of irrigation in individual regions to estimate the value of additional water allocation to irrigation. However, GDP benefits are misleading as a national benefit as analysis tends not to take account of opportunity costs, ie that some of the resource inputs used to measure GDP would not be idle otherwise. This applies particularly to labour resources; payments to labour are included as contributing to GDP whereas for cost benefit analysis these are treated as opportunity costs, representing what labour could have been earning elsewhere in the economy.

Reflecting this difference, in their national cost benefit analysis, Harris and Skilton¹²¹ estimate labour and transition capital costs for the different land uses and regions and use these to adjust the values developed by MAF.¹²² They present the results for a limited selection of regions (Table 10). The regional differences in value per hectare reflect differences in land use (eg horticulture vs pastoral farming) and climatic conditions (temperature and rainfall).

Table 10 Comparison of Value of Irrigation (\$/ha) (2004 values)

Region	GDP Contribution (\$/ha) ^a	Net Benefit of Water (\$/ha) ^b
Waikato	3,840	3,814
Canterbury	1,166	985
Marlborough	4,250	4,166
Otago	1,269	1,191
Tasman	4,656	4,320
Weighted average	1,930	1,407

Source: ^a Doak M, Parminter I, Horgan G, Monk R and Elliot G (2004) The Economic Value of Irrigation in New Zealand. MAF Technical Paper No: 04/01; ^b Harris S and Skilton D (2008) Cost-benefit Analysis for a National Environmental Standard for Water Measuring Devices. Report Prepared for the Ministry for the Environment. Harris Consulting.

In order to compare with other uses of water, data are needed on returns to water. An Aqualinc study for Environment Waikato¹²³ provides both per hectare and per m³ numbers (Table 11); it estimates a value of irrigation water of \$0.10-0.13/m³. We note that these estimates of per hectare benefits (\$291-380/ha) are approximately an order of magnitude less than those in Table 10 suggesting considerable uncertainty over these

¹¹⁹ Aqualinc (2008) Sustainable Freshwater Management – Towards an Improved New Zealand Approach. Prepared for the New Zealand Business Council for Sustainable Development.

¹²⁰ Doak M, Parminter I, Horgan G, Monk R and Elliot G (2004) The Economic Value of Irrigation in New Zealand. MAF Technical Paper No: 04/01.

¹²¹ Harris S and Skilton D (2008) Cost-benefit Analysis for a National Environmental Standard for Water Measuring Devices. Report Prepared for the Ministry for the Environment. Harris Consulting

¹²² Doak et al (op cit).

¹²³ Aqualinc Research Ltd (2004) Irrigation Efficiency and Water Allocation in the Waihou Catchment. Environment Waikato Technical Report 2005/09.

values. The per hectare benefits of Table 10 might suggest water values of over \$1/m³, assuming the same water use per hectare as in Table 11.

Table 11 Returns to Irrigation using Different Systems

Irrigation system:	K Lines	Long-lateral	Centre-pivot	Gun
Marginal benefits (\$/ha)	291	338	380	363
Returns to water (\$/m ³)	0.10	0.11	0.13	0.12

Source: Aqualinc Research Ltd (2004) Irrigation Efficiency and Water Allocation in the Waihou Catchment. Environment Waikato Technical Report 2005/09

One other data source is a 2005 report for MfE that examined the impacts of irrigation in the Mackenzie Basin.¹²⁴ For a volumetric entitlement of 172,687,430m³ per annum, it estimated a total value of water for irrigation of \$12-13 million per annum; this is equivalent to \$0.07-0.08/m³. However, this did not provide information on actual consumption (as opposed to permitted use) for which the value per m³ would be higher.¹²⁵ The mean demand is about 70-80% of the allocation, which would suggest a range of values of \$0.10 - \$0.11/m³.

Reports by SKM¹²⁶ and by Harris Consulting and others¹²⁷ assessed the value of potential uses of water in the Waitaki Catchment. They examined the costs and net present value of irrigation expansion discounted over 30 years. Given the up-front capital costs of conversion and the benefits that spread over time, these results demonstrate the importance of discount rate choice in calculating the net benefits of water. Aqualinc¹²⁸ showed the sensitivity of returns to dairy payouts (the price for milk as paid to farmers) (Figure 8) with irrigation water having a positive value to dairy farming above a milk price of \$3.89/kg milk solids. This is of particular note as dairy payouts have increased significantly since 2004.

¹²⁴ Ian Brown Consulting and Harris Consulting (2005) Environmental, Economic and Social Impacts of Irrigation in the Mackenzie Basin. Report to the Ministry for the Environment.

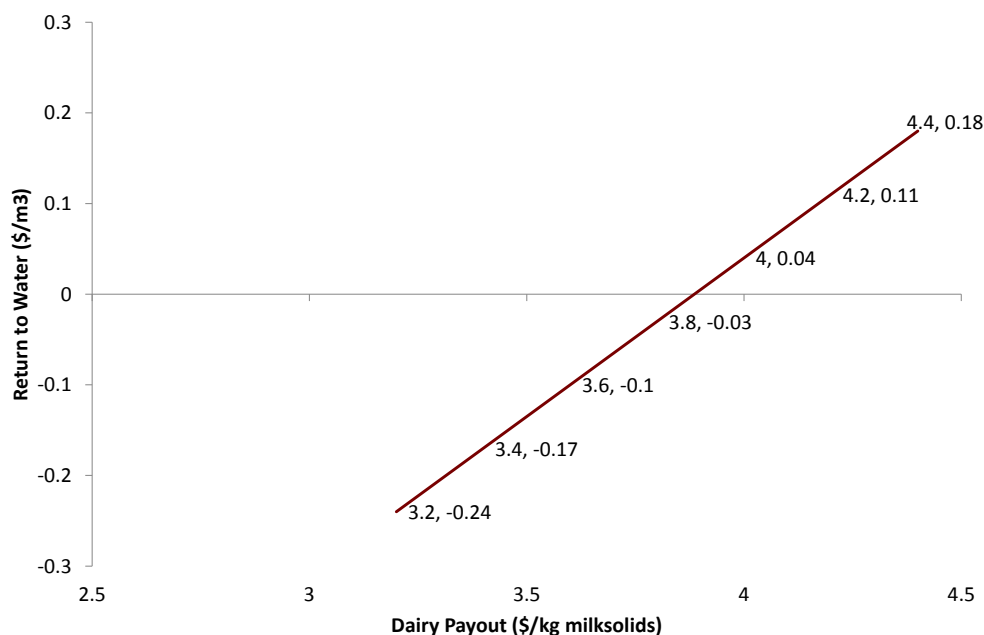
¹²⁵ Because the actual use is less than the permitted use the value per cubic metre would be estimated using a smaller denominator

¹²⁶ SKM (2004) National Cost Benefit Analysis of Proposals to Take Water from the Waitaki River. Final Report for Ministry of Economic Development.

¹²⁷ Harris Consulting, NZIER and Taylor Baines and Associates (2004) Regional Economic Analysis – Uses of Water in the Waitaki Catchment. Report for the Ministry for the Environment.

¹²⁸ Aqualinc Research Ltd (2004) Irrigation Efficiency and Water Allocation in the Waihou Catchment. Environment Waikato Technical Report 2005/09.

Figure 8 Sensitivity of Irrigation Benefits to Milk Payout



Note: figures next to the line show (dairy payout, return to water)

Source: Data from Aqualinc Research Ltd (2004) Irrigation Efficiency and Water Allocation in the Waihou Catchment. Environment Waikato Technical Report 2005/09

A1.2 Stock Water

Water is used for a variety of farm stock (dairy cattle, beef cattle, sheep, deer, horses, goats, pigs and poultry) for drinking water, milk cooling and plant/yard wash down, and for cleaning animals (horses, poultry and pigs). The value of water for stock use can be derived using gross margins (per stock unit or animal) and the water requirements per animal. A gross margin is calculated as the total income derived from some unit (a farm, a hectare or an animal) less the variable costs incurred in adding and managing the unit. It is thus a useful measure of the marginal value of adding an additional animal or hectare to a farm. Analysis using gross margins would be based on an assumption that allocation of additional water would enable additional stock to be added to a farm. The farmer gains the additional (gross) revenue and would need to pay the variable costs associated with adding another animal. In theory the farmer would be willing to pay additional costs up to the total surplus in order to add the additional animal; this cost can be used as an estimate of the willingness to pay for water.

Some estimates of stock water value using gross margins are provided in Table 12. The estimated value of stock water for dairy cattle is \$24/m³ and \$10-22/m³ for dry cows. However, there is a note of caution required to avoid double counting value between irrigation water and stock water. For dairy cattle, irrigation allows additional cattle to be added per hectare, and each additional cow requires additional drinking water. Attributing all the surplus (gross margin) to the stock water as a willingness to pay means there is no willingness to pay for irrigation water (and vice versa). The calculation is best undertaken for both irrigation water and stock water combined, and as an allocation to dairy farming, rather than as an allocation individually to stock water and to irrigation. Under this approach, water required for dairy farming includes

irrigation water of approximately 3,000m³/ha (derived from Table 11 and approximately 116m³/ha for drinking water (assuming 3 cows/ha), approximately 4% of the total. Consideration of stock water requirements reduces slightly the value of water estimated simply by using the irrigation numbers (Table 11).

Table 12 Estimates of Stock Water Value Using Gross Margins

	Dairy Cows	Dry Cows
Gross margin		
\$ per head	\$940 ^a	\$162 ^d
\$ per stock unit	\$134 ^b	\$34 ^e
Water use		
m ³ /head/year	38.7 ^c	7.3 – 16.4 ^f
m ³ /stock unit/year	5.5 ^b	1.5 – 3.5 ^d
Value (\$/m ³)	24.30	9.83 – 22.12

Notes: ^a Source: Perrin Ag Consultants (2010) Drury South Land Use Classification Analysis; ^b Assumes 7 stock units per dairy cow; ^c assumes 36 litres/head/day (Aqualinc 2007 Reasonable Stock Water Requirements Guidelines for Resource Consent Applications Technical report ~ December 2007. For Horizons Regional Council) plus 70l/h/day in the dairy shed (Aqualinc 2007); ^d assumes 4.75 su/dry cow; ^e Estimated as 6.2c/kg DM and 550 kg DM/SU from Farmax Annual Report. Farmax News (www.farmax.co.nz/download/Farmax%20newsletter%20No8.pdf); ^f 20-45l/head/day (Aqualinc 2007).

The estimates are simpler for dry cows for which there is a single use of water. The estimates suggest a greater willingness to pay for stock water for dry cows than total water for dairy. This is not to say that dry land farming is more profitable than dairy farming, but rather that water is a minor input to dry land farming. It can afford to pay more for water because it does not use very much.

A1.3 Hydro Electricity Generation

Hydro electric use of water is non-consumptive, but it makes water unavailable for other uses over some stretches of a river. The value of water for hydro electricity generation can be derived from information relating to the river (flow rate) and the station (height of water drop and turbine efficiency). Because of the high costs of plant construction, the value of water for hydro electricity differs between new and existing plants.

Existing Stations

The power output from a hydro plant is determined by the following formula:¹²⁹

$$\text{Power} = \text{Gravity} \times \text{Flow} \times \text{Head} \times \text{Efficiency}$$

Where: Power = output in kilowatts
Gravity = 9.81 m/sec/sec
Flow = m³/second of water flow through the turbine
Head = height in metres, ie the distance the water falls to the generator
Efficiency = the amount of power generated by a specific turbine as a fraction of the theoretical output

¹²⁹ See for example <http://www.pioneergen.co.nz/Hydro-Power.aspx>

Mighty River Power (MRP) publishes data on its Waikato River plants, including the head and the instantaneous flow rate required to generate 1 MW. We use this to estimate plant efficiencies and volume requirements per unit output (m³/MWh) (Table 13). The MRP data are provided in the first two columns; these are used to estimate a theoretical output eg $9.81 \times 3.7 \times 33.5 \times 100\% = 1,216\text{kW}$ and thus an efficiency, given that the flow rate is for the generation of 1MW (or 1,000kW).¹³⁰ The range of values includes an output from the Whakamaru Station that is above the theoretical maximum; we are unsure of the explanation of this and ignore the value below. We use the flow rate data to calculate the water volume required to generate 1 MWh.¹³¹

Table 13 Hydro Output for Mighty River Power Waikato River Plants

Station	Net head (m)	Flow (m ³ /s/MW)	Theoretical Output (kW)	Efficiency (%)	m ³ /MWh
Aratiatia	33.5	3.7	1,216	82%	13,320
Ohakuri	34.7	3.6	1,225	82%	12,960
Atiamuri	24.6	4.9	1,182	85%	17,640
Whakamaru	30	3.12	918	109%	11,232
Maraetai	61	2	1,197	84%	7,200
Waipapa	30	7	2,060	49%	25,200
Arapuni	52.4	2.16	1,110	90%	7,776
Karapiro	30	3.77	1,110	90%	13,572

Source: Mighty River Power; Covec calculations

Similar analysis of a number of small Otago power plants owned by Pioneer Generation shows generation efficiencies ranging from 47% (Wye Creek) to 91% (Ellis).¹³² Meridian Energy has a number of plants with significantly larger head heights than MRP but they do not publish the flow rates. In Table 14 we show an estimate of possible flow rates and water requirements for plants that range from 21.5m height at Waitaki to 166m at Manapouri. In the absence of plant-specific data we examine the implications of efficiency rates of 50% and 90%. The range of water requirements is from 2,456m³/MWh to 34,137m³/MWh to achieve the stated outputs.

Table 14 Range of Possible Flows and Outputs from Meridian Plants

Station	Net head (m)	50% efficiency		90% efficiency	
		Flow (m ³ /s/MW)	m ³ /MWh	Flow (m ³ /s/MW)	m ³ /MWh
Aviemore	37	5.5	19,836	3.1	11,020
Benmore	92	2.2	7,978	1.2	4,432
Manapouri	166	1.2	4,421	0.7	2,456
Ohau A	59	3.5	12,440	1.9	6,911
Ohau B & C	47.5	4.3	15,451	2.4	8,584
Tekapo A	32	6.4	22,936	3.5	12,742
Tekapo B	145.7	1.4	5,037	0.8	2,799
Waitaki	21.5	9.5	34,137	5.3	18,965

Source: Net head heights from Meridian Energy

¹³⁰ $1,000/1,216 = 82\%$

¹³¹ Flow rate $\times$ 3600 (ie the number of seconds in 1 hour), eg $3.7 \times 3600 = 13,320$

¹³² Pioneer Generation. Hydro Electric Schemes. www.pioneergen.co.nz/Brochure-2009.pdf

To estimate the value of water for this generation we simply use average wholesale electricity prices. We do not include any costs of generation as there are essentially zero variable costs for hydro stations.¹³³ Using an average price may not properly reflect values for storable hydro as they will tend to release water from storage during periods when they can earn a higher than average price, however the values will be discounted given that there will be a time delay before generation. Table 15 shows estimates of the value of water in hydro generation on the basis of average electricity prices at the Haywards electricity node (near Wellington) over the period 2008-10.¹³⁴ This suggests the value of water in hydro generation can range from approximately \$1.40 to over \$50 per thousand m³. These values are much lower than values in irrigation, but a difference is that hydro use of water does not consume the water;¹³⁵ it just moves it and makes it unavailable for other uses at a particular location and time.

Table 15 Value of Water in Hydro Generation

	Haywards price (\$/MWh)^a	Water value (low) (\$/1,000m³)^b	Water value (high) (\$/1,000m³)^c
2008	125.55	3.68	51.12
2009	46.93	1.37	19.11
2010	61.21	1.79	24.92
2011	62.09	1.82	25.28

Notes: ^a Average price at the Haywards electricity node (near Wellington) – source Electricity Authority Centralised Dataset; ^b Assumes 2,456m³/MWh; ^c Assumes 34,137m³/MWh

New Generation Plants

By new generation plants we mean plants that have not yet been built and for which a decision is being made on whether water should be allocated to it as opposed to other uses. The calculation being made is the price that the plant would be willing to pay for water. We would expect this to be very low, and probably close to zero.

Hydro generation has high capital costs that need to be recovered from the value of generation over the life of the plant. Current estimates of the average costs of generation¹³⁶ from new hydro are higher than the average wholesale price of electricity according to recent estimates by the Electricity Authority;¹³⁷ some types of hydro are relatively low cost and there will be some specific sites that will be better than others. The Electricity Authority's cost calculations will have been made with an assumption of a zero price of water. Most new generation plants will just cover their costs, taking account of the costs of capital and running costs over their lifetime (otherwise they would have been built already). However, this suggests that there is no surplus available which might be used to pay for water.

¹³³ This is the assumption used by the Electricity Commission in its market model.

¹³⁴ The Haywards node is often used as a proxy for an average price in New Zealand.

¹³⁵ There is some additional evaporation.

¹³⁶ By average we mean the annualised total costs of generation, including annualised capital costs, divided by the electricity produced.

¹³⁷ Electricity Commission (2010) 2010 Statement of Opportunities.

If the plant is built, the capital costs are sunk and are no longer relevant to the value. Once built the value of water to hydro generation becomes the higher value as estimated above for existing plants.

A1.4 Industry

There is a very wide range of uses of water in industry. This includes high value industries that may have very little use of water, eg service industry (offices) and others that have very high uses. The only identified study that reports on water use by industry is that of Ford et al;¹³⁸ they use 1997/98 data obtained from McDermott Fairgray to derive an estimate of value added¹³⁹ (contribution to GDP) per m³ of water consumed. The results in Figure 9 show total value added by each industry plus that of supporting industries, divided by the water consumption of the named industries and supporting industries.

This approach can result in very high estimates of willingness to pay for water. For example, the highest estimate is for real estate services for which an estimate has been made of the consumption of water by real estate offices. The calculation then spreads the whole value added of the industry across the very small amount of water consumed. However, it is a very large stretch from this to say that the industry would be willing to pay \$203/m³ for water as is suggested. However, it is likely that some industries will be willing to pay significant amounts for water.

A1.5 Residential and Other Reticulated Users of Water

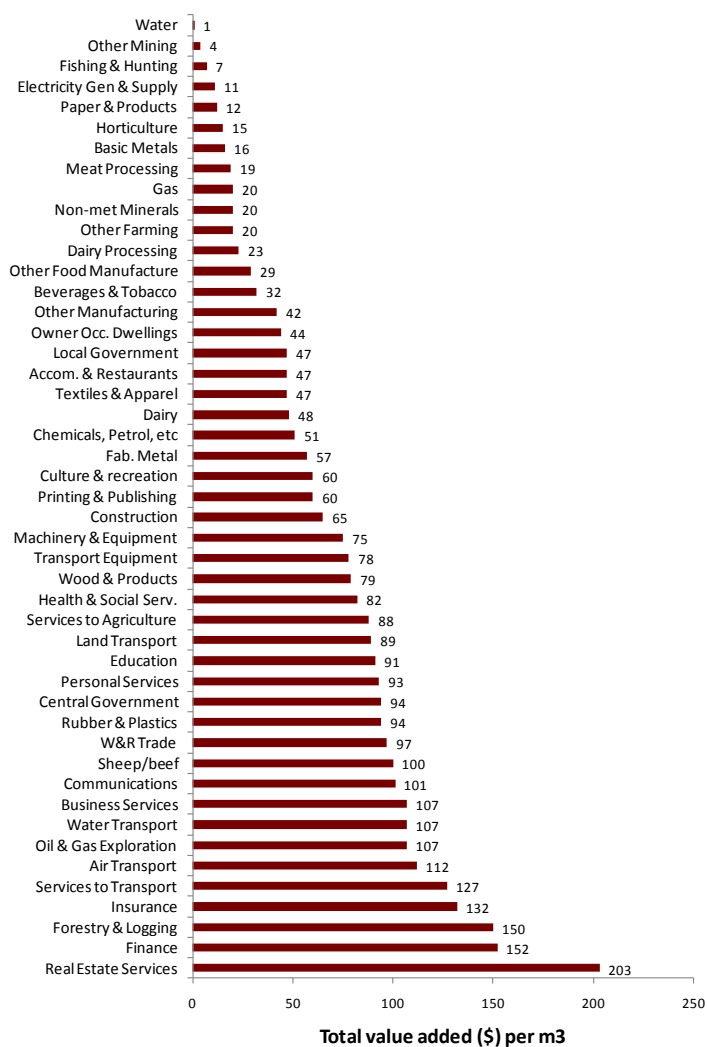
There are few data on the value of water to residents, eg in the form of a willingness to pay for water¹⁴⁰ or the costs of non-supply. Rather we assume that drinking water requirements are dealt with separately from the contestable allocations, ie drinking water providers will not be bidding for allocations. However, there may be some non-essential uses of water that are supplied via the reticulated system that may be better allocated to alternative uses.

¹³⁸ Ford S, Butcher G, Edmonds K and Braggins A (2001) Economic Efficiency of Water Allocation. MAF Technical Paper No 2001/7.

¹³⁹ Value added is similar to profit but it includes payments to workers (including owners).

¹⁴⁰ There are some estimates in White PA, Sharp BMH and Reeves RR (2004) New Zealand water bodies of national importance for domestic use and industrial use. Prepared for Ministry of Economic Development.

Figure 9 Total Value Added per Volume of Water Used (\$/m³)



Source: Ford S, Butcher G, Edmonds K and Braggins A (2001) Economic Efficiency of Water Allocation. MAF Technical Paper No: 2001/7

Annex 2 Lessons from Water Trading in Other Countries

This annex summarises some key elements of water trading systems in other countries. Quantity and quality markets are analysed in turn through discussion of the characteristics of a marketplace, as evidenced by examples from trading systems in other countries:

- **Commodity:** What is traded? The nature of the property right. How it is specified?
- **Participants:** Who is eligible to participate in trading? What is the role of the authorities or brokers?
- **Time Considerations:** Does the commodity have a time component, and how divisible is it? Can allocations be banked?
- **Design:** Including discussion of the institutional framework, the buying and selling process, and specifics such as environmental limits.

A2.1 Quantity Trading

A2.1.1 Defining the Commodity

The commodity in water quantity markets appears at first to be simply physical volumes of water. Value is generated from water from a variety of activities: irrigation of farmland, stock water, electrical generation, and a variety of industry and in-stream uses. The commodity in this case is split into the right to remove quantities of water from nearby systems, and the right to apply this water to a given purpose. In quantity markets, these rights are traded.

In California, landowners are permitted to pump groundwater¹⁴¹ so long as the use is reasonable and beneficial. Appropriative rights to water are allocated by the State Water Resources Control Board (SWRCB), and represent the right to divert water, so long as it is applied to beneficial use.¹⁴² California water markets trade permits, a commodity representing volumes of water which can be diverted and used beneficially.

Historically, and as is the current case in New Zealand, water consents include the right to *take* water out of the system, and the right to *use* water for a particular activity. In the Waikato region these two elements have been split in the development of a system of tradable rights. Typically water markets in Australia divide the commodity into the following elements:

- **Shares:** a right to a portion of the annual allocation, equating to a percentage of available volume;
- **Allocation:** quantities of water which may be removed from the system, specified as a volume per time period;

¹⁴¹ Groundwater which is flowing in a known and definite channel is treated the same as surface water. Percolating groundwater is outside the laws of surface water.

¹⁴² California Environmental Protection Agency (1999) Guide to Water Transfers.

- Use License: permitting the purpose of the water; and
- Delivery share: right to have water delivered to an area.

We explore examples from individual States below.

A2.1.2 Participants

Trading systems limit participation. For example:

- persons in Western Australia are only eligible to hold a water license if they have legal access to the land to which the license relates;¹⁴³
- the California State Water Resources Control Board (SWRCB) will only allocate appropriative permits if the water will be applied to a “beneficial use”.¹⁴⁴

A2.1.3 Australia's National Water Initiative

To ensure the long-term sustainability of Australia’s water the Council of Australian Governments (COAG) agreed that States should implement comprehensive systems of water allocation and entitlements backed by the separation of water rights from land title and clear specification of entitlements, and that the use of tradable water rights should be initiated.¹⁴⁵ This was built on in the National Water Initiative (NWI), in which governments across Australia have “agreed on actions to achieve a more cohesive national approach to the way Australia manages, measures, plans for, prices, and trades water. The NWI represents a shared commitment by governments to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity, for rural and urban communities, and for the environment.”¹⁴⁶ Under the NWI governments have made commitments to increase the trade in water rights.

A2.1.4 South Australia

A water licence provides a legal authority to take water from a prescribed water resource. Water licences are a personal property right and are not attached to land. Water licences have allocations endorsed on them as well as conditions as to how the water can be taken and used. The allocations and conditions reflect the provisions in the relevant water allocation plan. The entire licence, or parts or all of the allocation on the licence, may be traded according to the rules in the water allocation plan.¹⁴⁷

South Australia is currently in the process of unbundling water rights in which the existing water licences will be separated into their main components. These are set out in Table 16. There is a take element that includes the water access entitlement (defining the right to a share of the physical resource) and a right to construct works to abstract

¹⁴³ Government of Western Australia - Department of Water (2010) Operational Policy 5.05.

¹⁴⁴ California Environmental Protection Agency (1999) Guide to Water Transfers.

¹⁴⁵ Beech K (2006) The Use of Tradeable Water Rights in New Zealand. A dissertation submitted in partial fulfilment of the requirements of the degree of Bachelor of Laws (Honours) Faculty of Law University of Otago, Dunedin.

¹⁴⁶ www.nwc.gov.au/reform/nwi.

¹⁴⁷ www.pir.sa.gov.au/wid/water_resource_management/water_licensing_and_trading.

water (Water Resource Works Approval); and a use element (the site use approval). However, the volume of water taken is split from the other elements as a Water Allocation. In addition there are entitlements relating to access to a distribution system (a Delivery Capacity Entitlement).

A transfer can:

- include the transfer of a licence (including the allocation) to another person or legal entity, or the transfer of all or part of a water allocation from one licence to another licence;
- be short-term (known as a temporary transfer) or for an indefinite period of time (known as a permanent transfer);
- include a transfer of water between licensees within South Australia (intrastate transfer), or in the case of River Murray Licenses from other States to South Australia and from South Australia to other States in the case of a (interstate transfer).

Table 16 Unbundled Rights in the South Australia Water Trading System

Right	Description	Tradability
Water Access Entitlement	The on-going right to a specified share of the water resource, expressed in unit shares	Can be sold or transferred permanently or for a limited period
Water Allocation	The actual volume of water you are able to take in a water use year (it may vary from year to year depending on availability)	Can be sold or transferred
Water Resource Works Approval	A permission to construct, operate and maintain works (such as a pump, meter, well or dam) to take water at a particular location in a particular way	Not transferable
Site Use Approval	A permission to use the water at a particular location in a particular way	Not transferable
Delivery Capacity Entitlement	Right to access a proportion of the capacity of a water distribution system	Fully tradable

Source: www.pir.sa.gov.au/wid/water_resource_management/separated_water_rights; and Primary Industries and Regions Information Paper: Separating water entitlements

Most trading in the region takes place in the River Murray, 1,084 entitlement trades have taken place since 2009, amounting to 157 million shares changing hands.¹⁴⁸ In the same system, 2,867 trades of water allocations have taken place, at an average volume of 823 thousand m³ per trade.

¹⁴⁸ Department of Environment, Water and Natural Resources (2012) Water Connect – Water Trade Reporting.

A2.1.5 Victoria

Several water systems in Victoria have been declared as ‘regulated’; meaning that water levels are controlled through major storages and weirs. For these regulated systems in the Murray, Ovens, Broken, Goulburn, Campaspe, Loddon and Bullarook systems¹⁴⁹, water take and use licenses are unbundled into three new entitlements (Table 17).

Table 17 Water Rights in Victoria, Australia

Entitlement	Description
Water share	A share of the water available to be taken from a water system. Water shares are specified as a maximum volume of seasonal allocation that may be made against that share. They may be high-reliability ¹⁵⁰ or low-reliability ¹⁵¹ shares, where reliability is defined by the frequency with which full seasonal allocations are expected to be available.
Delivery share	An entitlement to have water delivered to land in an irrigation district and a share of the available water flow in a delivery system. Linked to land, stays with the property.
Water use licence	A water-use licence authorises water to be used for irrigation in a declared system, while a water-use registration authorises use for other purposes. Water-use licences and registrations were created as part of the unbundling reforms. Each water-use licence includes an annual use limit, and may also contain conditions specific to the location and circumstances of that particular licence. The licence (or registration) is attached to a specific parcel or parcels of land, and runs with the land if the land is sold, unless part of the property is sold separately.

Regulated Water – Shares and Allocations

For the regulated water systems declared in 2007 and 2008,¹⁵² water shares are legally recognised as a secure share of the available water take.¹⁵³ Specified as a maximum volume (thousand m³), a water share represents a perpetual right to a portion of the water resource, subject to conditions on caps or minimum flow rules.¹⁵⁴ Across the water season, the resource manager makes seasonal determinations, which specify what percentage of water share volumes are converted into actual water allocation for that season.¹⁵⁵ High reliability shares receive first priority for available water, being expected to reach an allocation of 100% in 95 years out of 100. Historical seasonal allocations for Northern Victoria are depicted in Figure 10

¹⁴⁹ Department of Sustainability and Environment (2012) Water Register – Glossary.

¹⁵⁰ High-reliability water-shares are expected to reach 100% allocations in 95 years out of 100.

¹⁵¹ In northern Victoria, these shares will be of the available water once there is enough water to meet higher-reliability water shares in the current year, and, with minimum inflows, to meet higher-reliability water shares in the following year.

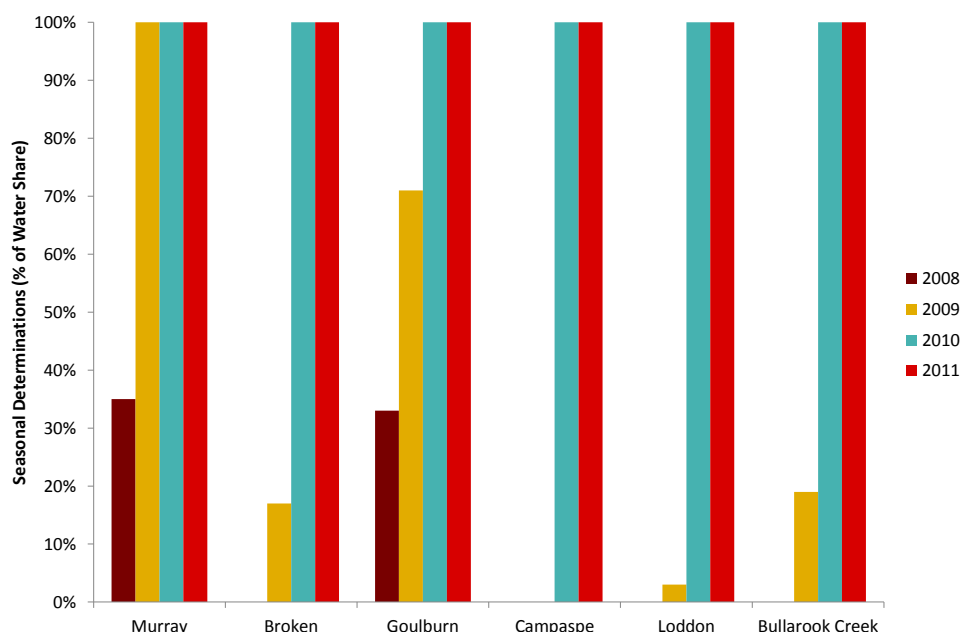
¹⁵² Thwaites, J (2007) Order Declaring Water Systems in Northern Victoria 2007.

¹⁵³ Thwaites, J (2007) Conversion Rules for Regulated Water Systems in Northern Victoria.

¹⁵⁴ Sinner, J, & Fenemor, A (2007) Opportunities for separating the take and use of water in planning frameworks and resource consents. Landcare Research.

¹⁵⁵ Department of Sustainability and Environment (2012) Victorian Water Register – Seasonal determinations.

Figure 10 Seasonal determinations for Northern Victoria, 2008-2012



Source: <http://www.nvrm.net.au/allocations/current.aspx>.

A person holding a high reliability water share of 100,000 m³ in Murray in 2009 would have received an allocation of 35,000 m³ for the year.

Both the water share (perpetual right) and the seasonal allocation (annual volume) are tradable on the Victorian Water Register.¹⁵⁶ Water shares can be held as an asset separate from land and sold, leased, or borrowed against (mortgaged).¹⁵⁷ Trades are allowed between water trading zones. Where this happens, the water share and allocation remain attached to the original system, but the allocation is 'tagged' for use in the new area. Tagging leads to the water share being associated with the new land, and is subject to additional administrative requirements from the interstate body to account for these allocations.¹⁵⁸ For example if trading from the Murray system to Goulburn, the water share source remains attached to the Murray system, with annual allocations of water from the Murray being tagged for use in Goulburn.¹⁵⁹ In 2010/11 there was 8.8 million m³ of inter-authority trade.¹⁶⁰

If approved by the local water corporation, based on local trading rules, volumes of water allocation which are unused can be transferred from the seller's allocation bank account to a buyer's bank account for use within the current period.¹⁶¹

¹⁵⁶ Department of Sustainability and Environment (2012) Victorian Water Register.

¹⁵⁷ Department of Sustainability and Environment (2012) Unbundling in Victoria.

¹⁵⁸ Department of Sustainability and Environment (2012) Water Act 1989 – 'Trading Rules.' Victorian Water Register – Rules and Maps.

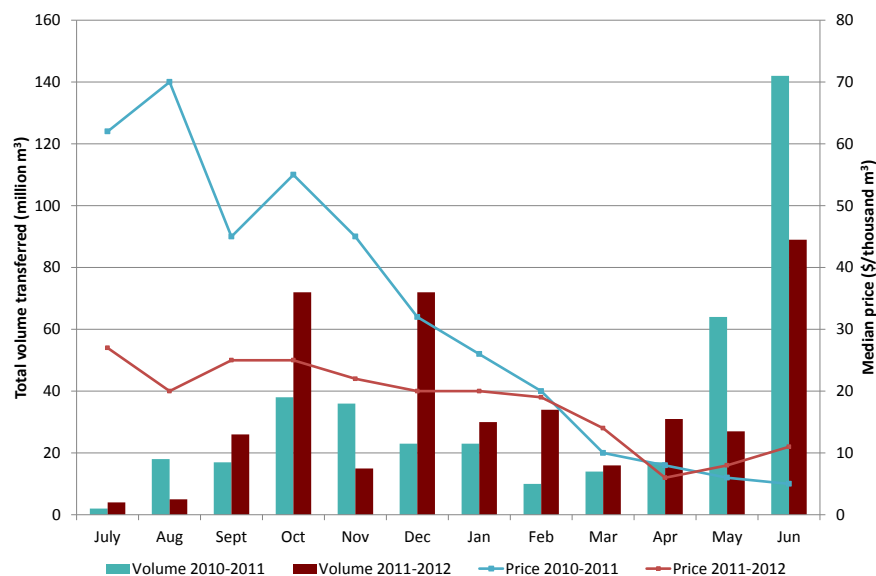
¹⁵⁹ Department of Sustainability and Environment (2012) Victorian Water Register – Water Share Trading.

¹⁶⁰ Department of Sustainability and Environment (2011) Victorian Annual Water Trading Report 2010/11.

¹⁶¹ Department of Sustainability and Environment (2012) Victorian Water Register – Water Allocation Trading.

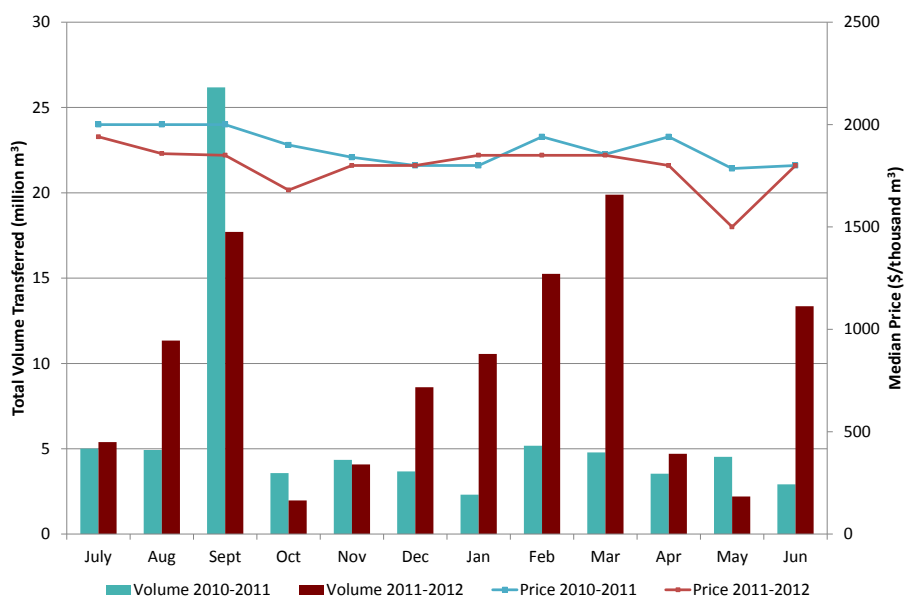
The perpetual nature of water shares make them significantly more valuable than annual water allocations. In Northern Victoria, the 2010/11 weekly median price for water allocation peaked at \$78/thousand m³, compared to \$1,940/ thousand m³ for water shares.¹⁶² Assuming a constant real price of allocations, this is equivalent to a real discount rate of 4%. Prices and volumes traded are summarised for shares (Figure 11) and allocations (Figure 12).

Figure 11 Transfer of water shares in 1A Greater Goulburn



Source: <http://waterregister.vic.gov.au/Public/Reports/WaterTrading.aspx> ; for 1A Greater Goulburn in the year 2011-2012.

Figure 12 Water Allocation Trades in zone 1A Greater Goulburn



Source: <http://waterregister.vic.gov.au/Public/Reports/WaterAllocation.aspx>; for 1A Greater Goulburn in the year 2011-2012.

¹⁶² Department of Sustainability and Environment (2011) Victorian Annual Water Trading Report 2010/11.

Evidently, substantial volumes of trades are taking place in Victoria. Total trade volumes have increased from 807 million m³ to 1,383 million m³ in 2010/11.¹⁶³ Median prices for both allocations and shares have been falling as a result of greater water availability in the systems.

Groundwater and Unregulated Water – Take and Use

For the remaining waterways not declared as regulated, and Victorian groundwater systems, the flow is not controlled by dams or weirs. These systems experience variable flows, which would make the conversion of shares into annual allocations impractical. Instead, water access in these areas is controlled by a combined “take and use” license. The take portion specifies where, how, and how much water can be taken from a system. Use governs what will be done with this water, eg “domestic and stock use – as well as general non-irrigation farm use”.¹⁶⁴

Take and use licenses are also transferrable, subject to the constraints of the Water Act, the Ministerial Policies for Managing Take and use licences, and local management rules.¹⁶⁵ Trading in these unregulated systems bears many similarities to the current situation in New Zealand with a requirement for approval of individual transfers.

Relevance to NZ

Although trading under the Victorian Water Register is an attractive model, applicability of the regulated surface water systems to the New Zealand case is limited.

Surface water flows in New Zealand can be quite variable, hindering the usefulness of the Victorian ‘shares and allocations’ model. To correctly convert water shares into actual allocations, accurate prediction of flows across the season is required. Variable surface water flow rates could lead to over-, or under-allocation of water across the year. However, flows can be better predicted in groundwater systems, below hydroelectric dams¹⁶⁶, or where close monitoring and hydrology lead to better forecasting of flows. In these cases the ‘share and allocate’ model could be implemented. At the very least, the Victorian Water Register can serve as evidence that simplifying administrative barriers does lead to increased water trading, and more efficient allocation as a result.

A2.1.6 New South Wales

Pressures on water extraction limits for catchments in New South Wales, Australia, led to the development of water sharing plans in the Water Management Act 2000.¹⁶⁷ This

¹⁶³ Department of Sustainability and Environment (2011) Victorian Annual Water Trading Report 2010/11.

¹⁶⁴ Department of Sustainability and Environment (2012) Take and use licenses and registration licenses.

¹⁶⁵ Department of Sustainability and Environment (2012) Take and use license trading.

¹⁶⁶ Permits to dam for hydroelectric generators will often specify a minimum flow rate below the dam. For example, Meridian Energy Limited holds a permit to dam for the Ohau Weir Control Structure which requires a flow of at “least eight cubic metres per second” (Environment Canterbury consent number CRC905330.3).

¹⁶⁷ Department of Primary Industries Office of Water (2012) Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources – Background document.

legislation featured the separation of land and water rights, facilitating the trade of access licenses.

Related Policy

The Plan must follow the blueprint for water reforms laid out by the NWI.¹⁶⁸ NSW state-wide standards, imposed by the Natural Resources Commission, require trading rules to maintain or reduce entitlements in high value stress, to protect groundwater sources, low flows, and the recovery of species threatened by extraction.¹⁶⁹ Additionally, there are action plans for the Murray-Darling Basin, and specific catchments, which the water sharing plan must be consistent with. In addition, the plan must ensure the maintenance of:

- Aboriginal cultural values in water;
- Landholder rights, town water supply access, and future water supplies.

Trading Between Water Sources

A refined approach for the development of water sharing rules has been adopted. For unregulated water sources (surface water), trades within a water source are permitted except:¹⁷⁰

- trades must not result in a net increase in entitlement within highly stressed water sources; and
- trades must not be into water sources with high in-stream values.

For inland catchments¹⁷¹:

- No trades are permitted into a water source under high hydrologic stress.
- Trades downstream are permitted, as long as the sources have a direct hydrologic connection.
- Trades through a Regulated River are not permitted.

A range of water source specific rules also govern the locations water may be traded from and to¹⁷².

A2.2 Water Quality Trading

Much like in Lake Taupo and the proposed scheme for Lake Rotorua, trading programmes are used in many countries to improve water quality outcomes. This section summarises the potential components of a trading system for water quality, illustrated by New Zealand and overseas schemes.

A2.2.1 Defining the Commodity

The US Environmental Protection Agency (US EPA) established the national-level Water Quality Trading Policy (WQTP) which is a baseline and credit trading mechanism. Participants in US trading schemes are allocated a total maximum daily load (TMDL),

¹⁶⁸ Department of Sustainability, Environment, Water, Population and Communities (2012) National Water Initiative.

¹⁶⁹ NSW Natural Resources Commission (2005) Statewide standards and targets

¹⁷⁰ Department of Primary Industries Office of Water (2012) Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources – Background document. Pg 27.

¹⁷¹ Ibid, p34.

¹⁷² Ibid p55.

usually measured in lbs which can be discharged.¹⁷³ By reducing discharge amounts below the TMDL, participants earn tradable credits, which can be sold.

In Australia, The Hunter River Salinity Trading Scheme allocates 1,000 salinity credits to nearby dischargers, each allowing release of up to 0.1% of the daily discharge 'block', as measured in a daily tonnage of salt.¹⁷⁴ These rights to discharge are tradable.

Trading schemes most commonly regulate the discharge of nitrogen and/or phosphorus. Some schemes in Australia trade salinity discharge rights; selenium and sulphur discharges are targeted in some US states.

In many US schemes, the tradable unit is a credit earned for the reduction of a pollutant below a specified amount. Bear Creek Watershed and the Chatfield Reservoir in Colorado both feature trading programmes whereby non-point source dischargers earn one saleable credit for every two pound reduction in phosphorous leach.

The commodity is defined in the form of allocations by total volume, volume per day/year, or as a percentage of water discharged for point sources. The Murray-Darling Basin Salinity Credits Scheme limits the mg/l of dissolved salts within discharge from nearby irrigation schemes.¹⁷⁵

A2.2.2 Trading Over Time

As units are often defined on a per-year basis, it is important to define whether participants can engage in 'banking' of credits, or whether credits lapse beyond the specified time frame. Where participants bank credits they can effectively trade with their future self, by saving a portion of one year's allocation for a later date. Where participants can accurately forecast their future demand for discharge rights, banking enables planning of activities over time to produce the most value. As noted for the Lake Rotorua scheme, the primary purpose of which was to reduce pollutant levels in the lake; "society will value decreases in leaching today more highly than decreases in the future."¹⁷⁶ Allocations for Hunter River are in the form of a daily 'Total Allowable Discharge' of salt, and lapse if left unused at the end of each day¹⁷⁷.

A2.2.3 Participants

Some schemes have limited compulsory participants to those that discharge above a threshold amount. This is because there are costs of participation and, for smaller sources, the costs of participating outweigh the benefits. Many schemes in the US target specific large point source dischargers, allowing them to purchase credits earned by improvements in non-point source (NPS) discharge management in the region. Long Island Sound Nitrogen Credit Exchange Program includes the 79 publicly owned

¹⁷³ Environmental Protection Agency (2003) Water Quality Trading Policy.

¹⁷⁴ Department of Environment and Conservation NSW (2006) Hunter River Salinity Trading Scheme.

¹⁷⁵ MacDonald DH and Young M (2001) A case study of the Murray-Darling Basin, CSIRO Land and Water.

¹⁷⁶ Kerr, S, McDonald, H, & Rutherford. Nutrient Trading in Lake Rotorua: A Policy Prototype.

¹⁷⁷ NSW Government (2012) Hunter River Salinity Trading Scheme.

sewage treatment plants which discharge over 20lbs (9kg) of nitrogen per day, and nearby NPS (farmers, landowners, storm water runoff).

The proposed nutrient trading scheme for Lake Rotorua requires participation by land areas losing ~500kg of Nitrogen per year. Dairy farms are estimated to leach 50kg/ha/yr of Nitrogen, thus all farms over 10ha would be included.

A2.2.4 Design

To encourage trading efficiency, the system should minimize search and bargaining costs, trade registration and approval, and encourage clear market price signals. System design plays an important role in achieving these goals.

- **Cap-and-trade systems** for quality involve determining the target level of pollutants and dividing this into allowable discharges amongst participants. Hunter River has a flexible salinity cap, varying between a 0 Electrical Conductivity (1 EC = 1µS/cm) discharge during low flows (<1,800ML/day) and increasing to unlimited EC in flood flows (>6,000ML/day).^{178, 179} Chatfield Reservoir's trading programme sets a cap of 7,446 lb phosphorus discharged to the 3,000sq mile catchment per year, distributed amongst the 6 public treatment works.
- **Baseline-and-credit** water quality markets will typically set a cap on point source dischargers, and allow nonpoint sources to voluntarily generate saleable credits by improving nutrient management for their land. These credits are measured as the reduction in quantities discharged below the baseline. In 2001, the City of Cumberland in Wisconsin purchased 5,000 pounds of phosphorous for \$14,526, in the form of credits generated by 22 farmers implementing BMPs on their land¹⁸⁰.
- **Sole-source offsets** are best exemplified in the Chatfield Reservoir Trading Program, where sewage treatment plants wishing to discharge above their allocated amount could do so by connecting homes to a sewage treatment plant and decommissioning their septic systems¹⁸¹.

A2.2.5 Trading Mechanism

- **Bilateral** trades are typically one-on-one bargaining, without a clear market price to send signals. Lake Dillon's trading program undertakes bilateral negotiation. High transaction costs for buyers are somewhat reduced by the

¹⁷⁸ Rocque, AJ (2001) Connecticut's Nitrogen Control Program. Connecticut Department of Environmental Protection.

¹⁷⁹ Water Info New South Wales (2012) Hunter River Salinity Trading Scheme.

¹⁸⁰ Environmental Protection Agency (2007) 'Water Quality Trading Toolkit for Permit Writers'. Appendix A is a detailed case study of 12 trading systems in the USA.

¹⁸¹ World Resources Institute (2009) Water Quality Trading Programs: An International Overview. No. 1.

uniformity of nonpoint source reductions from private septic systems¹⁸².

- **Exchange Markets** brings buyers and sellers together, with open information, uniformity of discharge credits, and clear prices. The Pennsylvania Water Quality Trading Program maintains an online trading marketplace¹⁸³
- **Clearinghouse** markets are operated by an intermediary, matching buyers and sellers of a uniform commodity. This role is often well suited to the regulatory authority, who may set a price, or bank credits, to achieve desired outcomes. Search costs for participants are reduced, and clear price signals make planning easier. Virginia's Department of Environmental Quality purchases nitrogen (\$11.06/lb), and phosphorus (\$5.04/lb) nonpoint source credits from a Water Quality Improvement Fund.¹⁸⁴

A2.2.6 Trading Framework

All quality trading designs require some initial allocation and determination of the 'cap', ie the quantity of discharge rights available to the market. With many of the schemes discussed, environmental targets will be determined by the governing authority, balancing the benefits of being able to discharge against the costs (environmental and otherwise) of doing so. The division of discharge rights amongst scheme participants is most commonly based upon relative historical use, or the allocation of discharge permits.

For these initial purposes and continued management of trading schemes, accurate measurement of point source discharges, and modelling to estimate nonpoint sources, is vital for the operation of a quality trading scheme.

Discharge permits may contain requirements for monitoring, reporting, review of conditions, and site-specific elements. Discharge permit holders participating in phosphorus trading in Red Cedar River in Wisconsin are required to undertake best management practices (BMPs) of phosphorous discharge on their property.¹⁸⁵

A2.2.7 Pennsylvania

As an example, a nutrient trading scheme is underway to reduce nitrogen and phosphorus in the Chesapeake Bay, Pennsylvania. 183 existing dischargers were permitted to discharge to the Potomac and Susquehanna watersheds. Based on their historical leaching, pollution load allocations were determined and allocated as part of the existing discharge permits. New facilities in the region are required to offset 100% of their nitrogen and phosphorus discharges with credits.

¹⁸² Pharino, C (2010) Sustainable Water Quality Management Policy: The Role of Trading.

¹⁸³ Available on the Pennsylvania NutrientNet website.

¹⁸⁴ Mid-Atlantic Regional Water Program (2007) Status of Water Quality Credit Trading in Virginia.

¹⁸⁵ Wisconsin Department of Natural Resources (2011) A Water Quality Trading Framework for Wisconsin.

Participants can generate credits by demonstrating a reduction in pollutants below the legal baseline requirements. Upon verification by the Department of Environmental Protection (PADEP), these credits can be traded to parties wishing to offset their discharge to comply with their National Pollutant Discharge Elimination System (NPDES) limitations.

An exchange market, Pennsylvania's Infrastructure Investment Authority (PENNVEST) hosts auctions for the trading of nutrient credits in the region. In the Forward Auction June 13th, 20,000 nitrogen credits for the 2012 Susquehanna season were sold for an average price of \$3.75 per share. Phosphorus traded most recently in November 2011, for \$4.73 per share.

Conversion of shares into pollutant loads depends on the Edge of Segment (EOS) and Delivery Ratio (NDR), indicating the pollutant runoff expected to reach the Chesapeake Bay from a given property. For example, in the Clinton region, NDR is 0.93 and EOS for pasture is 15%¹⁸⁶:

	Edge of Field Nitrogen Reduction	200.0lbs/year
(x)	EOS Ratio	15%
=	EOS Nitrogen Reduction	30lbs/year
(x)	Nitrogen Delivery Ratio (NDR)	0.93
	Nitrogen Reductions to Chesapeake Bay	27.9lbs/year
(=)	Total Credits Generated	27.9 credits/year

¹⁸⁶ Pennsylvania Department of Environmental Protection (2011) Watershed Segment Map.

Annex 3 Trading Other Commodities

A3.1 NZ Emissions Trading Scheme

The NZ Emissions Trading Scheme (NZ ETS) for greenhouse gases defines those undertaking specified activities as participants under the scheme; they must hold emission units (New Zealand Units or NZUs, which are denominated in tonnes) equal in number to their emissions in tonnes¹⁸⁷ or to the quantity of emissions that will result from the energy fuels that they produce.¹⁸⁸ NZUs are thus equivalent to rights to emit. The NZ ETS interacts with trading systems in other countries, particularly the clean development mechanism (CDM) established under the Kyoto Protocol;¹⁸⁹ participants can purchase approved international units and these can be used to create NZUs. The New Zealand government places some units on the market, but total scarcity of the resource (emission units) is defined by international supply and demand and this determines the price of emission units.

Within New Zealand, some NZUs are allocated initially on the basis of historical emission rates,¹⁹⁰ some are created through activities that absorb emissions (forest growth), whereas some participants (eg those using liquid fossil fuels) have been given no emission units and must purchase all their requirements on the market.

The NZ ETS has elements of a cap and trade system, but it is possible to increase emissions above the cap through the purchase of additional units created under baseline and credit systems.

A3.2 US Sulphur Trading

A cap and trade system for SO₂ emissions began in 1995 in the USA under Title IV of the 1990 Clean Air Act Amendments that established the Acid Rain Program. The goal of the Acid Rain Program was to reduce SO₂ emissions to approximately 50% of 1980 emission rates, a cut of approximately 10m tons. It sets a total cap on SO₂ emissions from electric power plants nationwide and was introduced in two phases. Phase I (1995–99) limits emissions by approximately 40% and Phase II (2000 forward) by 50%.¹⁹¹

The SO₂ trading system applies to electricity generating plants only, although other industrial plants can enter on a voluntary basis. Phase I started in 1995 and applied to the largest coal- and oil-fired power plants (greater than 100 MW_e and with emission

¹⁸⁷ Initially the obligation is 1 NZU for 2 tonnes of emissions.

¹⁸⁸ For example, coal mining companies are participants, but industries that combust coal, such as in electricity generation, are not (they may choose to opt-in to the scheme and become participants, taking over the obligation from the up-stream producers).

¹⁸⁹ Under the clean development mechanism projects in developing countries that reduce emissions below a baseline, or absorb emissions, can be used to create credits.

¹⁹⁰ In some instances those given emission units are not participants. This includes energy-intensive industries that will face an increased price of electricity.

¹⁹¹ US Environmental Protection Agency (EPA) (2000), 'Analysis of the Acid Deposition and Ozone Control Act (S.172)', prepared for The Senate Committee on Clean Air, Wetlands, Private Property, and Nuclear Safety. US Environmental Protection Agency, Office of Air and Radiation, Clean Air Markets Division.

rates greater than 2.5lbs/mmBtu¹⁹²—ie, 1,075g/GJ). It originally covered 263 units at 110 power plants, but other units opted in voluntarily; at the end of Phase I in 1999, there were a further 135 units in the programme, totalling 398 units in aggregate. Phase II started in 2000 and extended the coverage to all power plants with capacity above 25MW_e, and involves over 2,300 units.

Allowances are allocated in perpetuity, with initial participants given the same number of allowances every year for ever (or until government policy is changed). It means plant owners continue to be given allowances even when they close. Sales of allowances can be of the annual allowance or the right to a stream of future allowances.

The system has been introduced in two phases. In Phase I, the EPA gave allowances to units on the basis of a formula that used an emission rate (2.5lbs/mmBtu = 1,075g/GJ) of thermal input, multiplied by the unit's baseline energy input (the average amount of fossil fuel consumed from 1985 to 1987).¹⁹³ In Phase II, the EPA allocated allowances to each unit at an emission rate of 1.2lbs/mmBtu (516g/GJ) of heat input, multiplied by the unit's baseline energy input. Additional allowances were made available from the following sources:

- During Phase I, units could receive additional allowances by installing a technology that can be demonstrated to remove at least 90% of the unit's SO₂ emissions, or by reassigning their reduction requirements among other units employing such technology.
- A second reserve provides allowances as incentives for units achieving SO₂ emissions reductions through customer-oriented conservation measures or renewable energy generation.
- The third reserve contains allowances set aside for auctions, which are sponsored annually by the EPA.

The annual auction, which distributes approximately 3% of allowances, was very important in the early stages and was responsible for a large proportion of the initial trades. It helped to establish and reveal prices, ensuring price transparency for market players. In the absence of the auction, it is likely that there would have been a relatively long period of bilateral trading with no public information, and this would have tended to continue the perception of high prices, and the greater likelihood of more investment in emissions control using high-cost flue-gas desulphurisation (FGD) rather than switching to low sulphur coals.

A3.3 NO_x Trading

Ozone Transport Commission

A NO_x cap and trade system started in the north-eastern USA in 1999 and operated until 2002. It was established to assist the states in the Ozone Transport Commission

¹⁹² million British thermal units.

¹⁹³ There were some additional allowances distributed to certain states reflecting agreements made during the design phase: affected units in Illinois, Indiana, and Ohio were allocated a pro-rata share of 200,000 additional allowances each year from 1995 to 1999.

(OTC)¹⁹⁴ to achieve their ambient air quality standards for summertime ozone, which was hampered by transfer of ozone from upwind states. NO_x is an important precursor for ozone and the programme placed an overall cap on summertime NO_x emissions. The trading programme was established via regulations at the state level using a “model rule” created by the US EPA. The main design features of note are:

- it applied to seasonal (May–September) emissions only;
- the decision on allocation of allowances is made locally, at the state rather than federal level. States used a variety of grandparenting formulae;
- sources with large NO_x emissions must monitor using continuous emission monitors (CEMs), but those with lower NO_x emissions may use simpler estimation methods employing predictive emission monitors. The data must be reported electronically to the EPA;
- there is scope for voluntary opt-in by plants not otherwise required to comply.

Firms have two months to complete final trades at the end of each budget period to ensure compliance. Because the NO_x system is administered by states rather than the federal government, compliance penalties have been set in terms of offset requirements. If a company is out of compliance, it must surrender three allowances in the next compliance period for every ton of emissions in excess of allowances that have been surrendered in this period. This does not affect the liability of owners or operators under state law, and ultimately the sanction of removal of the right to operate.

There is no auction of allowances because this is regarded as unnecessary. Unlike when the SO₂ system was established, when the NO_x cap and trade system began there was already a well-functioning system of brokerage services with transparent pricing of allowances. It was believed, correctly as it turned out, that such price transparency would rapidly establish for NO_x allowances. This was assisted by two years’ allowance trading prior to the start of the first budget or compliance period.

NO_x Budget Trading Program

The NO_x Budget Trading Program (NBP) extended the OTC trading approach to 20 eastern states and the District of Columbia. The NBP ran from 2003 to 2008 and was then replaced by CAIR’s NO_x ozone season program. A cap was set on NO_x emissions on the basis of an average emissions rate per energy input to power plants of 0.15lbs/mmBtu (64.5g/GJ).

As with the OTC, the NBP was facilitated by a model rule produced by the US EPA that covered allowance allocation methodologies, monitoring and reporting requirements, allowance banking (see below), trading protocols, non-compliance penalties and administration systems.¹⁹⁵ The main departure from other trading systems is the proposal to use a rate-based approach with updating to the distribution of allowances. The total emissions cap is divided by the activity data from plants included in the

¹⁹⁴ The OTC comprises the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Delaware, the northern counties of Virginia, and the District of Columbia.

¹⁹⁵ Napolitano S, Stevens G, Schreifels J and Culligan K (2007) The Nox Budget Trading Program: A Collaborative Innovative Approach to Solving a Regional Air Pollution Problem. *Electricity Journal*, 20(9):65-76.

programme to yield an emissions rate. The EPA model rule included guidance for an input-based approach (emissions per unit of energy input), but some states (Connecticut, Massachusetts, New Hampshire and New Jersey) used an output-based approach (emissions per MWh of electric output). This rate is the basis for annual allocations to any plant that is included in the programme, both existing plants and new entrants. Significantly, output-based approaches would include allocations to plants with no emissions (ie, renewables and nuclear facilities).

In the EPA's model rule, the rate used for allocation is updated every five years, but individual states used options varying from annual to ten-year updating. Under a five-year approach, activity data are collected for each unit (the EPA proposed an average of the activity data from the two highest of four previous years). The cap is divided by the aggregate activity data to yield a rate that is used as the basis for the allocation to individual units. The allocations are then reduced proportionally so that a total of 95% of allowances are allocated initially, the remainder being retained for new entrants. For each unit, its activity data in the base year(s) times the agreed rate are used to calculate a number of allowances.

The rate-based approach is similar to historical grandparenting, but it results in plants with emission rates below the rate-based standard being given more allowances than they require, which provides them with an additional source of revenue.

New entrants are allocated allowances from the 5% set-aside, using the emissions rate and projected activity rates. At the end of the year, the allocation is adjusted to take account of the actual activity data and allowances removed (or extras given) as appropriate. If the allowance pool for new entrants is exhausted then new entrants will be required to purchase allowances in the market.

The new-entrants issue has been the main reason for the shift towards updating rate-based allocation methods. It is more important for NO_x emissions than for SO₂ because new entrants, expected to be largely gas-fired plants, will produce NO_x emissions whereas there are not expected to be many new coal-fired (SO₂-producing) plants.

The compliance approach is the same as used for the OTC NO_x programme—ie, using an offset requirement.

Clean Air Interstate Rule (CAIR)

The Clean Air Interstate Rule (CAIR) replaced the NBP from 2008 and is a multi-pollutant trading programme; it includes annual NO_x emissions, seasonal NO_x emissions and annual SO₂ emissions. CAIR covers 27 eastern states and the District of Columbia. States must achieve the required emission reductions either using an EPA-administered inter-state cap and trade system or using measures of the state's choosing.

Emission allowances for SO₂ sources subject to the Acid Rain Program can be used in the CAIR SO₂ trading programme. For NO_x trading, EPA provides emission allowances to each state. The states will allocate those allowances to sources (or other entities) using their own methods.

Cross-State Air Pollution Rule (CSAPR)

CSAPR took effect on January 1 2012 and replaces CAIR and the associated trading programmes. It covers 28 states. Unlike CAIR, SO₂ allowances under the acid rain programme cannot be used to comply with the CSAPR; rather the new rule creates a separate allowance system for SO₂ emissions, but sources covered by the Acid Rain Program must still use comply with that program. The Acid Rain Program requirements will not be affected by the CSAPR.

RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) is a cap and trade programme that has been adopted for the Los Angeles air basin.¹⁹⁶ The RECLAIM programme has a number of features that relate to environmental concerns that are relevant to discussions of water trading.¹⁹⁷

- It is divided into coastal (upwind) and inland (downwind) zones. Inland sources can obtain allowances from either zone, while coastal sources can only obtain and use allowances that originated in the coastal zone.
- Banking is not permitted in the programme but facilities are divided into two compliance cycles: one from January 1st to December 31st and the other from July 1st to June 30th. Transactions can be conducted with facilities in either cycle. The dual-compliance-period approach was adopted to avoid the possibility of allowance price volatility, particularly at the end of a compliance period, depending on whether there was an allowance shortage or excess.

A3.4 Fishing Quota Management

The New Zealand Quota Management System (QMS) sets annual limits on fish catch for individual species within geographically-specified areas; rights to a proportion of the annual limit are defined as tradable commodities. The Total Allowable Catch (TAC) is set for each Quota Management Area (QMA) to ensure stocks are maintained at or above a level that can produce the maximum sustainable yield (MSY).¹⁹⁸

The TAC is used in turn to define a total allowable commercial catch (TACC), taking account of expected removals and mortality as a result of recreational fishing, customary uses and all other fishing-related activities. TACCs are specific to individual stocks of fish within geographically separate Quota Management Areas (QMAs). Once TACC is set, the total is shared between owners of Individual Transferable Quota (ITQ) for that species and QMA.

Individual Transferable Quota (ITQ) are rights in perpetuity to a share of the TACC. In total, for each QMA, there are 100 million shares. Each year the owners of ITQ are

¹⁹⁶ Harrison, D. (1999), 'Turning Theory into Practice for Emissions Trading in the Los Angeles Air Basin', in S. Sorrell and J. Skea (eds.), *Pollution for Sale: Emissions Trading and Joint Implementation*, Edward Elgar, pp. 63–79.

¹⁹⁷ Harrison, D. (1999), *op cit*.

¹⁹⁸ In some instances, TAC may be set below the long term estimate of MSY with the aim of restoring fish populations so that they can produce MSY in future years.

awarded Annual Catch Entitlements (ACE) that provide the right to take a specific amount of a species of fish within that year. ACE are denominated in kg, and the number allocated to a holder of ITQ is calculated as TACC divided by 100 million, times the number of ITQ held, eg if the TACC for a species is 5,000,000 kg, then the owner of 50,000 ITQ shares is allocated 2,500 kg of ACE.¹⁹⁹

Both ITQ and ACE are tradable, and commercial fishers must ensure their catch is covered by ACE each year or they must make a deemed value payment. Deemed Value payments are payments for fish caught in the absence of ACE and, in theory, are set by the government at a level that is sufficiently high to encourage the purchase of ACE.

The ITQ system is a type of cap and trade system, but the deemed value payment is a variant that allows the cap to be breached under some circumstances.

A3.5 Biodiversity Offsets

Biodiversity offsets are being discussed in New Zealand and elsewhere. A biodiversity offset is a mechanism in which the residual damage to biodiversity from a development project is compensated for or replaced by a separate project, or set of projects, that enhance biodiversity.²⁰⁰ When part of a deliberate policy, the mechanism introduces an obligation on the developer to provide an offset project with outcomes that meet certain criteria.

The New Zealand Biodiversity Offsets Programme (BOP) is aligned with, and based on the principles of, the Business and Biodiversity Offset Programme (BBOP), which has been set up internationally as a partnership between companies, governments, conservation experts and financial institutions to explore the feasibility of using biodiversity offsets and whether they can achieve better and more cost effective biodiversity outcomes than alternative approaches. *No Net Loss* is established as one of BBOP's Principles on Biodiversity Offsets, introduced in the following context:²⁰¹

A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.

The idea behind biodiversity offsets is of replacing what is lost with something of equivalent or greater value at another location. In reality this is extremely difficult. Unlike emissions trading for which the commodity is relatively easily defined, biodiversity is highly site-specific, whereby producing an offset that provides no net loss is a challenging task and one that is still the subject of research and analysis more than of practice.

¹⁹⁹ $5,000,000/100,000,000 \times 50,000 = 2,500$.

²⁰⁰ ten Kate K, Bishop J and Bayon R (2004) Biodiversity Offsets: Views, experience, and the business case. IUCN, Gland, Switzerland and Cambridge, UK and Insight Investment, London, UK.

²⁰¹ Business and Biodiversity Offsets Programme (2009) Biodiversity offsets design handbook, BBOP, Washington, DC.

A3.5 UK Renewables Obligation

The UK Renewables Obligation requires electricity suppliers to supply a specified percentage (15.8% in 2012/13) of electricity using approved renewable sources. Proof of compliance is via holdings of Renewable Obligation Certificates (ROCs), which are allocated to renewable generators for every kWh generated from an approved source. ROCs are tradable commodities.

In a similar way to the deemed value payments under the ITQ system discussed above, obligated parties have the option of a buy-out payment. They can pay £40.71/MWh of ROC obligation as an alternative to purchasing ROCs.

As a further complication to the system, the revenues from the buy-out mechanism are returned to suppliers in proportion to their holdings of ROCs. This means that, while there is an overall under-supply, purchases of ROCs are worth more than the avoided cost of the buy-out because the value includes, in addition, the returned revenue from the buy-out.

The use of a buy-out is equivalent to a hybrid tradable permit emissions tax system. Normally, in contrast to taxes that provide price certainty, but emissions uncertainty, tradable permits provide emissions certainty but price uncertainty. Such a hybrid, in which firms have an option of purchasing allowances or paying a charge, provides certainty in achieving an emissions objective only if the cost is below a certain amount. Above this, emissions are allowed to increase.

A3.6 Packaging Recovery Notes

In the UK national targets for waste recovery and recycling are distributed to individual companies in the packaging chain that meet minimum thresholds for turnover and amount of packaging handled.²⁰² Compliance with these regulations was initially achieved either internally by firms or through membership of compliance organisations; but later markets in compliance certificates developed enabling firms to comply without joining a compliance scheme.

There is an overall obligation for recovery (70% in 2008)²⁰³ and, to achieve this, obligations for individual materials are allocated to those who:

- (i) manufacture raw materials for packaging (6%);
- (ii) convert raw materials into packaging (9%);
- (iii) pack and fill packaging, or use packaging to wrap goods (37%);
- (iv) sell packaging to the final user (48%).

Using these numerical obligations, for a packer/filler, for every tonne of packaging that it uses, the obligation is to recover $70\% \times 37\% = 25.9\%$. To demonstrate compliance with these obligations companies must hold evidence in the form of Packaging Waste

²⁰² Covec (2005) Economic Instruments for Waste Management. Report to Parliamentary Commission for the Environment.

²⁰³ This is the target for business and is greater than the national target (60%). The difference is because the business target does not cover small and medium-sized businesses.

Recovery Notes (PRNs). The most common way to comply with these requirements is for firms to pay a compliance organisation to coordinate the achievement of the obligations and to provide PRNs. They charge a management fee and invoice separately for PRNs. The price of PRNs is set in the market and represents the difference between the costs of recycling, including the purchase of materials from collectors, and the value of the processed materials. For their part, firms contracting with compliance schemes provide detailed information on quantities of packaging handled and therefore the size of the obligation to be fulfilled.

Registered recyclers (processors of materials) can produce PRNs when they process a tonne of material, eg recycle a tonne of glass cullet. Although it was not the original intention of the regulations, PRNs have become tradable commodities. Rather than becoming directly involved in recycling or joining a coordinated compliance scheme, PRNs can now be purchased online.²⁰⁴

A3.7 Key Design Components

The different systems illustrate a number of key design components and we outline these below before drawing some conclusions on this experience relevant to water trading.

Overall Design

We noted above that trading designs are often separated into separate categories of cap and trade, baseline & credit and offset systems. In practice the systems may have elements of all three and the characteristics merge at the edges.

For example, the NZ ETS has some characteristics of a cap and trade system, but without a cap. Entities in the NZ ETS, and New Zealand as a whole, can increase their emissions, effectively without limit, provided that they purchase units to cover their obligations. Even the international regime established under the Kyoto Protocol is not a complete cap and trade because credits can be introduced that are created by systems that could be characterised as baseline and credit systems or offsets.

A number of the systems have other outlets from a pure cap and trade, including combined trading systems and charges. This includes deemed value payments under the NZ ITQ system for fisheries and the UK's Renewables Obligation.

The individual components of the design are more useful points of focus for discussion than the overall classification.

Commodities

The commodities that have been defined under the different trading regimes have consisted of either rights or fulfilled obligations. These include:

- rights to emit a specified quantity of a pollutant in a specified time period;
- rights to catch a specified quantity of fish;

²⁰⁴ See for example, www.t2e.co.uk/

- fulfilled obligations to generate renewable electricity;
- fulfilled obligations to recycle specified quantities.

In all cases the commodities were created through regulation and did not exist previously. Key characteristics are that the commodity is clearly specified; the purchaser knows that ownership of the commodity meets certain legal obligations that otherwise apply and the value of the commodity is determined by the costs of non-compliance penalties. We noted above the example of Biodiversity Offsets for which there is no clearly specified commodity and hence some difficulty in creating a market.

Creating commodities has been simplest where the associated environmental effects are uniform. This is most clearly seen in greenhouse gas emissions where the location of emissions does not matter and a truly global market can develop. Local or regional pollutants, such as SO₂ and NO_x do have localised effects, but the programmes have been introduced at a time when total allowed emissions has been reduced significantly. In practice this has meant that environmental outcomes have improved everywhere despite emission reductions being concentrated in some locations.

Concerns in California specifically with this shift in the location of emissions have led to a novel design in which trading is restricted by direction. The practical implications of this are that there is some reduction on the potential number of buyers for an emissions allowance.

Water trading will be most effective where a commodity can be created that is clearly specified and where the potential number of buyers is maximised. We address this issue further under *Liquidity* below.

Liquidity Issues

Liquidity is an important element of the design of any market. It means that buyers can readily find the commodities they wish to purchase and sellers can readily find a purchaser for their surpluses. This is best achieved through a clearly specified commodity, numerous buyers and sellers and low transaction costs. Other elements that improve liquidity have been mechanisms that enable price discovery so that market participants can more readily make decisions on whether or not to enter the market.

Emission allowances have been ideally suited to trading programmes, particularly in the US systems where there have been large numbers of traders and the potential to purchase small quantities, allowing numerous trades to occur.

Liquidity can also be increased through allowing other parties to enter the market. For example, parties simply wanting to speculate on price movements increase the number of potential traders. This is beneficial for the establishment of the various market mechanisms to facilitate trades, including the establishment of brokerages and/or exchanges. Objections to such components of a trading system include the potential for market speculators to profit from trades.

The challenge for water trading will be over the number of potential traders.

Banking and Borrowing

A number of trading schemes have introduced the potential for banking (keeping available allowances to use at a future date) or borrowing (using future allowances now making fewer available in later time periods). A number of systems have allowed banking, especially for emissions-related impacts because it achieves earlier compliance; this has been particularly so in systems such as the US SO₂ trading system where the cap was shrinking over time in steps; banking allowed the stepwise reductions to be smoothed out.

Borrowing has not been introduced in any trading systems, particularly because of the risks of non-compliance.

Under the NO_x OTC trading system, limited banking of permits was allowed. Sources can bank indefinitely and can use allowances from the current or previous years. However, if the bank reaches 10% or more of the total annual budget, a system of flow control is used to increase the costs of using the bank. After the bank has breached the 10% trigger, the ratio of banked allowances to the allowed bank size is used to devalue all banked allowances. This ratio is used to define how many allowances in each unit's bank can be surrendered 1:1 against emissions, with the others required to be surrendered at a 2:1 ratio. For example, if the total cap is 100,000 tonnes (10% = 10,000) and there are 20,000 tonnes in the bank then the flow control ratio is $10,000:20,000 = 0.5$. The number of banked allowances in each company's account is multiplied by this ratio to determine how many allowances can be traded at a 1:1 ratio.

The implications of flow control are that allowances of different vintages have different prices.