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Water for a Healthy Country

Economic evaluation of
alternative water allocation
options in the South West region
(Busselton-Capel, Bunbury and
Blackwood groundwater areas)

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Executive Summary

This study evaluates the economic benefits of allocating water from the Busselton-Capel, Bunbury and Blackwood groundwater areas to the Integrated Water Supply System (IWSS) and the South West region, at two different levels of total water availability. The emphasis of the analysis is on the net economic value of consumptive water use associated with different allocation decisions. There is no attempt to compare the non-market impacts and trade-offs associated with different total extraction levels, and the results should be interpreted accordingly.

The analysis suggests that if it can be determined with a high degree of certainty that 160GL can be drawn from the study region's groundwater resources without unacceptable impacts, then there is a clear economic case for allocating 45 GL to the Water Corporation. The main cost of this allocation option would be reduced development of the dairy industry in the South West region, but the benefits to society in terms of reduced water supply cost would exceed the foregone regional economic growth.

However, if the sustainable yield of the aquifer is only 112 GL, then there is not a clear economic case for allocating water to the Water Corporation. Some of the main uncertainties influencing the net economic outcome are the value of reliability of urban water supply, alternative opportunities for addressing supply-demand imbalance in the IWSS, and the risk of unacceptable impacts, none of which were quantified in this analysis. Another uncertainty is the potential value of growth in the region. The economic analysis shows that under an optimistic demand growth scenario (consistent with strong market outlook assumptions for agricultural produce), then the opportunity cost of allocating water to the Water Corporation, in terms of foregone regional water uses, is of a similar magnitude to the benefits of reduced supply cost in the IWSS. Results also indicate that if the construction of the South West Yarragadee is delayed until 2012, reflecting a less stringent IWSS reliability target, then the additional 45 GL under question would have a higher value if it remained in the region, rather than being allocated to the Water Corporation.

Analysis of net economic benefit to the State is not the only economic consideration. Alternative allocation scenarios result in very different income distributional impacts. For example, if the South West Yarragadee borefield were to be constructed for supply in 2009 and regional allocations were based on the residual from a 112 GL total allocation, the cost to the region in terms of foregone economic development would be \$256 m, and the benefit to the IWSS would be \$295m in terms of reduced supply augmentation cost. The net difference in these two values, which is the net benefit to the state, is \$39 m. This is an order of magnitude lower than the cost imposed on the region in terms of reduced economic growth potential. Under the same 112GL allocation scenario, a four year delay in construction of the Water Corporation's proposed borefield (which would occur under less stringent reliability requirements for the IWSS) would be sufficient to shift the economic merit in favour of allocating all the water to the South West region. The longer the decision is delayed, the weaker is the justification for allocating to the Water Corporation, because the regional economic growth in the interim strengthens the economic case for allocating to the region. The value of system reliability is clearly a critical one, yet to date has been determined by political judgment rather than economic analysis.

An analysis of the potential costs of stranded assets in the Water Corporation development, that might arise if a generous water allocation had to be clawed back

as a result of unanticipated impacts, was conducted for a range of water management options. The distributional impacts associated with clawing back water rights in the event of an over-allocation were shown to differ widely according to what water management arrangements are put in place for clawing back water rights. This suggests that the question of who should bear the cost of correcting for an over-allocation should be considered before any allocations and investment decisions are finalised.

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1. Introduction

The Department of Water is considering an application made by the Water Corporation for a 45 GL licence to extract water from the Busselton-Capel groundwater area of the South West Yarragadee aquifer, which will be used to augment supply into the Integrated Water Supply System which supplies the urban water needs of the Perth metropolitan area and some regional towns.

The opportunity cost of allocating water to the Water Corporation is the reduced potential for growth in water-using industries in the South West region (Bunbury, Busselton-Capel, Blackwood groundwater areas) which extends from Bunbury to Augusta. Whether or not these two competing demands are in conflict at all depends on the total quantity of water available for consumptive uses, and market conditions that affect growth in demand for water in the region.

Modelling studies of aquifers in the South West region indicate that there is an increased risk of impact as allocation levels increase. Above 95 GL, these impacts are expected to be small, with risks of impact occurring likely to increase at abstraction levels above 160 GL.

This study evaluates the economic trade-offs associated with allocating 45GL of water to the Water Corporation, under two different total allocation scenarios, being 112GL and 160GL. The study is *partial* in that it does not consider the economic (non-market) impacts of possible environmental and social consequences of different allocation levels, and the results should be interpreted accordingly. That is, the values presented in this report represent the economic values of consumptive uses associated with different abstraction levels, and these should be considered in the context of the risks associated with these levels of total abstraction from the aquifer.

The outline of the report is as follows. The approach to the economic evaluation is presented in the next section, then the potential demand for water in the region, and the values associated with using this water are discussed. The following section deals with supply augmentation in the Integrated Water Supply Scheme, and the values associated with allocating water from the study region to the Water Corporation. The economic analysis of the water allocation options, including the distributional impacts of these options, and the potential risk of stranded assets under the 160GL scenario are then presented and discussed.

2. Method of analysis

The study applies the standard economic methodology of social cost benefit analysis to estimate the consumptive use values of water allocation options. Cost benefit analysis is commonly used to guide investment decisions where a particular choice has a future stream of costs and benefits associated with it. The approach uses the standard financial appraisal method of discounting, which brings the future stream of costs and benefits into present day terms, to enable direct comparisons to be made between alternative options. The basis of cost benefit analysis is the proper representation of the stream of costs and benefits associated with alternative options. In this analysis, the stream of costs and benefits associated with alternative water allocation options is the value of the water in a particular activity. In the case of agriculture, where lack of water would mean that dryland agriculture would be conducted instead of irrigated agriculture, the value of water is the extra income that can be earned from irrigation. In the case of industrial and urban uses, where lack of water from one source would generally lead to a higher cost water supply option being used to meet resource demand, the value of water is the difference between the two alternative costs of water supply.

Implicit in social cost benefit analysis is the principle of compensation. The welfare economics argument is that if the net social benefits of a particular option are higher than another option, then society is better off by choosing that option, because *in principle* the winners could compensate the losers and still be better off. However, because the principle of compensation is not usually applied in practice, it is important to also consider the potential distributional consequences of alternative options. The distributional impact of alternative allocation options are quantified in this report.

The study is conducted over a 50 year time horizon reflecting the economic life of the longer lived assets. A discount rate of 4% is used, which reflects the long term real rate of interest (Quiggin, 1997).

A number of allocation options are considered for two different total allocation limits, reflecting more and less conservative scenarios. For a particular total allocation level, allocations to the region with and without the Water Corporation proposal are based on modeling results from the Department of Water, which account for the location of the proposed Water Corporation borefield in the Busselton-Capel groundwater area. Thus in the allocation scenarios where water is allocated to the Water Corporation, most of the reduction in allocation to the South West occurs in the Busselton-Capel groundwater area.

3. Values derived from allocating water to the region

3.1. Current uses of water

The Department of Water's WRL licensing database was used to determine licensed allocations at June 2005. Current use of licences was based on recent investigations by the Department. Licensed allocations and current use are shown for each of the groundwater areas in Table 1, according to the main use categories.

Table 1. Water use and entitlements in the region at 2005

<i>Groundwater area</i>	<i>Water using industry</i>	License	Use
<i>Bunbury</i>	<i>Horticulture</i>	7.36	4.62
	<i>Viticulture</i>	0.33	0.21
	<i>Dairy and pasture</i>	3.87	2.29
	<i>Mining</i>	1.0	0.2
	<i>PWS, Industry, Services, Riparian</i>	30.3	21.6
	<i>Total</i>	42.9	28.9
<i>Busselton - Capel</i>	<i>Horticulture</i>	14.5	8.3
	<i>Viticulture</i>	3.8	2.5
	<i>Dairy and pasture</i>	13.1	7.2
	<i>Mining</i>	15.3	3.8
	<i>PWS, Industry, Services, Riparian</i>	27.3	9.1
	<i>Total</i>	74.0	30.9
<i>Blackwood</i>	<i>Horticulture</i>	6.2	4.1
	<i>Viticulture</i>	0.3	0.2
	<i>Dairy and pasture</i>	6.7	5.4
	<i>Mining</i>	1.1	0.2
	<i>PWS, Industry, Services, Riparian</i>	0.5	0.4
	<i>Total</i>	14.8	10.3
Total, South West Region	<i>Horticulture</i>	28.1	17.0
	<i>Viticulture</i>	4.4	2.9
	<i>Dairy and pasture</i>	23.7	14.9
	<i>Mining</i>	17.4	4.2
	<i>PWS, Industry, Services, Riparian</i>	58.1	31.1
	<i>Total</i>	131.7	70.1

Source: Department of Water, extracted from licensing database

3.2. Potential growth in water use

Water in the Bunbury, Busselton-Capel and Blackwood groundwater areas could potentially support regional growth, by enabling expansion of water-using industries, and by providing for the domestic water needs of a growing population. The projection of the potential for water-related development in the region over the 50 year time frame of the study is subject to considerable uncertainty. For this reason, the study takes the approach of defining upper and lower bounds for projecting growth potential.

3.2.1. Agricultural demand

The potential for future development of irrigated agriculture in the region is subject to considerable uncertainty, as it will be determined by the rate of growth in markets for produce. Potential for growth in the domestic market will be limited to one to two percent per year, so the achievement of growth rates higher than one to two percent will depend on how export markets grow. While it can be expected that markets in Asia will grow significantly over the next few decades due to population and income growth, the market share that can be achieved by Western Australian producers will depend on their competitiveness compared to other suppliers. Over the 1990s export market growth was very strong, at around five percent per year for vegetables, but this was partly attributable to a very favourable exchange rate in the major overseas markets, and growth has slumped more recently due to competition with Chinese suppliers (Brennan 2004). To deal with the high degree of uncertainty in forecasting future demand growth, the valuation of water values in the region will be conducted by estimating upper and lower bounds on potential growth.

The Waters and Rivers Commission commissioned a study of growth prospects for agricultural industries in the South West region in 2003, which predicted growth in water demand to the year 2030 (Economic Consulting Services 2003). An alternative set of values were derived by Brennan (2004), who assessed the prospects for agricultural water demand growth by examining the relative importance of domestic and export markets in the associated industries, and assessing the prospects for growth in these markets. The alternative estimates are compared in Table 2, as annual growth rates¹. The growth estimates derived by Economic Consulting Services (2003) are similar to the “strong market outlook” scenarios projected in Brennan (2004) and will be used to represent the upper bound on water demand growth in agriculture. The lower bound will be represented by the “weak outlook” reported in Brennan (2004).

Table 2: Projected annual growth trends in agricultural industries

Industry	ECS (2003)	Brennan (2004)*	
		Strong outlook	Weak outlook
Fruit		4.7%	2.3%
Vegetables		3.2%	1.6%
Horticulture	3.6%		
Dairy	3.4%	2.3%	1.1%
Wine	5.7%	6%	3%

**This analysis examined the relative importance of domestic and export markets in these industries and the prospects for growth in each market*

The Economic Consulting Services (2003) study provided a spatial dimension to their growth projections, and these are used in this study to project growth rates in the three groundwater areas. The low growth scenario attributes the same spatial pattern of industry expansion. The assumed growth rates reported in Table 3.

¹ The ECS projections were converted to annual growth rates assuming a constant pattern of growth over the projection period.

Table 3. Agricultural growth rates used in analysis

Groundwater area	Bunbury	Busselton-Capel	Blackwood
<i>High growth scenario</i>			
Dairy		4.1%	4.2%
Horticulture	3.4%	2.5%	3.1%
Viticulture		4.9%	12.0%
<i>Low growth scenario</i>			
Dairy		1.3%	1.3%
Horticulture	2.4%	1.7%	2.1%
Viticulture		2.3%	7.9%

3.2.2. Non-agricultural demand

The Economic Consulting Services (2003) study also investigated the growth prospects for non-agricultural water demand. Apart from mining, which is not expected to grow in the medium to longer term, all other uses were projected to grow at 3% per year². An alternative estimate of 2% per annum, which they reference in their report, has been forecast by the South West Development Commission. These two values are used to represent high and low estimates of non-agricultural demand growth in this study.

3.3. Representing the value of water in different uses

In economic terms, water extracted from a particular source is factor of production used in producing goods or services that have an economic value. The economic value of the water used can be derived from understanding the nature of the production process, the downstream market, and the substitutability of the water from a particular source with the next alternative source. This is the approach taken in this study, and the details of the method are presented below. The values of water in regional uses, estimated using this approach, differ markedly from the values reported in a study commissioned by the Water Corporation (Economic Consulting Services 2005). One of the reasons for this large difference is that the present study deals explicitly with the opportunity cost of water from the Busselton-Capel, Bunbury and Blackwood groundwater areas, whereas the Economic Consulting Services (2005) study focused on the value of water *per se*, and did not measure this value according to economic theory. These issues are outlined in Box 1, where the differences between the water values estimated by the two approaches are compared.

3.3.1. Agricultural uses

In the case of agricultural uses, water use is tied to the land and is therefore location specific. The value of water in irrigated uses can be derived in the same way that land values are derived. That is, as the expected stream of income that can be derived from access to physical resources at a particular location, after all cash, labour and capital costs are accounted for. The value associated with access to

² The exception in their report was potential additional industrial demand growth for Kemerton, but subsequent discussion with the Department of Water indicate that this area is outside the study region (Catherine Harrison, Personal Communication).

water is the difference between the residual profit, earned from access to land and water, and the income that would be earned using dryland agriculture, which is determined by the value of land on dryland farms³. These values can also be calculated in net annual terms, as was done for the present study.

Applying this approach to dairy and horticultural industries in the South West, based on gross margin budgets from the Department of Agriculture, and estimates of labour requirements, capital investment costs, and assessment of product price risk, Brennan (2004) calculated an annual return to water for potatoes of \$745 per ML, and for carrots of \$345 per ML. Perennial fruits were estimated to return an annual value to water of \$512 per ML for apples and \$211 for stone fruits. Reflecting the importance of potato growing in the region, a value of \$500 per ML was selected to represent horticulture in this analysis.

The estimation of the value of water in the wine industry is more problematic, because there is a large value added on the farm associated with wine production, and because there is a large degree of variation in the return to irrigation, depending on the price premiums attained by the vineyard. Production of bulk wine grapes may not have a high return to water. For example, based on Department of Agriculture budget information, Brennan (2004) estimated the return to water in wine grape growing on the Swan Coastal Plain to be \$170 per ML. On the other hand, very high returns to water are achieved in premium wine growing areas. The experience of the McLaren Vale in South Australia demonstrates the value of water in a premium wine region, where there is anecdotal evidence to suggest that water entitlements⁴ have been traded at \$10,000 per ML. McLaren Vale is also the only irrigation area in Australia where a self-funded wastewater recycling facility has been developed (Hatton McDonald and Dyack 2004). These observations suggest that a high value to water should be expected in the present study area where most of the demand growth is expected to be in the premium Margaret River region. In this study, it is assumed that the value of water in the viticulture industry is the same as assumed in other horticultural industries, at \$500 per ML.

Using the same approach to estimate returns to water in irrigated dairy production, Brennan (2004) found a wide range in returns according to region and irrigation technology. She estimated a return to water of \$259 per ML for irrigated dairy on the Scott Coastal Plain, based on large central pivot irrigation systems. Since this is the technology that is most likely to be adopted in the study region in the future, this figure is used to represent the value of new dairy growth in this study.

3.3.2. Non-agricultural uses

Unlike self-supply agricultural uses, most other water uses obtain water from a public utility, and the cost of foregoing abstraction in a particular location to supply the public utility is the difference between the cost of acquiring water from this source compared to the cost of the next available supply source. In the case of urban water, for example, a restriction on the quantity of water available from groundwater resources in the region, to supply of residential water demand in a Busselton or Bunbury, might lead to supplementation by alternative sources. The value of the water in the relevant South West groundwater areas can then be measured as the

³ The separation of the value of land and water can be problematic in areas where water rights are not defined separately, because in these cases the value of the land includes the value of access to irrigation. However, this problem can be overcome by using the value of land in dryland farming in adjacent regions with similar biophysical resources except for access to water.

⁴ A water entitlement is the right to take water in perpetuity and is therefore a capitalized value, like a land value.

Box 1: Assigning economic values to water

Assessing economic efficiency requires attention to the allocation of resources, that is all resources used in producing a particular output, and any measure of output value that doesn't account for the cost of production, nor the opportunity cost of resources, does not represent true economic value. The true measure of the value of allocating a resource to a particular use is the opportunity cost of that water. What would happen if water were not allocated to the Water Corporation? What would happen if water were not allocated to the region? These are the proper questions to guide an economic evaluation of allocation options.

The economic values of different water uses presented in the Strategen (2006) report, taken from Economic Consulting Services (ECS 2005), are based on the proposition that the economic value of water can be determined by taking the gross value of production in a particular industry and dividing that value by the total quantity of water used, to derive a per unit value. For example, the value of output sales from mining and petroleum in Western Australia in 2003 was \$27 billion, and by dividing by the estimated water used in this industry (430GL per annum), they derived a value for water in mining of \$63 per kL. The issue with this approach is that takes *all* the resource rents attributable to *all* factors of production, and attributes these values to water. This method results in those industries where water is a relatively less important factor of production being assigned a very high value. In order to use the state accounting figures to assign values for water, it would first be necessary to work out the residual value that is left after all other factors of production including intermediate inputs, land, labour and capital are accounted for.

Moreover, even if it were possible to derive an estimate of the value of water using state accounting figures, this does not necessarily imply that these values can be ascribed to the water available in the study region. This is because the maximum willingness to pay for water from this particular source depends on the substitution options available to supply a particular water demand. If no substitution options are available, then the value of water from a particular source is the lost consumptive value of the water, whereas if substitution to another source is cheaper than foregoing consumption, then it is the cost difference between the two substitutes that represents the value of water from the particular source.

These considerations were used in deriving the values of water used in this study, which are compared with the ECS (2005) estimates in Table B1.

Table B1. Values used in this analysis and those presented by ECS (2005)

Regional uses	ECS (2005)	<i>This study</i>
Dairy	\$0.47 to 2.0 per kL	\$0.26 per kL
Horticulture	\$0.67 per kL	\$0.50 per kL
Viticulture	\$4.00 per kL	\$0.50 per kL
Urban (regional)	\$100 per kL	\$0.60 per kL
<i>Relative values as a percent of urban</i>		
Dairy	.05% to 2.0%	43%
Horticulture	0.67%	83%
Viticulture	4%	83%

difference between these two costs. The Economic Regulatory Authority (2005b) has recently determined that the long run marginal cost of water supply for Bunbury is \$0.56 per kL, and for Busselton is \$0.52-0.66 per kL. Since the cost of providing water through desalination is around \$1.20 per kL, then the value associated with allocating water from the regional groundwater sources to the urban water utilities in the South West is around \$0.60 per kL, being the additional cost that would be incurred in supplying water to customers if an alternative source had to be found. Since many of the light industry and service sectors in the South West are supplied at utility rates, the same value is assigned to these uses. The same value was also applied to mining.

3.4. Projected growth in values of water

The forecast growth in potential water use for different value categories, by groundwater area, is shown in Figure 1. These are all presented on the same scale to allow direct comparison between the values in the different groundwater areas. To illustrate the difference between potential water use and the economic value of those uses, the case of the Busselton-Capel groundwater area, under a high growth scenario, is shown in Figure 2. The dairy sector has a much lower share of water values compared to its share of potential water use.

In the water allocation options considered in this analysis, the potential growth in regional demand is constrained by the amount of water allocated to the region. In conducting the economic analysis, it is assumed that when water is in scarce supply, development of the lowest value industries is curtailed in favour of the higher value uses. Thus the dairy industry, and in some cases the horticultural industries, are prevented from developing their full growth potential, in favour of urban and industrial growth in the region.

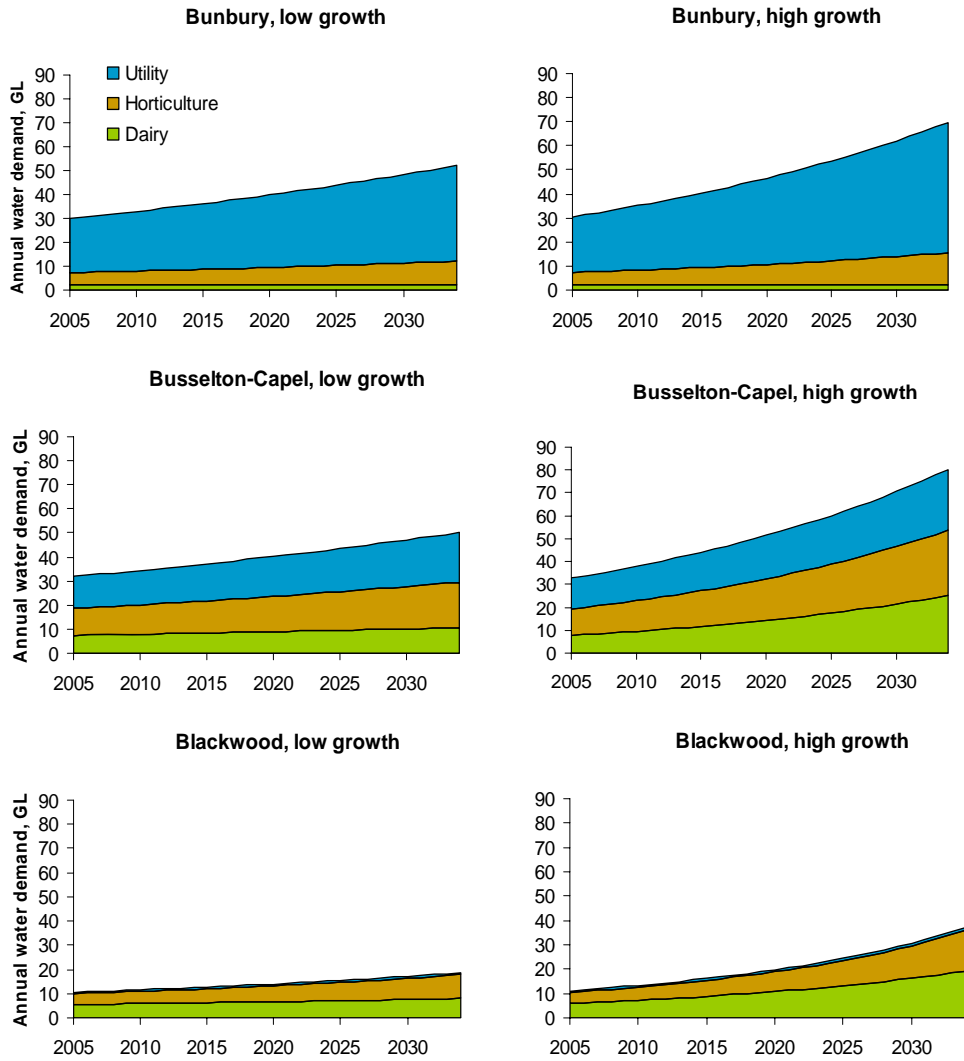


Figure 1. Projected growth in the potential demand for water in region

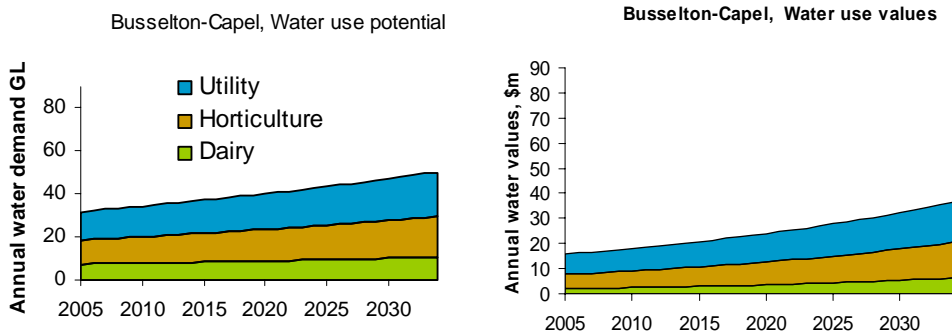


Figure 2. Example of difference between water quantity used and economic value

4. Value derived from allocating water to the Water Corporation

4.1. The need for the South West Yarragadee borefield

In their Source Development Plan, the Water Corporation report that the two main opportunities being considered for supply augmentation in the near future are the development of the South West Yarragadee, and the construction of a second desalination plant (Water Corporation, 2005). According to the costs presented in that report, the South West Yarragadee is the cheaper option. Applying the same opportunity cost approach that was used to value water in the region, the value of South West Yarragadee water allocated to the Water Corporation is the cost saving associated with developing the South West Yarragadee source, compared to the cost of supplying water through a new desalination plant. However, there are a number of caveats that must also be considered. In particular, whether the South West Yarragadee development really represents the most efficient strategy for dealing with demand-supply imbalance is an open question, as is the selection of the appropriate level of reliability for urban water supply which influences the timing of construction. These matters can not be considered outside the broader context of water resources management in Western Australia.

4.1.1. Climate change and water resources management

A series of dry years in recent times has had a significant impact on the annual average recharge of dams and aquifers, to the extent that the Water Corporation is now basing its supply-demand projections on two possible climate scenarios going forward: these are the most recent 8 years and the most recent 30 years. Reduced rainfall over the most recent 30 years has reduced the yield of surface water dams by 50% compared to the long term historical average, and the run of dry seasons in the past 8 years have further reduced yields by 30% (Water Corporation, 2005).

One option for dealing with the reduced run off associated with lower rainfall is to change the land use in the catchment area. For example, it has been shown that the harvesting of pines and changes to burning regimes could have a significant impact on water recharge on the Gnangara Mound (Department of Environment, 2005). Trials are underway to investigate the potential for forest thinning to improve run-off into dams in surface water catchments (Water Corporation 2005). However, while land use changes may offer opportunities for mitigating the effect of climate change on run off, the water resources management arrangements in Western Australia do not explicitly deal with recharge-affecting land uses. This means that even if forest thinning can be shown to increase catchment yields, the Department of Water has no legal mechanism for implementing changes to the way forests are managed. Thus decisions about the South West Yarragadee are being made in the context of sub-optimal arrangements elsewhere in the water resources management regime of Western Australia.

4.1.2. Rural-urban trade

The South West Yarragadee proposal is effectively a rural-urban trade, because it involves foregoing potential future regional uses to allow water to be supplied into the Integrated Water Supply System. However, the opportunity costs of water in the region are relatively high because of the potential for development of industries as well as agriculture, and because a substantial proportion of the agricultural

opportunities have high economic value. In contrast, there are opportunities for the Water Corporation to buy water from irrigators in the South West Irrigation area that may provide an alternative rural-urban trade. The predominant use of water in the South West region is flood irrigated pasture, some of which is occurring on salinized and waterlogged soils. Whilst the Water Corporation has recently negotiated a trade with the irrigation cooperative, there is further potential for water to be bought from irrigators in this region. However, current arrangements do not permit individual negotiation with farmers, which has meant that opportunities to trade have been limited and the price paid to recover water to date has been considerably higher than the opportunity cost of water in irrigated agriculture in the region. For example, the cost of piping water in exchange for 17 GL of water from the Harvey Waroona region was \$72m, whereas the value of the water used in irrigated agriculture is around \$25m.

Another difference between buying water from irrigators in the South West scheme, and potential future irrigators in the Bunbury, Busselton-Capel and Blackwood groundwater areas is the mechanism for compensation. Since property rights are explicitly assigned to irrigators in the Harvey-Collie region, then private trades between the Water Corporation and these farmers would result in compensation to the farmers who choose to sell water⁵. In contrast, property rights have not been assigned to potential users of groundwater resources in the South West region.

4.1.3. Supply reliability

The Water Corporation's preferred timing for augmenting the Integrated Water Supply Scheme with the South West Yarragadee development is to supply water in 2009. This is based on the current planning goal of catering for an eight-year climate scenario with a high reliability, defined as a "1 in 200 year risk of a total sprinkler ban" (Water Corporation, Source Development Plan, 2005). On the other hand, if supply forecasts were based on the recent 30 years of climate, the South West Yarragadee borefield would not be required until 2020. A range of possible starting dates for the South West Yarragadee, based on the Source Development Plan, are shown in Table 4. The impact of alternative reliability requirements on timing of augmentation is quite substantial.

The Economic Regulatory Authority has questioned the adoption of such a high reliability standard for urban water supply, and has illustrated the high cost associated with such standards in the context of the decision to construct the first desalination plant at Kwinana (Economic Regulatory Authority 2005a). Similar issues arise in evaluating the South West Yarragadee proposal. A full examination of the economic benefits of allocating water to the Water Corporation would really require an investigation of the economic value associated with providing a 1 in 200 level of supply reliability. Since time does not permit this level of analysis, the approach taken in this study is to evaluate the South West Yarragadee option for a range of assumptions regarding the timing of supply augmentation.

⁵ In fact, the current articles of association in the South West Irrigation Cooperative do not permit individual irrigators to sell water outside the scheme.

Table 4: Timing of construction as influenced by planning goals

Reliability (Risk of sprinkler ban)	Per Capita consumption kL	Climate	Year required
1:30	155	30 year	2029
1:100	155	30 year	2024
1:200	155	30 year	2020
1:30	170	30 year	2022
1:100	170	30 year	2018
1:200	170	30 year	2014
1:30	155	8 year	2016
1:100	155	8 year	2013
1:200	155	8 year	2009

4.1.4. Other demand management options

The planning projections made by the Water Corporation do incorporate strong demand management assumptions. For example, the 155 kL demand forecast is consistent with the level of consumption that has been achieved since the imposition of two-days-per-week sprinkler restrictions. According to the Water Corporation's reported scheme use (Figure 2.3, Source Development Plan), per capita consumption fell by 20 kL per capita as a result of restrictions, and this is equivalent to a reduction in demand of around 16% per household. However, whether or not the full scope of demand management measures have been explored, as an alternative to augmenting supply in 2009, is an open question.

For example, increasing water prices is an alternative demand management option that would be expected to reduce consumption. Household water consumption in Perth is the largest of all Australian capital cities, and water prices are the lowest. Around 60% of Perth consumers pay prices that are only half the long run marginal cost, implying that the demand signals being used to justify the Water Corporation's investment decisions are distorted. Brennan (2006) has estimated that if prices were set at the cost of desalination (\$1.20 per kL), a reduction in residential demand of between 9 and 17 percent might be expected (equivalent to 15 - 30 GL per annum)⁶. An efficient pricing policy could delay the need for the South West Yarragadee, even in the absence of sprinkler restrictions. The same model reported in Brennan (2006) has been used to estimate that the combined effect of pricing and 2-day per week restrictions, and predicts a reduction in demand of 30 to 40 GL per annum. The claim in the Strategen (2006) report that allocating to the Water Corporation is 'economically efficient' takes no account of the fact that current pricing practices, and the apparently urgent need for supply augmentation, contravene economic efficiency principles.

⁶ These results differ from the findings of the Economic Regulatory Authority (2005), who predicted a very modest impact of pricing reform. The reason is that their analysis only looked at average values and didn't account for the differences in price response between indoor and outdoor uses, nor in the effect of demand heterogeneity on marginal price signals to different consumers. The economic model reported in Brennan (2006) takes account of this highly heterogeneous demand characteristics and was calibrated to match the variation in consumption between households using 2002 consumption data.

4.2. Economic comparison of the South West Yarragadee and desalination

The analysis conducted in this study is based on the costs provided in the Source Development Plan (Water Corporation, 2005). The cost of developing the South West Yarragadee is estimated to be \$383 m, with an operating cost of 22 cents per kL. The cost of integrating the South West Yarragadee into the IWSS would add an additional \$36 m, being for construction of the Ravenswood Pump Station and upgrading of the Tamworth Pump Station (Water Corporation, 2005). Because time and commercial confidentiality do not permit an investigation of these values, sensitivity analysis is conducted to estimate the impact of a 20% capital cost increase during the construction phase.

Two alternative supply costs for a second desalination plant are reported in the Source Development plan. These have capital and operating costs of (424 m, \$0.56 per kL) and (514 m, \$0.36 per kL) respectively. In addition, integration into the IWSS would require the upgrade of Tamworth and Nicholson Road Pump Stations, costing \$21 m. The high capital cost option is used as the baseline in this analysis, and sensitivity analysis is conducted using the alternative figure.

In estimating the economic value of the two alternative supply sources, it is assumed that 50% of the capital invested in the South West Yarragadee development has an asset life of 50 years, and that only 20% of the desalination plant had a 50 year asset life. The remaining assets were assumed to have an asset life of 30 years⁷. These differences in economic life were dealt with using an annuity method. The net present value of the two supply augmentation options are presented in Table 5.

Table 5. Value of water from the South West Yarragadee for the Integrated Water Supply System

Augmentation option	Capital	Operating	Net Present Value	Opportunity cost of South West Yarragadee
South West Yarragadee A	\$421 m	0.22	\$674.54	
Desalination A	\$535 m	0.36	\$969.35	\$294.81
<i>Sensitivity</i>				
South West Yarragadee B ¹	\$505 m	0.22	\$768.55	\$200.80
Desalination B ²	\$445 m	0.56	\$1,048.48	\$373.94

1. Based on 20% higher capital cost, compared to the baseline Desalination option. 2. Based on alternative estimate of cost in Source Development plan, compared against the baseline South West Yarragadee option.

⁷ These assumptions were based on suggestions by Lloyd Werner, Water Corporation.

5. Analysis of the 112 GL option

5.1. Net economic values

The distribution of water between groundwater management for the two alternative 112 GL allocation options is shown in Table 6. Also shown is the marginal use over different time horizons, which demonstrates the squeezing out effect of demand growth on the lower value water uses. Where allocations are low relative to demand, it is assumed that water is first allocated to higher value uses. This is the type of internal water allocation that would occur under conditions of scarcity when water markets tend to mature.

Table 6. Water allocations in ground water sub areas under the 112 GL scenario

	Bunbury	Busselton-Capel	Blackwood
Allocate to region only			
Water allocation	33	68	11
Marginal use in year 10	Horticulture	Dairy	Dairy
Marginal use in year 30	Urban	Dairy	Horticulture
Allocate to WC and region			
Water allocation	33	23	11
Marginal use in year 10	Horticulture	Horticulture	Dairy
Marginal use in year 30	Urban	Urban	Horticulture

Because economic values in the region are growing over time, the outcome of a net present value analysis depends on the time frame chosen. This is demonstrated in Figure 3, which compares the stream of annual economic values associated with allocating water to the region only, compared to allocating 45GL to the Water Corporation and the balance to the region. The first graph compares the economic values projected from the year 2009, which is when the South West Yarragadee will come on line under an 8-year climate, high reliability planning criteria. The second graph in figure 3 shows the annual stream of values that are generated under the assumption that the South West Yarragadee construction is delayed until 2015. If values are examined from this starting point, then the economic values associated with the region-only allocation are relatively higher, because the region starts with a higher base level of demand. Over time, the annual economic value of water grows in the region and at some point in the future the water becomes more valuable under the 'region only' scenario. The six year gap results in a bringing forward of the point where the annual total value of water is greater for the region only option, compared to the Water Corporation plus region option, from 24 years to 19 years. These differences in annual economic value streams have important implications for the net present value analysis.

Results of the cost benefit analysis are presented in Table 7, for two different economic growth assumptions and for different timing of investment assumptions. The first set of numbers show the net present value of consumptive uses of water where water is allocated to the Water Corporation, under the assumption of high economic growth. The distributional impacts are also shown. The net present value results represent the real value of money in the year indicated, and are higher when construction is delayed because the total benefits of water consumption in the region are increasing over time, and later commencement implies a higher base line level of water demand. The second set of values show the economic benefits associated with allocating water to the region only. The difference between these two sets of values

indicate the net benefit or cost of allocating water to the Water Corporation, shown in the right most column of the table. It can be concluded that if the evaluation is based on supply augmentation occurring in 2009, then there is a positive net benefit associated with allocating water to the Water Corporation under a high potential regional growth scenario. However, relaxation of the reliability requirement on the IWSS to a 1:100 year sprinkler ban, which would delay the construction of the South West Yarragadee to 2012, would reverse the result. Delay in construction means that the opportunity cost of not allocating to the region is higher, because the base level of demand is greater. Under the high growth scenario, the superiority of allocating only to the region increases as the augmentation year is delayed.

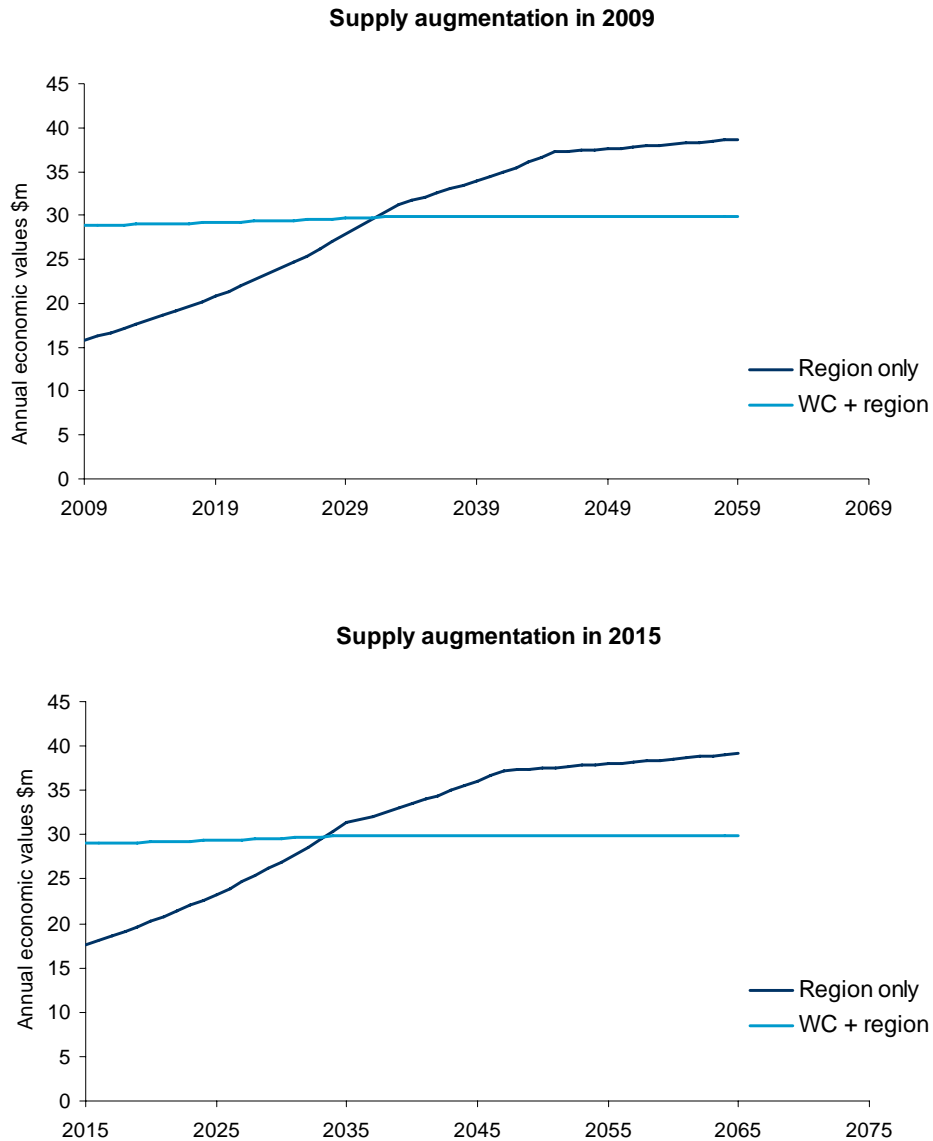


Figure 3. Annual economic values associated with consumptive use of water under the 2 allocation options

Under pessimistic regional growth assumptions, the economic value associated with allocating water to the Water Corporation is higher, as indicated by the second set of economic values in the table. The true value of water in the region is likely to lie somewhere in the range of the high and low demand growth scenarios. Thus there is some uncertainty as to whether the net economic benefit of allocating water from the South West Yarragadee to the Water Corporation will have a positive economic benefit or not.

Since the timing of construction is critical to the net economic value when demand growth is on the high side, a full economic analysis requires an assessment of the economic value of system reliability. Since there have been no economic studies on the value of reliability in Western Australia, it is not possible to provide a full economic analysis of the water allocation decision.

Table 7. Results of net present value analysis for water allocation options under 112 GL scenario*

	Year of supply augmentation	Region	Net present value \$m		
			IWSS	Total	Difference
<i>High demand growth</i>					
Allocate to WC and region	2009	816	295	1,111	39
	2013	829	295	1,124	-4
	2020	842	295	1,137	-80
	2024	846	295	1,141	-121
Allocate to region only	2009	1,072	0	1,072	
	2013	1,128	0	1,128	
	2020	1,216	0	1,216	
	2024	1,262	0	1,262	
<i>Low demand growth</i>					
Allocate to WC and region	2009	802	295	1097	134
	2013	815	295	1110	106
	2020	830	295	1125	55
	2024	836	295	1131	24
Allocate to region only	2009	963	0	963	
	2013	1004	0	1004	
	2020	1070	0	1070	
	2024	1107	0	1107	

*Values reported are in dollar values in the stated year of supply augmentation

5.2. Distributional issues

The distributional consequences associated with the different assumptions regarding the timing of augmentation are demonstrated in Figure 4. The green bars show the net benefit to the IWSS in terms of reduced water supply cost, and the blue bars show the foregone economic opportunity associated with allocating 45GL of water to the Water Corporation instead of to the region. The net difference between these costs and benefits are the values reported in the right-most column of Table 7.

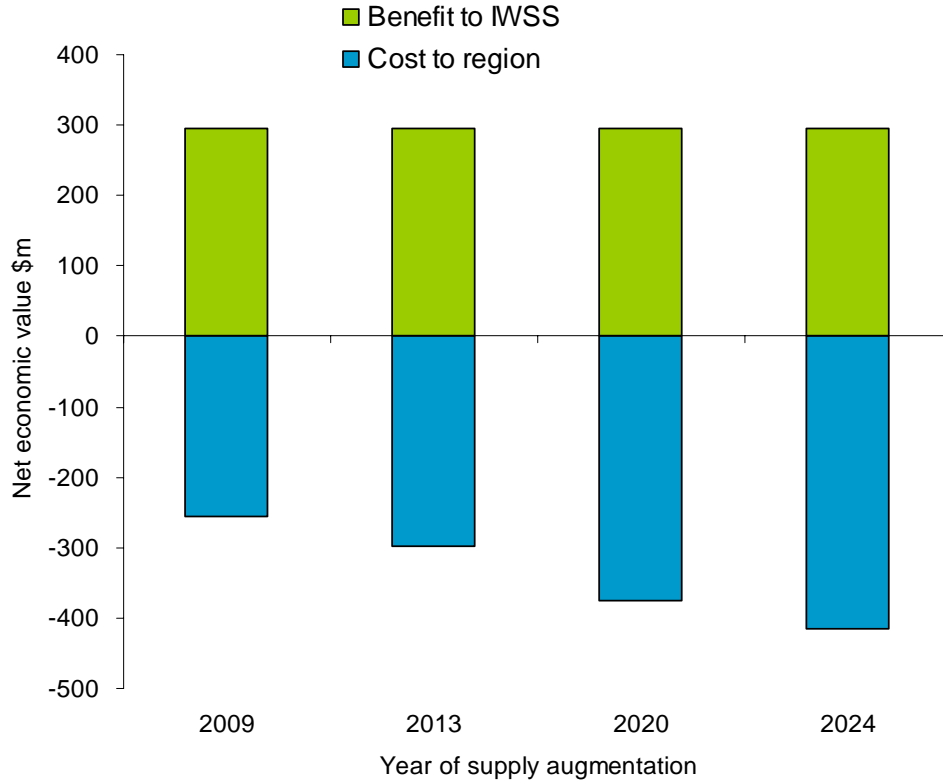


Figure 4. The distributional consequences of allocating water to the Water Corporation, high demand growth, 112GL scenario.

5.3. Sensitivity analysis on net economic value and distributional impacts

A number of sensitivity analyses were conducted and the high and low ranges of these analyses are presented in the following figures.

Figure 5 shows the worst case against allocating water to the Water Corporation. This was based on the assumption of a 20 % higher capital cost associated with constructing the South West Yarragadee development, and the case of high regional economic growth. The green bars show the benefit of reduced supply cost to the IWSS, and the blue bars are the foregone economic opportunities in the region. The case for allocating to the Water Corporation, even under an 8 year climate scenario, is completely eroded. Even under an early commencement date the costs to the region, in terms of foregone economic values, is far greater than the benefits of allocating water to the Water Corporation, under these assumptions.

The best case in favour of allocating water to the Water Corporation under the 112GL scenario is where costs of desalination are relatively higher, and where demand growth is low. This is illustrated in Figure 6.

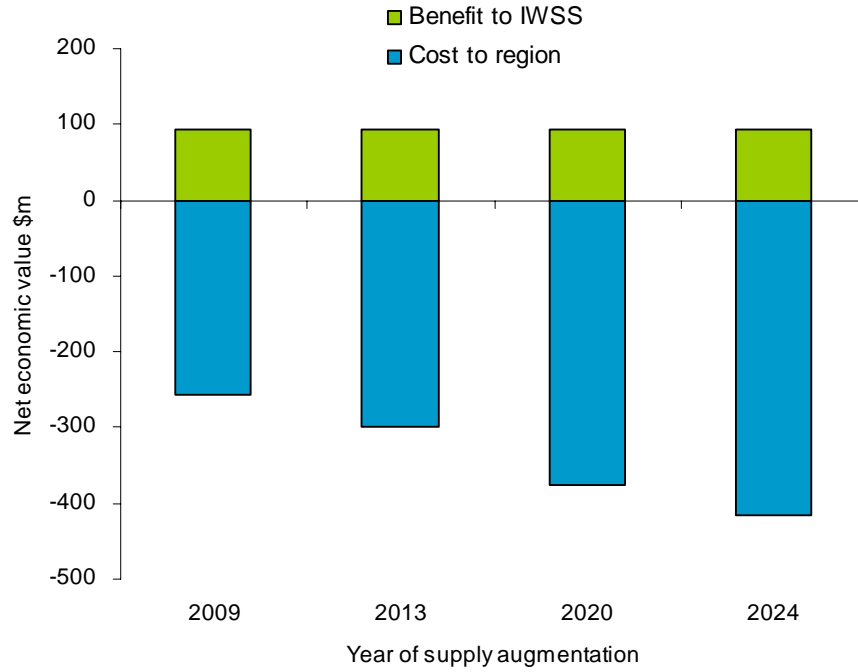


Figure 5. Costs and benefits of allocating water to the Water Corporation, worse case for Water Corporation, with a higher 20% cost and high demand growth

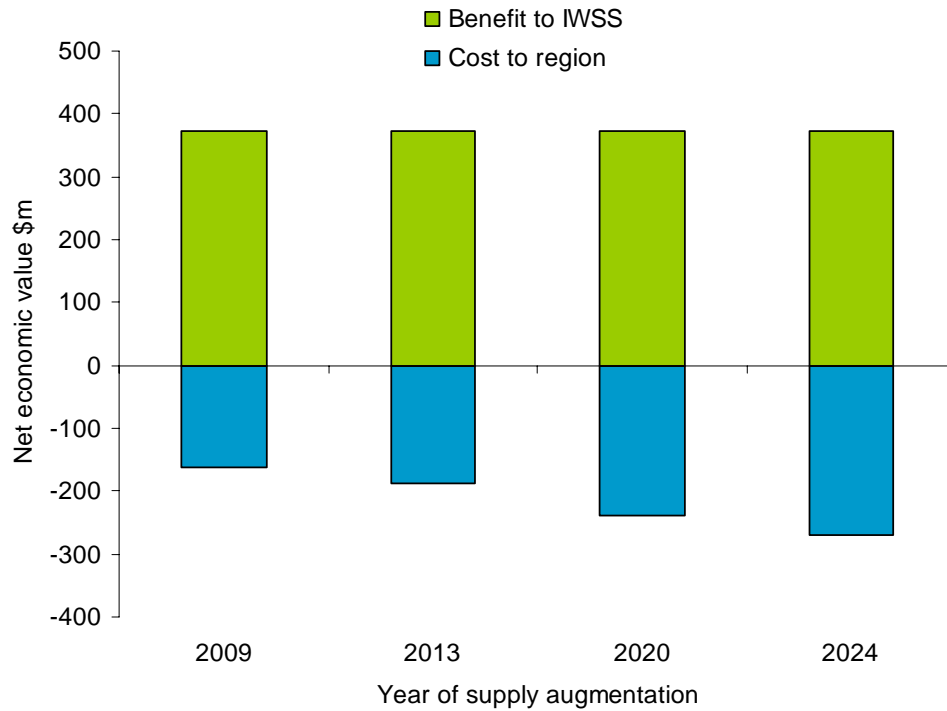


Figure 6. Costs and benefits of allocating water to the Water Corporation, best case for Water Corporation, with a high cost of desalination and low demand growth

6. Analysis of the 160 GL option

6.1. Net economic values

Where 160GL is available for allocation, the opportunities for regional growth are much less constrained. The assumed allocation levels under this scenario, and the projected marginal uses of water in the each groundwater management area at different points in time, are presented in Table 8.

Table 8. Assumed water allocations under the 160 GL scenario

	Bunbury	Busselton-Capel	Blackwood
Allocate to region only			
Water allocation	33	68	11
Marginal use in year 10	Hort	Dairy	Dairy
Marginal use in year 30	Urban	Dairy	Hort
Allocate to WC and region			
Water allocation	33	52	31
Marginal use in year 10	Hort	Hort	Dairy
Marginal use in year 30	Urban	Dairy	Dairy

Results are presented in Table 9, and indicate that there is a clear economic case for allocating water to the Water Corporation if this higher level of abstraction can be allocated with the confidence that there are no unacceptable risk of impacts associated with it. Even under high demand growth and a late commencement time for the South West Yarragadee development, the net economic value associated with allocating water to the Water Corporation is positive.

Table 9. Results of net present value analysis for water allocation options under 160 GL scenario

	Year of supply augmentation	Region	Net present value \$m		
			IWSS	Total	Difference
<i>High demand growth</i>					
Allocate to WC and region	2009	1099	295	1394	206
	2013	1160	295	1455	178
	2020	1253	295	1548	117
	2024	1298	295	1593	73
Allocate to region only	2009	1187	0	1187	
	2013	1277	0	1277	
	2020	1431	0	1431	
	2024	1520	0	1520	
<i>Low demand growth</i>					
Allocate to WC and region	2009	984	295	1279	286
	2013	1031	295	1325	280
	2020	1106	295	1400	264
	2024	1147	295	1442	251
Allocate to region only	2009	993	0	993	
	2013	1045	0	1045	
	2020	1136	0	1136	
	2024	1191	0	1191	

7. Stranded assets risk associated with revised allocations

An issue that arises in evaluating the Water Corporation's proposed South West Yarragadee investment is the risk of stranded assets, which might arise if water allocations need to be reduced as a result of unacceptable impacts. The sunk investment in infrastructure may have an influence on how allocations are revised, and also whether they are revised at all.

There are a number of possible outcomes. First, if there are no effective claw back mechanisms in place, the cost will be borne by the environment and other users of the water *in situ*. Alternatively, there are a number of claw back mechanisms that might be applied. According to the principles of the National Water Initiative, system yield risks are required to be borne by users in proportion to their entitlements. This scenario is called a "proportional reduction" in the following discussion. Two alternative mechanisms that are evaluated are one that gives priority to the Water Corporation, and one that gives priority to the region. That is, in the first case, all Water Corporation entitlements are honoured, and in the second case all regional entitlements are honoured and the residual is allocated to the Water Corporation.

These alternatives were evaluated by comparing scenarios where 160GL is allocated to the region, then after 5 years rights are either left unchanged or reduced to 112 GL as a result of unacceptable impacts. In this evaluation it is assumed that the supply augmentation occurs in 2009. The distributional and total impacts on the Water Corporation, and the Busselton-Capel region, are compared in Figure 10. (The other two regions are assumed to be unaffected by the adjustment to entitlements.)

The green bars in the Figure show the benefit to the Water Corporation, associated with having access to the South West Yarragadee. This is the difference between the total cost of supplying 45 GL of water from the South West Yarragadee (plus supplementing it if there is reduced yield), less the cost of supply the full amount from a desalination plant, which is the cost that would be incurred if there was no allocation made to the Water Corporation in the first place. The blue bar shows the benefit to the region in terms of the value of the water resource to local users. The quantity of water that would be allocated to the Water Corporation under each 'claw back' scenario are indicated above the bars.

The "no adjustment" scenario demonstrates the benefits that could be achieved by the two stakeholders if there is no claw-back in entitlements. The next three values show the impact of different water allocation options. The size of the green bar can be compared with the green "no adjustment" bar to indicate the net impact on the Water Corporation. If water rights are clawed back in proportion to entitlements, then the Water Corporation would be forced to construct a desalination plant to meet additional supply⁸, so the net benefit associated with having access to the South West Yarragadee would decline. If priority were given to the Water Corporation, the cost would be borne by the region in terms of reduced growth in water using industries. If the needs of the region were honoured and Water Corporation were given the residual water, they would actually end up incurring higher costs than they would have incurred if they had never been allocated water from the South West Yarragadee in the first place. Which of these allocation scenarios, if any, would be implemented would depend on water management arrangements and political

⁸ Only the costs of building enough desalination supply to meet the deficit are considered in this analysis. That is, the proportion of plant required to meet the gap is attributed as a cost.

decisions of the day. Clearly if trading were possible then it is likely that the Water Corporation would seek to buy rights from regional users, rather than incur the cost of stranded assets, but any such trade would require further assessment of localised impacts and may not be physically possible.

The final two scenarios shown in the figure compare the net and distributional benefits of a more modest original allocation, where only 112GL of rights are granted. The relative size of the distributional impacts of these range of scenarios shown here outweigh the differences in the total net benefits to the state.

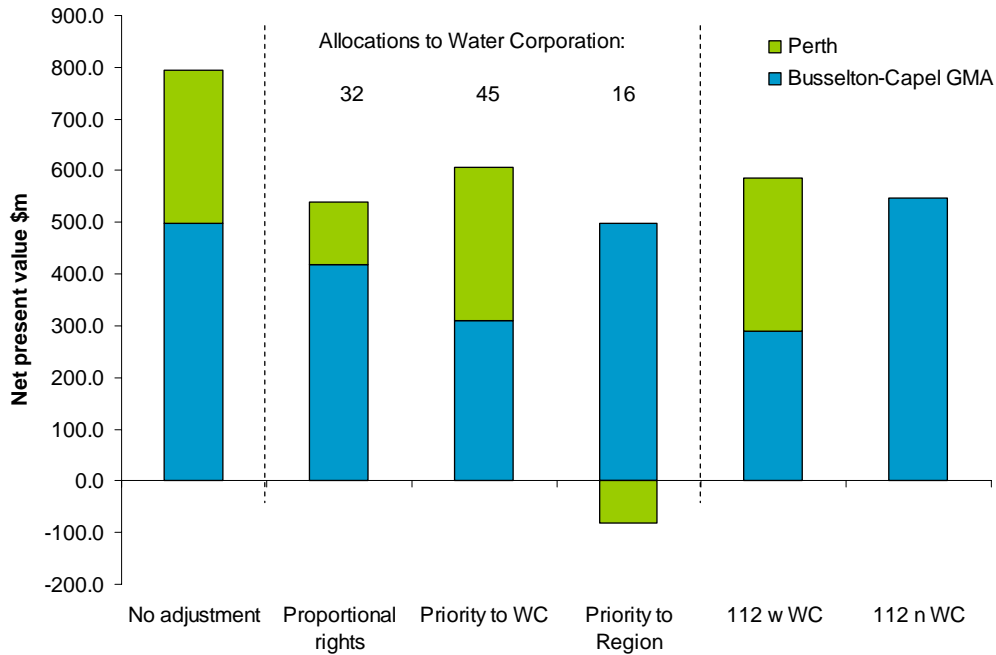


Figure 10. Evaluation of the impact of clawing back allocations from 160GL to 112GL (commencement 2008, high demand growth)

8. Conclusions

The economic analysis of the consumptive use values of water from the Busselon-Capel, Bunbury and Blackwood groundwater areas indicates that there are a number of factors influencing whether or not the allocation of water to the Water Corporation has economic merit.

Most importantly, the potential for constraining growth in the region means that the economic value of alternative allocation options depends on the total amount of water that is available for allocation. A more conservative approach to water allocation, such as the 112 GL option considered here, would imply that the allocation of water to the Water Corporation could constrain regional development. In contrast, if it can be determined with a high degree of confidence that 160GL is available for allocation, then there is more scope for regional growth and the regional opportunity cost of allocating to the Water Corporation is lower.

If a conservative approach is taken to allocating water in the region, such as the 112GL option examined in this study, then there is not a clear economic case for allocating water to the Water Corporation. Some of the main uncertainties influencing the net economic outcome are the value of reliability of urban water supply, alternative opportunities for addressing supply-demand imbalance in the IWSS, and the risk of unacceptable impacts, none of which were quantified in this analysis. Another uncertainty is the potential value of growth in the region. The economic analysis shows that under an optimistic demand growth scenario (consistent with strong market outlook assumptions for agricultural produce), then the opportunity cost of allocating water to the Water Corporation, in terms of foregone regional water uses, is of a similar magnitude to the benefits of reduced supply cost in the IWSS. Results also indicate that if the construction of the South West Yarragadee is delayed until 2012, reflecting a less stringent IWSS reliability target, then the additional 45 GL under question would have a higher value if it remained in the region, rather than being allocated to the Water Corporation.

The decision to allocate water based on a less conservative approach (such as the 160GL scenario considered in this study) should take into account the possibility that rights may have to be reduced in the event of an unforeseen adverse impact. Analysis of the potential cost of 'clawing back' water allocations from a 160GL benchmark highlights that there will be a wide variation in the economic impact on the region and the Water Corporation, depending on how rights are interpreted and prioritized. This illustrates the importance of setting clear mechanisms in place for dealing with such eventualities, before an allocation decision is made.

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