Resource Economics Unit

INQUIRY INTO COMPETITION IN THE WATER AND WASTEWATER SERVICES SECTOR: WATER TRADING ISSUES

Prepared for the Economic Regulation Authority

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Resource ***E***conomics ***U***nit: *Inquiry into competition in the water and wastewater services sector: Water Trading Issues.* Report to the Economic Regulation Authority 30th October 2007.

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The report gives advice on water trading matters in relation to the current Inquiry into Competition in the Water and Wastewater Sector being conducted by the Economic Regulation Authority. The views expressed are not necessarily the views of the Authority or any other department or agency of the Western Australian Government.

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SUMMARY OF PRINCIPAL FINDINGS

1. The report finds that there may be considerably more potential for water trading in future, particularly in the direction of the Integrated Water Supply Scheme (IWSS), than may have been so far appreciated. This finding is based on the extent of current institutional barriers to trade, the lack of a fully operational water market at present, and evidence that there are significant volumes of low-value water that could be traded.

2. Wider trading could offer significant benefits in the form of i) more cost-efficient source development projects for the IWSS and (ii) the transfer of other water, including fit-for-purpose water, between users outside of the IWSS. As one example it has been estimated that a net benefit to the Water Corporation of between $30M and $59M was obtained from the Harvey-Waroona trade alone. The trade also benefited consumers by helping to avoid more severe water use restrictions.

3. There is currently an institutional bias against water trading. The Water Corporation tends to favor large projects with good prospects for timely completion and guaranteed water quality with minimal treatment (excluding desalination plants). Irrigation cooperatives tend to limit trading to irrigation system efficiency gains. The natural resource managers face many - as yet unresolved - issues that affect their ability to regulate and/or facilitate trades. The effect is to devalue entitlements, and to delay or lose opportunities for more efficient approaches to water supply.

4. The opportunity costs of current water use patterns, which could be revealed through a more open water trading regime, are not being signaled to decision makers: examples include decisions about plantation forestry, Gnangara Mound land and water allocation, and further transfers of water use in the south west.

5. There are significant opportunity costs involved in any delay of institutional reforms in relation to water trading. The resolution of outstanding natural resource management issues, such as in Gnangara and the Collie Basin, is a key constraint. It will be a mistake to delay water trading reforms until these issues are totally resolved.

6. Further thought needs to be given to the important role of irrigation cooperatives in facilitating trading. A recent report of the Australian Competition and Consumer Commission suggests a way forward for calculation of termination or exit fees, thus widening the scope for trading and avoiding the competitive distortions of exit fees linked to water volumes rather than actual irrigation system costs.

7. A mechanism needs to be developed to signal the opportunity costs of water use in plantation forestry to plantation landholders. The current scope of water reform could be widened to deal with this.

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TABLES

FIGURES

UNITS USED

10^3, 10^6, 10^9	:	thousand, million, billion
$1m^3$	:	one cubic metre, one kilolitre
$1m^2$	:	one square metre
KL, ML, GL	:	kilolitre (thousand litres); megalitre (million litres) , gigalitre (billion litres)
Ha	:	a hectare, (equals 100m x 100m, or 10^4m^2)
Km^2	:	a square kilometre; equals 100 hectares
$/KL	:	dollars per kilolitre
Present Value	:	the value today of a future dollar value
Discount rate	:	the rate of interest used to discount a future dollar to calculate its present value e.g. x% per year
Asset Value	:	the Present Value of a future stream of net income obtained from the use of an asset (e.g. the use of an entitlement to draw water)
Cost of a water project ($/KL)	:	the Present Value of costs of the project divided by its average annual yield in KL

1. BACKGROUND AND METHODOLOGY

1.1 Western Australia and the National Water Initiative

Western Australia became a signatory to the National Water Initiative in April 2006. The Western Australian Government had already established a Water Reform Implementation Committee, in September 2005, to provide advice on progressing water reform in the State. This Committee published *A Blueprint for Water Reform in Western Australia* (Water Reform Implementation Committee, December 2006). The Western Australian Government then published its Response to the blueprint document in February 2007.

The Department of Water has been charged with implementing the agreed reforms, and is following the steps described in *Western Australia's Implementation Plan for the National Water Initiative* (Government of Western Australia, April 2007).

1.2 Inquiry into Competition in the Water and Wastewater Services Sector

The Economic Regulation Authority is undertaking an *Inquiry into Competition in the Water and Wastewater Services Sector*, at the request of the Western Australian Treasurer. Its final report is due by 31st March 2008.

As a part of the Inquiry, Resource Economics Unit, Perth, was engaged by the Authority to provide advice on water trading matters, with special reference to:

- Progress being made with proposed reforms;
- The economics – benefits and costs- associated with the reforms, including an analysis of the proposed reforms' ability to enhance competition in the water and wastewater services sector;
- An assessment of the extent to which water trading can be used as an alternative source of bulk water; and
- A discussion of issues arising from the proposed reforms, including the potential for inter-regional trades, issues of market dominance, potential for water hoarding, potential for anti-competitive activity by holders of water, and key constraints on the implementation process in respect of water trading.

1.3 Definitions

1.3.1 Water Trading

This report refers to the exchange of an entitlement to withdraw water as a result of payment by a purchaser to a vendor. The entitlement may be (i) an existing license to withdraw water issued under the Rights in Water and Irrigation Act, 1914 (RiWI), or

(ii) a Water Access Entitlement (WAE) issued in future under the proposed system (see Section 1). Trades may alter the location where water is used. Under both the existing and proposed systems trades are subject to approval by the Department of Water.

1.3.2 Water Market

A water market is a number of individuals or agencies communicating within a set of institutional rules about their respective values (willingness to pay) for a water access entitlement or a licence to draw water. The rules include the defined legal properties of the water access entitlement, conditions for the exercise of its use, auction systems, and other common law requirements.

It is worth noting that the 2007 Nobel Prize in Economics was awarded to three economists, Leonid Hurwicz, Eric Maskin and Roger Myerson, who developed "Mechanism Design Theory". This theory offers a way of assessing which market arrangements are best for particular circumstances, including monopoly or oligopoly situations, state of knowledge held by participants in the market, and institutional constraints (Prize Committee of the Royal Swedish Academy of Science, 2007).

1.4 Methodology

In addressing the brief, Resource Economics Unit has gathered available data and information from published sources, and has interviewed the following agencies:

- Department of Water: sections dealing with water reform management and natural resource management
- Water Corporation: pricing and evaluation and corporate business development sections
- Harvey Water
- CSIRO
- Forest Products Commission

Resource Economics Unit acknowledges the very positive response obtained from each of the above, but accepts sole responsibility for the report.

In the short time available for the work it was necessary to utilise the best available published economic research without any attempt to bring all data up to a common (recent) year. For example the data on IWSS source development options are for 2005, while estimates of agricultural water use and water values are for 2000/1. The data are therefore to be considered as illustrative only. Despite these differences the order-of-magnitude estimates are sufficient to support the conclusions drawn.

2. PROPOSED REFORMS AND PROGRESS WITH THEIR IMPLEMENTATION

2.1 Previous Water Trading in Western Australia

While implementation of the National Water Initiative will change the mechanisms for water trading in Western Australia, it should be understood that there has been trading in the past within the previous (soon to be modified) legislation: primarily the Rights in Water and Irrigation Act, 1914 (RiWI Act).

Data on volumes traded since 2002-03 are discussed in Section 3.4.

In general terms, examples of the capacity to trade under existing legislation include (i) the capacity of individual farmers to privately negotiate a price for a transfer of a license to take water, (ii) the capacity of an irrigation cooperative to negotiate a water transfer to a water utility in exchange for a payment to be used for irrigation delivery system upgrades, and (iii) the capacity of an irrigation cooperative to similarly transfer water to anther user such as a large industrial undertaking. In each case the exchange of the entitlement to take water has been subject to approval by the (now) Department of Water.

Government policy regarding such transfers was set out in Statewide Policy No 6: Transferable (Tradeable) Water Entitlements for Western Australia (WA Water and Rivers Commission, 2001). The Policy stated that the benefits of being able to trade water entitlements were (i) ability of water to migrate to higher economic uses, (ii) introduction of new water users and industries, and (iii) encouragement of more efficient water use.

2.2 What are the proposed reforms?

The *Blueprint for Water Reform in Western Australia* made a total of 72 recommendations of which 10 related specifically to water trading. The following provides a brief summary to provide the overall context of the proposed reforms and then details the water trading reforms that are proposed. Readers are advised to consult the Blueprint document itself, and the Government Response.

The thrust of the proposed reforms, with particular emphasis on aspects that impinge on water trading is as follows:

- ***Statutory Water Management Plans* (*SWMPs) (Recommendations 1 to 16).*** These are viewed as the primary mechanism through which reforms will be managed having due regard to the sensitivity of regional and local differences. SWMPs will be guided by Schedule E of the National Water Initiative. Aspects that are especially important to resource allocation and water trading include the definition of "consumptive pools", a requirement to account for the water

use of plantation forests, and the development of locally applicable water trading rules.

- ***Water Access Entitlements (WAEs) (Recommendations 17 to 27).*** A new type of water entitlement will be introduced called a "Water Access Entitlement". This will confer on the holder a share of a consumptive pool defined in a SWMP. WAEs will be issued in perpetuity to the holder, and will be tradeable. Outside of the areas for which SWMP has been developed, existing water licenses, and basic rights to take water for rural domestic and stock use and for use by indigenous groups will continue. A key change is that in future the water access entitlement will be "unbundled" from other statutory approvals, including a "works approval" and a "site use approval". These approvals were previously included when granting a water license. Thus from a trading point of view the purchaser of a water access entitlement will have to be sure that separate approval is obtained for (i) any required works, and (ii) the specified use of the water at the new site. See also Section 2.3.7.
- ***Metering (Recommendations 28 to 41).*** Comprehensive water metering will be introduced. The costs of metering to be borne primarily by the water user. The pace at which this will be introduced will depend at least in part on progress with SWMPs. It is not proposed to meter water that is used for rural domestic and stock use. Holders of water access entitlements of less than 50ML may also be exempted under particular circumstances. See also Section 2.3.6.
- ***Water Resource Management Charges (Recommendations 42 to 47).*** A new water license administration fee to be introduced, to be hypothecated to the Department of Water solely for the purpose of water licensing and administration, including introduction of a new automated water licensing administration system.
- ***Invest in Water Use Efficiency (Recommendations 55 to 60)***. These recommendations include several that are of direct relevance to water trading. They include (i) a suggestion that consumptive pools be set at levels that encourage trading, (ii) release of water by tender or auction, and (iii) SWMPs to develop rules designed to minimize water trading transactions costs.
- ***Integrate Land and Water Planning (Recommendations 61 ad 62)***. These recommendations relate to the strengthening of land use planning processes with regard to water quality impacts, and the identification of areas suitable for accommodating the growth of irrigated agriculture. Both aspects have an important role in setting the geographical and planning context for water trading in future.
- ***Increase Self-Management (Recommendations 63 and 64).*** These recommendations emphasise the important role of community engagement in both planning and implementing change.
- ***Implementation (Recommendations 65 to 72).*** The Department of Water to be responsible for implementing the reforms. *Western Australia's National Water*

Initiative Implementation Plan to set specific milestones for the reform process, including new legislation in 2008, accompanied by installation of the new water access entitlements register, substantial completion of SWMPs by 2010, and commencement of the state-wide metering program in 2008.

In addition to the above, recommendations 48 to 60 specifically address proposed reforms for water trading. Briefly summarised these are:

- SWMPs to actively support water trading
- Establishment and oversight of private sector water broking services
- Prices paid to be publicly available in a timely manner
- Metering a pre-requisite for the trading of WAEs
- No anti-speculative regulations to be promulgated provided that future water releases are made through tender or auctions
- Existing fair-trading and trade practices legislation to be used in cases of monopoly abuse, including the holding of water.
- Consideration be given to the ways in which water service providers might negatively impact the emergence of water trading

2.3 Progress with Implementation

The Department of Water provided a written progress report in response to a set of questions posed by Resource Economics Unit. The following are key points mentioned, liberally interspersed with comments by the author. The financial data given in Section 2.3.2 has been obtained from the State Budget Papers for 2007-08.

2.3.1 WA's Implementation Plan for the National Water Initiative

Western Australia's National Water Initiative Implementation Plan was published on 1 August 2007 and is available on the Department of Water website at:

http://portal.water.wa.gov.au/portal/page/portal/PlanningWaterFuture/NationalWaterInitiative

This provides an update on progress in relation to issues common to the National Water Initiative and the Blueprint/Government Response.

2.3.2 Resources for implementation

As is shown in Table 1, the Western Australian Government has provided a total of $43.9M over the four years commencing 2006-07 in respect of water reform initiatives.

Our overall assessment is that the resources provided to the Department are commensurate with the task. However, it is noted that in the area of water resource management some relevant positions are still unfilled. This is a decision that relates to the availability of suitably qualified applicants, as well as the need to build team

capacity at an appropriate pace. It is perceived that there are risks associated with too rapid a build up.

Table 1: Financial appropriations to the Department of Water in respect of water reform initiatives

Year	Budget Estimate ($M)
2006-07 (Budget estimate)	9.7
2007-08 (Forward estimate)	12.5
2008-09 (Forward estimate)	11.2
2009-10 (Forward estimate)	10.5
Total	43.9

Source: State Budget Papers, 2007.

2.3.3 Capacity Building Program

The Department of Water has embarked on a two-phase approach to address skills shortages. Phase one is underway and is concentrating on ensuring that the existing reference network can be operated at an acceptable level. The Department of Water is recruiting at career start levels and providing comprehensive in-house training which complements the TAFE Open Training and Education Network's Hydrography Certificate IV. This phase will end in late 2008 when the final intake of graduates.

The Department of Water is also actively participating in the Technical Working Group of the federally supported Water Industry Training Review.

A second phase will be required to support any expansion of the existing surface water reference-monitoring network in Western Australia. Before this can proceed, the Department of Water will need further intakes of hydrographic trainees well in advance of the construction of new monitoring sites.

Similarly, the Water Corporation has recognised and addressed this issue by implementing succession planning, graduate, apprenticeship, traineeship and cadetship programs as well as talent management, knowledge transfer, coaching and mentoring.

2.3.4 Legislation

Parliamentary Counsel has been provided with the drafting instruction for the new Water Resources Management Bill. As in the Government Response Recommendation 21, the unbundling of licensing instruments including works approvals and site use approvals will be addressed through the new legislation.

The Blueprint, recommendation 52, recommended that no provision be made in the legislation for anti-speculative behaviour. The Government Response qualified this by noting that the Government would review existing legal mechanisms to determine

whether these provide sufficient protection against anti-speculative behaviour. The Department of Water has received advice from the State Solicitors Office that that the Trade Practices Act 1974 provides sufficient protection against anti-speculative behaviour.

2.3.5 Registry System for Water Access Entitlements

Registers of water access entitlements are essential to:

- enable trade;
- provide a reliable database of water access entitlement holders;
- record the interests of any parties, including the Registered Proprietor; and
- record changes in relation to the Registered Proprietor of water access entitlements as a result of the transfer or trade of entitlements.

In addition to the registry for water access entitlements, a record of periodic water allocations, water use, statutory approvals and temporary water trading will be required. The actions recommended by the Compatible Registers Working Group have been incorporated into the Implementation Timetable where relevant for Western Australia. Development and implementation of these actions parallel progression of actions in entitlements (see Section 3.1 of the Implementation Plan).

2.3.6 Metering program

In the future, metering will generally be required:

- for all new water licences or water access entitlements (regardless of the licensed volume) from a date that is yet to be determined; and
- for existing licensed water users with an annual allocation of 50 megalitres or greater.

Metering may also be required for water users with an existing allocation of less than 50 megalitres where:

- there is a need to manage specific risks to environmental water requirements,
- water quality and impacts on other water users;
- trading is undertaken, or there is an intention to trade;
  there is conflict over water use;
- there is community demand for water metering; and
- the requirement to meter is specified in an existing water management plan or licence.

The Department of Water is currently assessing the necessary legislative changes needed to facilitate any statewide metering program. The Department will also undertake a detailed scoping study of metering needs for Western Australia. This will include details of when and where metering will be undertaken. This study will

commence in the near future and take time to complete. In the mean time the Government's pilot metering project in Gnangara will continue and knowledge gained from the pilot project will better place the Department to assess difficulties and costs associated with the vast array of meter installations.

The plan, once developed, will be communicated to relevant stakeholders and include a priority for metering areas across the State. In addition, it will include details of any costs or fees associated with the metering program. Once the plan is completed the Department will write to affected licensees providing detail of proposed meter installations in priority areas. It will then contact individuals to arrange a suitable time for a representative to meet with water licensees and discuss information about the proposed meter installation.

2.3.7 Statutory Water Management Plans

Western Australia will align with the requirements of the National Water Initiative with respect to statutory management plans, in a manner appropriate to the management of its water resources.

It is proposed that these plans cover all groundwater and surface water management areas, state wide, on an individual or grouped basis. Where groundwater and surface water resources significantly interact with each other, the plan will cover both resources. Statutory Water Management Plans will be based on the best available information. They will codify and extend the existing obligations and responsibilities of water users and the resource manager.

Plans will be comprehensively reviewed within ten years of completion. Plans may, however, have triggers or mechanisms to amend some aspects (such as the amount of the consumptive pool available to be used) during the tenure of the plan without the need for further detailed review. This allows for an adaptive management approach informed by a constantly improving information base.

The completion of Statutory Water Management Plans for all areas in the State will take many years, with some plans taking up to three to four years to complete. This is due to the need for detailed monitoring and gathering of environmental information along with processes to consult with stakeholders. Given this, existing plans will continue to guide water resources management decisions in the interim period.

The Department of Water is currently preparing a Regional Water Plan for the South West region. The plan will provide a strategic framework for water resource management in the South West for the next 25 years.

Please refer to Appendix C of Western Australia's Implementation Plan for the National Water Initiative for more detail on planning.

2.3.8 Water brokers

Recommendation 49 in the Blueprint asks that the Government determine how best to support the emergence of an active water trading market, including through

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supporting the establishment and oversight of private sector water broking services and engaging experts in market mechanisms to expedite the water reform process.

There has been no progress on this issue at this point in time.

2.4 Unresolved Items

A number of matters flowing from the Blueprint, and accepted by the Government still require resolution. These are outlined in the following sub-sections.

2.4.1 Reliability coding

The *Blueprint* recommended that future policy and legislation should allow for categories of water access entitlements with different reliabilities and other relevant attributes. Reliability coding refers to the labelling of a Water Access Entitlement with a defined code that specifies the frequency with which reduced allocations might be necessary due to variations in the capacity of the resource to supply all entitlements. Such variations might reflect climatic or other events. For example, river pumping might have low reliability, water supplied from a regulated river system higher reliability. Groundwater reliability might be seen as a function of depth to water table in surficial aquifers, or may be stated in terms of an unknown time to depletion for fractured rock aquifers.

The Government Response to the *Blueprint* noted that perpetual Water Access Entitlements will have different reliabilities as specified in Statutory Water Management Plans. This will require provisions in the new water resources management legislation. Thus, it appears that this issue will be dealt with on a case-by-case basis as part of the development of a Statutory Water Management Plan and determination of a consumptive pool.

2.4.2 Auction or tender arrangements

The arrangements for auctions and tenders have not been developed any further from the Government Response

2.4.3 Risk assignment framework

Please refer to the Government Response, recommendation 9 and the National Water Initiative. Further work is to be undertaken on a risk assignment framework for WA.

2.4.4 Periodic assessment of kL/share

A Statutory Water Management Plan will include allocation rules for access. Both the water access entitlement and water extraction approval will be subject to periodic allocations of the share of water that may be taken from the consumptive pool and the amount that may be extracted from the site. Although the periodic allocations may vary between six monthly and up to three years (as determined by a statutory

management plan for access), there should be an annual announcements of the periodic allocations. This will provide greater certainty for those with water access entitlements and water extraction approvals.

Periodic announcements would be in the form of available kilolitres per share in accordance with the rules defined in the relevant statutory management plan for access;

2.4.5 Development of environmental allocations and consumptive pools: trading considerations

National Water Initiative Paragraph 35 provides for the statutory recognition and protection of water provided by the State to meet agreed environmental and other public benefit outcomes defined within the relevant water plans, either under plan rules or as environmental entitlements.

The Government Response states that environmental water provisions be addressed through rules-based approaches (e.g. water access rules and environmental flow rules) or through water access entitlements held for environmental purposes, and that either of these options be applied as appropriate in accordance with statutory water management planning processes. In addition, the Government notes that water to meet agreed environmental outcomes will be held separate from the consumptive pool, as outlined in Recommendation 4.

Arrangements to trade environmental water are to be determined.

2.4.6 Farm dams

The size of farm dams being constructed to capture overland flow for irrigation and aesthetic purposes is a very significant management issue in the southwest. Where there is a significant impact on downstream water users or the environment a SWMP may require the licensing of farm dams. The SWMP will determine the form of water entitlements that will apply:

- a basic right for stock and domestic purposes, in those areas where there is no significant impact on the water balance;
- as a water licence, if farm dams are not part of a consumptive pool; or
- a water access entitlement, if farm dams are to be considered part of a consumptive pool.

3. ECONOMIC ASSESSMENT OF THE PROPOSED REFORMS

3.1 Economic Rationale

The trading of water entitlements, like the trading of any asset, is a mechanism for transfer from some preceding use into one where the value of the asset is higher. In benefit-cost terms, purchasers of water are able to compensate the vendors, and remain better off. Water trading has been particularly beneficial where there is a resource constraint, whether through the limitations of the prevailing hydrology or because of concerns to protect water-dependent ecosystems, or both.

Trading is thus a mechanism for achieving an efficient allocation of (i) the water and (ii) the economic resources of labour and capital required to deliver it. For example, it would be more economically efficient to transfer traded water into the Water Corporation's Integrated Water Supply Scheme (IWSS) with a net cost of $1.5/kL (after transfer and including any required treatment) than to construct a new source of supply at a cost of $2.0/kL.

Morrison (1982) undertook an economic analysis of options for water supply in the south west of WA from Perth to the south coast up to the year 2005. Given the sources then available for metropolitan supply, their assumed hydrological characteristics and the associated unit supply costs (which have since been significantly changed by declining rainfall), Morrison concluded that there was no economic case for transferring water from southwest irrigation to metropolitan supply. However, the situation has much changed. The sources considered by Morrison to be available for metropolitan supply have long since been developed, have suffered declining yields and have been supplemented by construction of the Kwinana seawater desalination plant.

The situation now presents a stark choice between undisputedly high cost options such as further desalination plants and potentially more efficient options. The remaining options may (i) present greater levels of risk management, (ii) require more active natural resource management of currently non-potable sources, or (iii) require more complex negotiations among stakeholders. It is appropriate to ask whether current institutional arrangements encourage such initiatives, and whether more open water trading market can play a part in achieving more efficient outcomes for the future.

3.2 Approach

This economic assessment is presented in five parts.

- Section 3.3 provides a qualitative assessment across all WA regions of "prospectivity" for a water trading regime. This is done by rating each

region against a number of criteria indicating favourable conditions for the operation of water markets. The section concludes that the most prospective areas for early introduction of markets are in the south west of the State including all areas from Gingin to the south coast.

- Section 3.4 presents data on trades recorded in the Department of Water's licensing data base.
- Section 3.5 draws together available evidence on the likelihood of future water trade under the new regime considered from the point of view of potential vendors and potential purchasers, and makes an assessment of the benefits to water traders.

Two case studies are then presented:

- Section 4 discusses the case trading of surface water by the Harvey Water irrigation cooperative
- Section 5 discusses the prospects for water trading on the Gnangara Mound

Section 6 presents our conclusions.

3.3 Regional Assessment

Conditions favour the introduction of trading regimes where:

- There are limitations on the total size of the resource relative to demand, or high costs for expanding overall water availability;
- There exist significant differences in the economic value of water to different users;
- The natural resource or existing constructed infrastructure allows for relatively easy exchange of water use entitlement. It is notable in this regard that many WA regions have negligible surface water resources and water supply comes mainly from groundwater often to spatially dispersed users. This means that physical transfer is less easily arranged than for example in large river systems or integrated supply networks;
- The costs of physical transfer of the traded water are low: because either the natural system or existing/new infrastructure can cope cost-effectively with new flows following trades.
- The number of trades and the amount of water involved is such as to have compensating effects: e.g. where there is likely to be two-way trade across hydrological boundaries;
- There is a natural resource manager with the sufficient information and models to cost-effectively check the acceptability of a proposed trade considering the potential social, economic, hydrological and environmental impacts.

Using the criteria outlined above, Table 2 gives a qualitative assessment of the current suitability of each region in WA for early introduction of trading regimes. The regions are the "Water Demand Regions" based on administrative boundaries used in the Water 2000 Study, a part of the National Land and Water Resources Audit (Water and Rivers Commission, 2002), shown in Figure 1.

Figure 1: Western Australia water demand regions
(after National Land and Water Resources Audit , 2002)

The following sub-sections discuss our findings.

Regions with relatively low suitability at present:

- East Kimberley: while there is physical ease of transfer and high density of usage in the Ord Irrigation Scheme, there is relatively small variation in cropping patterns (currently mainly sugar), a very large resource and low marginal cost for water supply expansion.
- Murchison: while water demand is significant and growing, the region contains widely-distributed mine sites and small settlements; there is negligible agricultural activity; the resource is entirely made up of groundwater.
- Eucla: the region contains widely-distributed mine sites and small settlements, there is negligible agricultural activity; the resource is entirely made up of groundwater.
- Midlands: this is the northern agricultural area of WA where land use is mainly grains and pastoral. There is negligible irrigated agriculture. Water users are widely spread at very low density. Demand growth is slow. There are few natural or man-made conveyance systems.
- Upper Great Southern: this is the central and southern agricultural area of WA where land use is mainly grains, sheep and cattle. There is negligible irrigated agriculture. Water users are widely spread at very low density. Demand growth is slow. There are few natural or man-made conveyance systems.
- Pallinup: this is the southern agricultural area of WA where land use is mainly grains, sheep and cattle. There is negligible irrigated agriculture. Water users are widely spread at very low density. Demand growth is slow. There are few natural or man-made conveyance systems.
- West Kimberley: only a very small percentage of the available resource is utilised at present. Possibly, there could be economic grounds for trading water given the diversity of water uses and demand growth.

Regions with medium suitability:

- East and West Pilbara: there is a negligible amount of irrigated agriculture. Rivers are ephemeral and long-term surface storage in reservoirs is impracticable due to extremely high rates of evaporation. Seawater desalination is common in the coastal oil and gas industries, which require guaranteed dedicated water supplies. Iron ore mines account for by far the largest share of regional water use. These two demand regions are experiencing rapid growth in demand through growth of its industrial and mining base. There could be benefits from trading between mining enterprises, which could have high marginal values for water. If BHP Billiton and Rio Tinto were to merge their access entitlements would accrue to the new entity, leaving several much smaller mining companies in the market.

- Gascoyne: there is relatively low diversity of use. Expansion of the irrigation area at Carnarvon (bananas) is facing water resource limitations. It would be straightforward to operate a trading scheme, but transfers would be very localised.
- Greenough: use is fairly diverse, and irrigated agriculture is a small part of the total. Natural or constructed transfer systems are absent.
- Goldfields: use is dominated by the spatially distributed gold and nickel mining industry and associated industrial and urban areas. There is no surface water, and most of the available groundwater is hyper-saline. Prospects for water access trading viewed as moderate.
- Moore: use is dominated by irrigated agriculture. Supply is entirely from groundwater.
- Blackwood: use is dominated by irrigated agriculture with many farm dams. Limited demand growth at present.
- King: High proportion of surface water, diverse uses, with irrigated agriculture forming a moderate part of the total water use; relatively short natural streams entering the Southern Ocean offer some delivery capacity.

Regions with higher suitability:

- Perth: major urban water demand with high existing utilisation of available surface and groundwater resources, both of which are threatened by climate change. Significant amounts of water are also being used for irrigated agriculture (mainly horticulture, vineyards, and orchards) and to supply the evapo-transpirational demands of pine plantations. There is high density of use. Supply is increasingly dominated by groundwater. Natural and constructed delivery systems are available.
- Peel: major growth area to the south of Perth. Irrigated agriculture still accounts for a significant proportion of water use. High density of uses. Natural and constructed delivery systems available
- Preston: principal irrigation area of the southwest. Irrigated agriculture accounts for a high proportion of total use. There is a wide range of use values. Accessible to the constructed delivery system.
- Vasse: significant grape growing area. Irrigated agriculture accounts for a high proportion of total use. Substantial diversity of use values. Accessible to constructed delivery system. Focus of attention for major new groundwater development by the Water Corporation to serve the integrated water supply system.

Table 2: Qualitative assessment of the appropriateness of water trading in each WA region.

No.	Water Demand Region	Estimated Use in 2005-06 GL	SW as % of total	% Irrig.Ag Use	% of SY needed by 2020	Diversity of Use Values	Growth in demand	Density of Use	Natural transfer system	Major constructed transfer system	Suitability Rating
1	East Kimberley	384	64	93	10	L	M	H	✓	✓	L
2	West Kimberley	20	57	28	4	H	M	M			M
3	East Pilbara	78	13	0	14	M	H	M			M
4	West Pilbara	56	10	0	20	M	H	M	✓	✓	M
5	Gascoyne	49	29	21	10	L	L	H	✓		M
6	Murchison	87	0	1	22	L	H	L			L
7	Greenough	57	0	10	40	H	M	M	✓		M
8	Goldfields	190	0	0	34	L	H	L		✓	M
9	Eucla	15	0	2	10	L	M	L			L
10	Midlands	27	1	0	9	L	L	L			L
11	Moore	150	1	82	26	M	M	M			M
12	Perth	712	12	17	68	H	H	H	✓	✓	H
13	Peel	82	28	42	10	H	H	H	✓	✓	H
14	Preston	267	36	65	22	H	H	H	✓	✓	H
15	Vasse	54	26	68	20	H	H	H			H
16	Blackwood	37	43	85	4	L	M	M	✓		M
17	Upper Great Southern	8	1	2	2	L	L	L		✓	L
18	Pallinup	4	0	6	4	L	L	L			L
19	King	12	71	33	13	M	M	M	✓		M

Data for estimated use in 2005-06, surface water resource %, and % use in irrigated agriculture have been taken from the projections given in the Water 2000 Study (currently being updated)

3.4 Recorded trades 2002-3 to 2006-7

3.4.1 Approach

This section summarises approved trades in water entitlements over the last five years. Generally, the number of trades has been limited and the volume of entitlements traded small. While several large trades have occurred, these have been the exception.

The Department of Water's Water Resource Licensing data base (WRL) was interrogated to identify water trades completed between July 2002 and June 2007. Efforts were made to exclude transfers of licences due to land and business ownership change and where a licensee moved his operations to a separate location with the same water entitlement. Trades were double-checked where they occurred in resources in which the licensed entitlements totalled less than 85% of the allocation limit. Most of these cases were found to be uncompleted transfers, property or business ownership changes or were not proceeded with. These were removed from subsequent analysis.

Nevertheless, it is likely that not all transfers were included. Transfers due to a change in land and/or business ownership are not easy to distinguish from a "true" trade in water entitlements as the application process is essentially the same. This is especially the case if a new licence number is issued when the application is received. Transfers can be approved before the resource is fully allocated. While the need to purchase entitlements when new entitlements could still be granted appears unnecessary, there can be sound resource management reasons for approving trades before a resource is fully allocated. For example, trading water entitlements is preferable to granting additional entitlements if the trade avoids placing increased pressure on a local part of the resource or an important wetland.

The Department of Water's records exclude trades *within* irrigation cooperatives, because these are administered by the particular cooperative, and individual irrigators hold a certificate of water entitlement from the cooperative rather than a license under the RiWI Act.

Under the National Water Initiative reforms, the last water entitlements of a particular resource are to be released through a market mechanism such as auctioning or tendering. This is intended to establish a clear initial price signal to guide subsequent water entitlement trading. Such mechanisms have not been used historically in WA. Thus the start dates for water entitlement trading in particular resources have not been clearly specified.

Accepting these limitations, the following pages summarise trades in water entitlements in WA that have been recorded over the last five years.

The greatest number of trades occurred in the Swan (13) and Wanneroo (20)

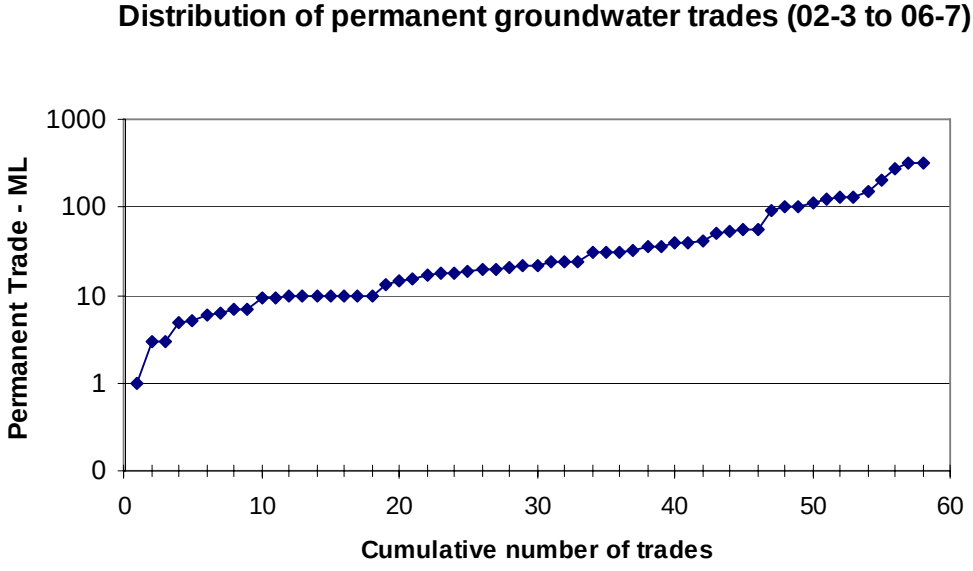
Groundwater Management Areas. Within the Wanneroo Management Area most trades occurred in the Carabooda (6) and Mariginiup (8) sub-areas (see Table 1). These trades represent 3.4% and 7.4% of the committed allocations in each subarea.

The largest single trade was 317 ML and occurred in the Lake Preston South Sub Area of the South West Coastal Management Area. A limited number of larger applications to trade (including one above 2000 GL) were received but not completed.

3.4.2 Permanent groundwater trades

Figure 2, Table 3 and Table 4 present details of trades in groundwater entitlements between 1 July 2002 and 30 June 2007. A total of 58 trades were recorded, and occurred in 24 separate groundwater management sub-areas. The groundwater entitlements traded totalled 2,994 ML, with the mean and median trade being 51.6 ML and 21.6 ML respectively. This represents only 1.4% of the committed allocations in the sub-areas where trades have occurred.

Figure 2: Distribution of permanent groundwater trades 2002/3-06/7



The number of permanent groundwater trades each year has remained relatively stable over the last five years averaging 12 per year (see Table 2).

Table 3: Permanent groundwater trades by GW Area, sub-area and aquifer

GW Area Name	GW Subarea Name	Aquifer Name	Trades		Allocated
			No	Sum – ML	- ML
Perth	Perth South Confined	Perth - Leederville.	1	3	5,372
Wanneroo	Nowergup	Perth – Superficial	1	6	2,793
Busselton-Capel	Donnybrook	Perth - Upper Leederville	1	10	2,590
South West Coastal	Lake Preston	Perth – Leederville	1	20	420
Carnarvon	Basin 1	Carnarvon – Superficial	1	36	7,564
Bunbury	Bunbury Yarragadee Confined	Perth - Yarragadee South.	1	90	20,197
Gingin	SA 3	Perth - Leederville.	1	130	3,356
Gingin	Seabird	Perth - Superficial Swan	1	270	20,849
South West Coastal	Lake Preston South	Perth - Superficial Swan	1	317	10,997
Swan	South Swan	Perth – Superficial	2	19	4,058
Swan	East Swan	Perth – Superficial	2	39	946
Broome	12 Mile	Canning – Broome	2	48	894
Mirrabooka	Landsdale	Perth – Superficial	2	64	1,387
Busselton-Capel	Bslt-Capel Yarragadee Conf'd	Perth - Yarragadee South.	2	150	89,256
Wanneroo	Neerabup	Perth - Superficial	2	150	2,636
Gingin	SA 6	Perth - Leederville - Parmelia.	2	271	7,607
Mirrabooka	State Forest	Perth - Superficial	2	331	798
Busselton-Capel	Quindalup - Vasse	Perth - Upper Leederville.	3	52	1,840
Wanneroo	Lake Gnangara	Perth - Superficial	3	80	8,863
Cockburn	Thompsons	Perth - Superficial Swan	4	77	6,375
Swan	Swan Confined	Perth - Leederville.	4	167	5,454
Swan	Central Swan	Perth – Superficial	5	31	1,720
Wanneroo	Carabooda	Perth - Superficial	6	276	8,183
Wanneroo	Mariginiup	Perth - Superficial	8	358	4,860

Table 4: Number of permanent groundwater trades by financial year

Financial Year	2002-03	2003-04	2004-05	2005-06	2006-07
No of Trades	12	12	7	15	12

3.4.3 Temporary groundwater trades

Temporary rights to water are granted through the approval of agreements to take water under an existing licence. These agreements relate to the rights to take water in12 month periods (usually a financial year). Approvals to take water can be repeated over several years.

Over the last five years, 12 annual agreements to take water under an existing groundwater licences have been approved. These have totalled 14,650 ML, or averaged 2,930 ML/yr over the five years. Almost 90% of the amount temporarily traded have been taken under two licences. The first and largest was an agreement to take 3,940 ML in 2005-6 and 2006-7 under a licence held in the Yarragadee Confined Subarea of the Busselton-Capel Management Area. The second was an agreement to take 1,679 ML in 2002-3, 2003-4 and 2004-5 under a licence held in the Cockburn Confined Subarea of the Cockburn Management Area.

3.4.4 Surface water trades

From July 2002 to June 2007, 16 permanent trades in surface water have been recorded in ten surface water management sub-areas. These have totalled 6,251 ML (see Figure 3Figure 3 and Table 5) and been dominated by three trades in the Harvey River Basin. A number of the permanent trades of less than 10 ML are probably associated with land ownership changes. Over the same five years, there have been eight temporary trades. These have averaged 3,843 ML/yr, and have been dominated by five temporary trades, again in the Harvey River Basin.

Figure 3: Surface water permanent trades 2002/3 – 2006/7

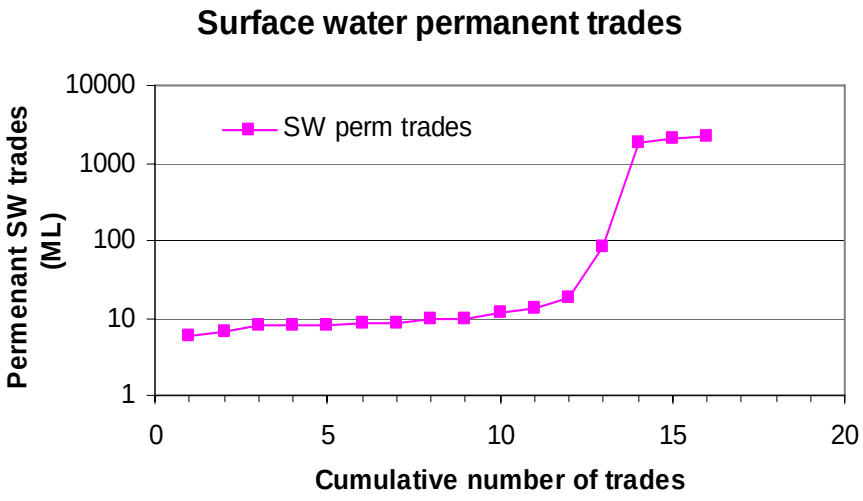


Table 5: Permanent trades of surface water, by river basin , 2002/3 – 2006/7

River Basin	Sub-Area	Permanent Trades		Temporary Trades		
		Total ML	No.	Total ML over 5 yrs	Average ML/yr	No.
Ashburton River	Ashburton River Basin	0	0	2	0	1
Busselton Coast	Margaret River Tributaries	13	1	0	0	0
Harvey River	Drakesbrook and Samson Brook	3,900	2	10,300	2,060	3
Harvey River	Harvey River	20	2	0	0	0
Harvey River	Harvey River and Logue Brook	2,150	1	8,650	1,730	2
Moore-Hill Rivers	Lennard Brook	18	1	0	0	0
Murray River	Serpentine River	40	5	0	0	0
Preston River	Preston River Tributaries	8	1	0	0	0
Swan Coastal	Canning River	6	1	0	0	0
Swan Coastal	Marbling Brook	11	1	0	0	0
Warren River	Treen Brook Catchment	85	1	0	0	0
Warren River	Upper Lefroy Catchment	0	0	150	30	1
Warren River	Warren River System	0	0	115	23	1
	Total (Rounded)	6,251	16	19,217	3,843	8

All the large surface water trades have been associated with an agreement between Harvey Water and the Water Corporation to pipe the supply of irrigation water in the Harvey and Waroona Districts and use the water so saved to supply the Integrated Water Supply Scheme. The agreement is being phased in from 2004/5 to 2009/10 as shown in **Table 6**. The associated water entitlement trades are being assessed and approved each year as each stage of the piping project proceeds. However, the Water and River Commission has given in principle support to water entitlement transfers related to Samson Brook and Harvey River. As at June 2007, in principle support for the Logue Brook transfers has not yet been given because of unresolved issues related to water quality protection and water based recreation in Logue Brook dam catchment.

Table 6 indicates that by 2009/10, 17.1GL/yr is expected to be permanently traded from Harvey Water to Water Corporation. As noted above, approval in principle has been given for the first 11.8 GL/yr to be traded. This relates to water entitlements from Samson Brook (at Samson Brook Dam) and Harvey River (at Stirling Dam). To date the amount permanently traded under the piping agreement has been 6,050 ML.

Table 6: Schedule of trades from Harvey Water to the Water Corporation as at June 2007

	Lic No	04/05	05/06	06/07	07/08	08/09	09/10	Total
	Samson Brook Dam							
Permanent			1.8	2.1	2.1			6.0
Cumulative Permanent			1.8	3.9	6.0			
Water Corporation Total Licensed Volume (Actual and Proposed)	152691 (3)	8	9.8	11.9	14			
Harvey Water Total Licensed Volume (Actual and Proposed		17.46	15.66	13.56	11.46			
Temporary		3	4.2	2.1				
Total Traded		3	6	6				
	Stirling Dam							
Permanent				2.15	1.55	2.1		5.8
Cumulative Permanent				2.15	3.7	5.8		
Water Corporation Total Licensed Volume Lic 150533 (3) (Actual and Proposed)	150533 (3)		34.81	36.96	38.51	40.61		
Harvey Water Total Licensed Volume 98950 (6) (Actual and Proposed	98950 (6)		68.0	65.85	62.15	58.4		
Temporary			4	4.65	2.15			
Total Traded			4	6.8	5.85	5.8		
	Logue Brook Dam							
Permanent					2.15	1.65	1.5	5.3
Cumulative Permanent					2.15	3.8	5.3	
Temporary					2.0	1.5	0	
Water Corporation Total Licensed Volume (Actual and Proposed)	150533 (3)			0	2.15	3.8	5.3	
Harvey Water Total Licensed Volume 98950 (6) (Actual and Proposed)	98950 (6)			65.85	62.15	58.4	56.9	
Total Traded					4.15	5.3	5.3	17.1

3.4.5 Trading prices

The prices at which water entitlements have been traded have not been well documented. While the application form to transfer water entitlements includes space for the trading price to be provided, the field is often left blank. As many applications are also associated with changes of land ownership, Department of Water has not insisted that a transfer price be specified on each application. Some applications have erroneously included the $200 transfer fee as the transfer price. Given these limitations, only 11 cases of permanent trade in groundwater were found to have a reliably documented trading price. These are listed in Table 7, ranked in order of increasing trading price.

Table 7: Permanent trades where the price was reliably documented

GW Area Name	GW Subarea Name	Financial Year	GW Subarea Name	Aquifer Name	Transfer	
					Volume -ML	Price - $/ML
Wanneroo	Mariginiup	2004-5	Mariginiup	Perth - Superficial	30,750	$488
Mirrabooka	Landsdale	2006-7	Landsdale	Perth - Superficial	40,000	$500
Wanneroo	Mariginiup	2003-4	Mariginiup	Perth - Superficial	24,000	$500
Wanneroo	Mariginiup	2003-4	Mariginiup	Perth - Superficial	18,000	$500
Wanneroo	Carabooda	2002-3	Carabooda	Perth - Superficial	10,000	$1,000
Wanneroo	Nowergup	2006-7	Nowergup	Perth - Superficial	6,300	$1,000
Gingin	SA 6	2005-6	SA 6	Perth - Leederville - Parmelia.	40,000	$1,100
Wanneroo	Neerabup	2006-7	Neerabup	Perth - Superficial	100,000	$1,500
Busselton-Capel	Donnybrook	2006-7	Donnybrook	Perth - Upper Leederville	10,000	$1,650
Wanneroo	Neerabup	2005-6	Neerabup	Perth - Superficial	50,000	$1,650
Busselton-Capel	Quindalup - Vasse	2005-6	Quindalup - Vasse	Perth - Upper Leederville.	15,000	$2,200

The trading prices for permanent groundwater water entitlements have ranged from $488/ML to $2,200/ML ($0.488/KL and $2.2/KL respectively). There is insufficient information to draw any trends in the trading price of groundwater water entitlements since 2002-3.

The prices of temporary trades in groundwater entitlements were only reliably recorded in two cases. These were $68 ML/yr and $220 ML/yr ($0.068/KL ad $0.22/KL respectively) and occurred in the Carabooda Sub-area of the Wanneroo Groundwater Management Area and the Bunbury Yarragadee Confined Sub Area of the Bunbury Groundwater Management Area respectively.

Trading in surface water entitlements has been dominated by the inter-sectoral trade between Harvey Water and Water Corporation, where irrigation entitlements are being traded to public water supply entitlements over six years. An overall price per ML can be inferred from Water Corporation's payments to Harvey Water for the costs

of the piping Project. By 2009-10, when the full 17.1 GL/yr is expected to be permanently traded, Water Corporation will have paid Harvey Water $72 million towards the piping project. This is equivalent to a permanent trade price of $4,210 per ML ($4.21/KL). See Section 4.3.2 for further comments on this.

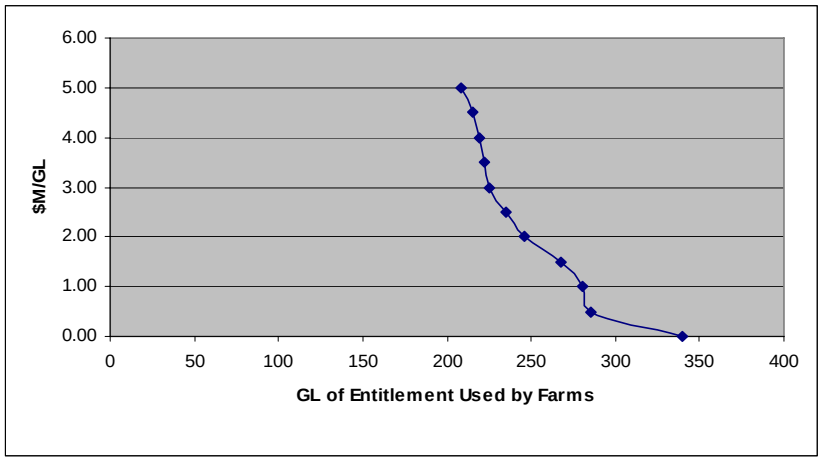
3.5 Willingness to trade water

3.5.1 Willingness to sell

As irrigated agriculture is the major user of "low value" water, and the holder of a major proportion of existing licensed water volumes it must be considered as the major, if not only, source of water for trading. The demand curve for water by irrigated agriculture provides the basic tool for an assessment of potential volumes and prices for water trades within agriculture and from agriculture to other user sectors.

A recent report published by the WA Department of Agriculture and Food (Brennan, 2006) has examined current and future demand for irrigation water in Western Australia. Enterprise models were constructed for different types of irrigated agriculture. The expected annual return to water was estimated by taking the gross margin of each irrigation activity, and distributing this return to land, capital and water respectively. Estimates of on-farm use of irrigation water were based on application rates for different types of crops or pasture. Demand for irrigation water was then expressed as a function of its asset value, assuming a perpetual water entitlement. The demand curve estimated by Brennan for the year 2000-01 is reproduced in Figure 4.

Figure 4: Aggregate demand for water in irrigation in the South West of Western Australia (after Brennan. 2006).



Source: D.Brennan (2006) Current and future demand for irrigation water in Western Australia. Department of Agriculture Resource Management Technical Report 307.

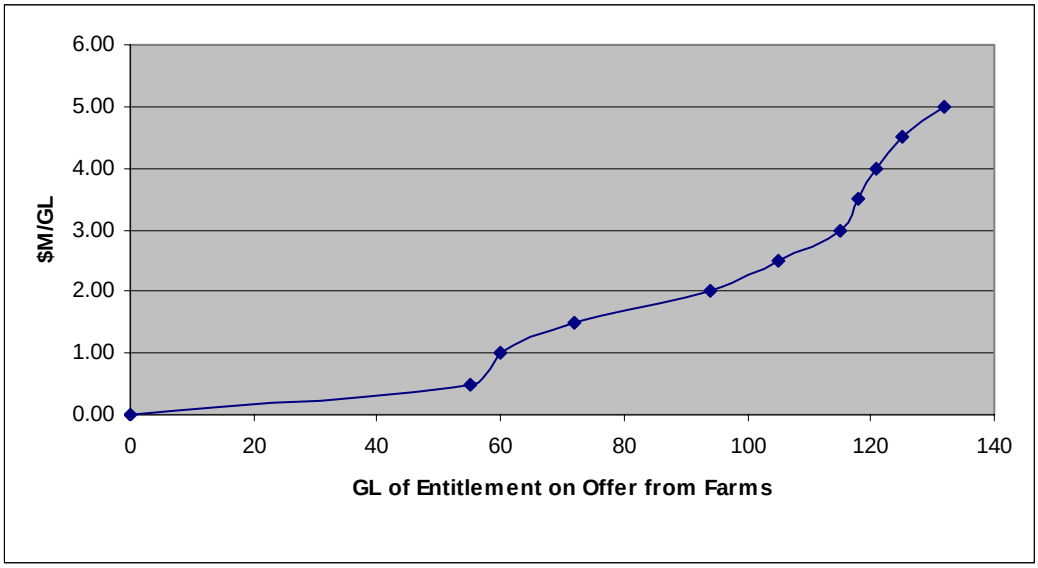
The demand curve plots the quantity of water that is currently used against its asset value, and gives an indication of the opportunity cost of water used in irrigation agriculture in the south west of Western Australia from Gingin in the north to Blackwood in the south and including a small amount of irrigation which occurs in the Upper Great Southern Region.

It is seen that with free water and current farm types total water use of around 350GL/yr could be expected. The demand curve suggests that if all bids for irrigation water in a trading situation were to be priced at an asset value of $5M/GL (equivalent to $5/KL as an asset value and around $0.4/kl on an annualised basis), use would fall by $150GL to around 200GL/yr.

The demand curve can be used to derive a supply curve for trades. Assuming that the market price (asset value) of water changed from zero to $5/Kl the demand curve suggests that farmers would offer 350GL – 200GL = 150GL of water entitlements to the market. Figure 5 shows the supply curve for trades using this rationale. It is important to note that this is a supply curve for water entitlements "at the farm gate". No account is taken of any transactions, transfer or treatment costs for the water offered for trading.

The horticultural sector has been growing strongly in WA in recent years, particularly due to strong export orientation. Over the past eight years, annual growth in exports of fruit has been 10 per cent, and vegetable export growth has been 5 per cent (Brennan, 2005). Therefore, the demand curve for water trades has almost certainly shifted to the right: i.e. more water will be used at any given price. Consequently, the supply curve is likely to have shifted to the left: i.e. less water is likely to be traded at any given price.

Figure 5: Expected supply of tradeable water from south west irrigation farms at different water asset values.



Nevertheless, it may be concluded that under a full system of transferable water entitlements there is a potential pool of around 150GL that could be made available for transfer from irrigators in the south west of the State.

It is also apparent from the supply curve shown in Figure 5 that the "offer price" is a fraction of the price of water currently delivered to urban or industrial users. At the upper end of the range considered, a water asset value of $5M/GL is equivalent to $0.4/kL on an annualised basis, which is well within the range of new source development costs for the IWSS. At $1M/GL, equivalent to $.08/kL on an annualised basis, the supply curve suggests that 60GL could be offered. It is emphasised that the data considered here are for the year 2000, and prices would need to be inflated to account for changes in water values since then. Nevertheless, the data are sufficient to indicate broad orders of magnitude.

Whether the resource available for trading by irrigators would be attractive for non-agricultural purchasers is another matter, as they have to consider the quality of the water and whether that requires additional treatment or catchment protection, the costs of transporting it to its point of use, and the prospect of obtaining use, works and environmental approvals. Earlier studies by the ERA have suggested a figure of $0.44/kL for treatment and transport associated with the Harvey-Warooona trade. This level of additional costs falls comfortably within the range of source development costs indicated by the Water Corporation.

Table 8: Estimated water use in irrigated agriculture, 2000-01

Region	Horticulture	Pasture	Other	Dominant Source	Total
Gingin	38	1	7	GW	45
Metro North	24	1	3	GW	28
Metro East	51	1	3	GW	54
Metro South	20	2	1	GW	23
Mid West	3	2	3	GW	8
Peel-Harvey	17	91	2	SW	109
Whicher	19	3	2	SW	24
Preston-Warren-Blackwood	56	5	1	SW	62
Great Southern	18	1	1	SW	19
Total South West	244	106	22		372

Note: *row and column totals may not add due to rounding*
Source*: D.Brennan (2006) Current and future demand for irrigation water in Western Australia. Department of Agriculture Resource Management Technical Report 307.*

As can be seen from Table 8, some 200GL, over a half of the water used in irrigated agriculture in 2000-01, was in areas served predominantly by groundwater (i.e. in the Gingin, Metro and Mid West regions). This in itself limits potential trade to relatively small (consumptive pool) areas unless the volume offered for trade is sufficient to make piping and export economically feasible. It is also apparent that water used for

irrigating pasture, which has the lowest marginal values, was less than a quarter of the total. These figures demonstrate that the amount of waterthat could be traded in practice may be significantly less than the 150GL suggested by the supply curve.

3.5.2 Willingness to buy

The Water Corporation is the prime, if not the only, potential buyer of traded water. However, water trading currently plays only a minor part in source development planning by the Water Corporation. Table 9 shows options for scheme expansion currently under consideration by the Water Corporation, together with the confidence level it attaches to each option, their expected yields and cost in terms of $/KL. The options have been listed by order of cost with the lowest cost option first.

It is seen that two options relate to water trading: (i) "Irrigation Efficiency Stage 1, Harvey-Waroona" supplying 18GL, and (ii) "Irrigation Efficiency Stage 2, Collie, supplying 19 GL. In addition to these, the Water Corporation and Harvey Water are currently negotiating with respect to an irrigation efficiency project for the Logue Brook reservoir. If this goes ahead it will add a further 5GL. A condition imposed by the seller, Harvey Water, in each case is that only the gains in irrigation efficiency, notably through upgrades to channel delivery systems and replacement with piping, will be available for trading, leaving the volume of water available to irrigators unchanged. However, in the case of the Waroona-Harvey trade the project size was also limited by the amount of potable water that could be obtained from the relevant dams.

Table 9: Source development options currently under consideration by the Water Corporation

	Confidence Level (H, M, L)	Project Size (GL)	Cumulative Supply Contribution (GL)	Cost $/KL (High Cost Basis)
Gnangara Groundwater	L	20	20	0.20
Other catchment Thinnning	L	34	54	0.22
Wungong Catchment Thinning	M	6	60	0.25
Wellington Dam Desalination	L	45	105	0.60
Eglington Groundwater	M	17	122	0.69
Yanchep Groundwater	M	11	133	0.70
Irrigation Efficiency Stage 1(a) Waroona/Harvey	H	18	151	0.75
Irrigation Efficiency Stage 1(b) Logue Brook	M	5	156	NA
SW Yarragadee	H	45	201	0.89
Wellington Dam Pump-back	M	15	216	0.92
Brunswick R.	L	30	246	0.98
Seawater Desalination No 2	H	45	291	1.25
Irrigation Efficiency Stage 2: Collie	M	19	310	1.50
Gingin Groundwater	L	30	340	2.00

Source: Marsden and Jacobs (2006), Securing Australia's urban water supply: selected case studies. Report to the Department of Prime Minister and Cabinet. (with adjustment for Logue Brook).

Note that the two principal trading sources are estimated to supply water to the IWSS at a cost of $0.75/Kl and $1.50/Kl respectively. In the case of the Harvey-Waroona trade, which is now a fact, the "farm gate" asset value of up to $5.0/Kl ($0.4/kL on an annualised basis) compares with the Water Corporation's estimate of a cost of this additional source for the IWSS of $0.75/kL/yr.

3.5.3 Benefits of trading

The benefits of trading accrue to both purchasers and vendors. Taking the Waroona-Harvey trade as an example:

- The purchaser, the Water Corporation, benefited in at least two ways. (i) the additional potable supply was achieved at a time of great stress on water supplies, and in advance of development of the South West Yarragadee aquifer or the planned seawater desalination plant at Kwinana; and (ii) the project was more efficient in terms of its cost in $/kL than other alternatives in the IWSS source development plan other than catchment thinning, which is currently being evaluated at a research level. In many ways, smaller projects flowing from trade may be brought on stream in a more timely manner than large projects where there is considerable controversy and the possibility of delay. The avoidance of more severe water use restrictions also benefits households.
- The vendor, Harvey Water irrigation cooperative was able to undertake the Channel Replacement Project using the proceeds of the trade. A fuller description of these benefits is given in Section 3.5.3

The value of benefits of the water trade to the Water Corporation may be estimated as the savings in discounted costs of the IWSS development plan, plus a gain in consumer surplus attributable to the avoidance of more severe water use restrictions.

At present there are so many uncertainties about the way in which the IWSS source development plan will be progressed, that it becomes difficult to specify a sequence of source development costs that could be avoided through the trade. We have ignored catchment thinning options as, judging by the published unit prices shown in Table 9, they would be by far the most efficient options available.

We have assumed for the sake of argument that the next source development would be the SW Yarragadee aquifer, followed by a second seawater desalination plant, presumed to be at Binninup, and then a sequence of smaller source developments selected from the "Medium Risk" category with the cheapest first.

A "high" and a "low" benefit estimate is given. The assumptions were as follows:

- ***High producer benefit estimate***: the Water Corporation's "low" demand growth assumption of 155 kL/pp/Yr; in the absence of the Harvey-Waroona trade, the proximate developments would have to be two large,

medium to high cost sources namely the SW Yarragadee aquifer followed by the Binninup seawater desalination plant followed by development of other sources.

- ***Low producer benefit estimate***: Water Corporation "high" demand growth assumption of 170 kL/pp/Yr; in the absence of the Harvey-Waroona trade the sequence of source developments (but not their timing) remains as described in the "high" benefit assumption.

It should be noted that these estimates, being based on year 2005 cost estimates, probably understate the actuals.

Figure 6: IWSS Source development sequence without trade (note the first capacity increment is large (SW Yarragadee)

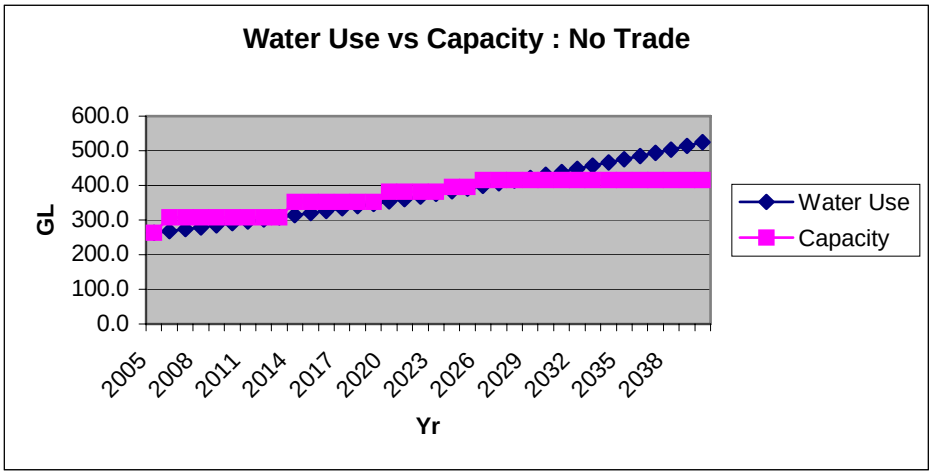
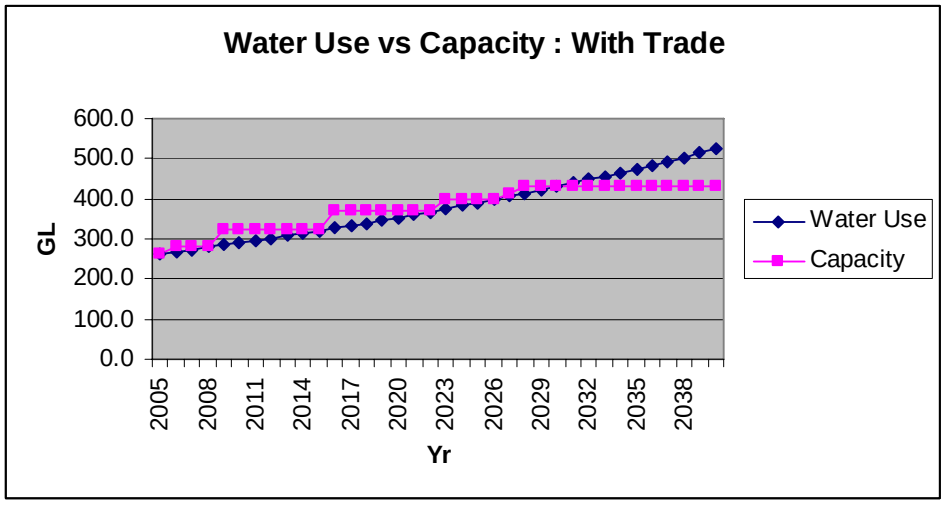


Figure 7: IWSS Source development sequence with the Harvey-Warooona trade (note the first capacity increment is small (Harvey-Warooona trade), and delays the more costly SW Yarragadee project



The effect of the Harvey-Waroona trade is obtained by comparing Net Present Value of the IWDSS source development with and without the Harvey-Waroona trade, assuming that the trade would be the first source. The results are given in Table 10.

Table 10: Net Present Value of an assumed IWSS source development sequence with and without the Harvey Waroona water trade ($M)

Trade Assumption	Demand Growth Assumption	
	Low "155"	High "170"
Without Harvey-Waroona	1,553	1,747
With Harvey-Waroona	1,494	1,717
Net Benefit of Harvey-Waroona	59	30

Note that a higher net benefit is obtained under the "low" demand growth assumption because if demand grows slowly then the alternative, more costly, source developments are more spaced out over time and therefore their NPV is smaller. It is seen that savings to the Water Corporation for IWSS source development a result of the Harvey-Waroona trade are assessed to be from $30M to $59M. These are net figures after taking account of the actual cost of the project to the IWSS.

In addition, it is a reasonable assumption that, in the absence of the Harvey Water trade, consumers would be faced with tightened restrictions on water use. This would be necessary in the face of rising aggregate demand and static supply. The economic concept of consumer surplus measures the amount they would have been willing to pay to maintain their initial level of consumption when faced with tougher water use restrictions, over and above the amount they would actually pay. It is assumed that in the absence of the Harvey Water trade there would have been a 2-year delay in source expansion. Given the balance of demand and supply at the time this not unreasonable. In addition, a low price elasticity of demand for water of –0.17 is assumed, indicting that a 10% change in price to consumers will bring about a 1.7% change in consumption. It is also assumed that there is a linear demand curve in the region of the current price and quantity. On this basis it is reasonable to impute that in the absence of the Harvey Water trade there would have been a loss of consumer surplus amounting to around $5M.

The third group of benefits is those accruing to members of Harvey Water. In benefit-cost terms the payment from the Water Corporation to Harvey Water was a "transfer payment", for Harvey Water to do with as its members wished. Put another way, the Channel Replacement Project was an "optional extra": an independent project that could be subject to its own cost-benefit analysis, rather than being combined into the total cost of the source development project. Harvey Water ***could*** have chosen to do the trade with the Water Corporation ***without*** doing the Channel Replacement Project and then distributing the $70M to its members as a dividend. The irrigators would

then have had to accept a reduction of 17.3GL in the total amount of water available to them. Considering the low marginal values of water in some uses, particularly pasture irrigation, this would have been a rational decision for at least some irrigators Thus, it could be inferred that all the money paid by the Water Corporation to Harvey Water was a benefit of trading to the irrigators, to be offset by the marginal value of surrendered water. Only the latter effect would be an eligible "cost" to enter into a benefit cost analysis. The irrigators' decision to invest the money on the Channel Replacement Project was actually independent of the issue of trading, even though the project was always presented as an integrated proposal. If the transfer payment from the Water Corporation to Harvey Water is netted out of the source development costs shown in Table 9 this would substantially reduce the real cost of the irrigation efficiency projects relative to other projects. The difference reflects a difference in accounting practice as between commercial organizations (viz the Water Corporation and Harvey Water) and economic (social cost-benefit) analysis. It also reflects the fact that a fully functional water trading market was not in operation. With efficient markets the issue would almost certainly not arise, as the price of the traded water would reflect its true opportunity cost to the vendor.

Have the farmers benefited from the improved irrigation water delivery system? It has not been possible to quantify this empirically. However, with a Gross Value of Agricultural Production of around $100M/yr, as reported by Harvey Water, it would require around a 7% increase in GVAP, (or an equivalent reduction in costs) over twenty years to provide a real rate of return of 5% on the investment of $88M in the Channel Replacement Project (of which $70M came from the Water Corporation and $18M from members of Harvey Water). An additional benefit to the agricultural sector will be that in future it will be relatively easy with the installed pipe system to transfer use within the irrigation area, thus facilitating structural change.

In conclusion it is worth repeating that the asset values exchanged in a water trade should be conceptually separated from actual resource costs in evaluating a trade.

3.5.4 Future prospects for water trading by Harvey Water

Beyond the Logue Brook project currently under examination with a trade of 5GL, the next major opportunity will be the Irrigation Efficiency Stage 2 project, in the Collie Irrigation District within the Harvey Water area. This has an anticipated 19GL of potential source water for the IWSS, based on irrigation efficiency gains.

It is notable that the unit cost of water from this scheme is estimated to be double that for the Harvey-Waroona trade ($1.5/kL against $0.75/kL). There are two main reasons for this: (i) the Collie Irrigation District is more remote from existing IWSS infrastructure, so "hook-up" costs are higher, and (ii) the costs of a channel replacement project are said to be much higher in the Collie Irrigation District.

Referring to the discussion of transfer payments for water in Section 3.5.3 above, from the point of view of a benefit-cost analysis the appropriate measure of costs is:

- Social opportunity cost = hook-up and treatment costs plus the marginal value of water surrendered

The marginal value of water surrendered is not the same as the costs of a channel replacement program, as shown above, and this should be taken into account in evaluating the benefits and costs of the Irrigation Efficiency Stage 2 project.

4. CASE STUDY: HARVEY WATER

4.1 Situation and history of the irrigation area

The Harvey Water Irrigation Area (HWIA) is located to the west of the Darling Scarp on the Swan Coastal Plain, around 100 kms south of Perth. It covers an area of 112,000 hectares (around 75 kms long and 15 kms wide) in three Irrigation Zones: Harvey, Waroona and Collie. There is currently around 10,000 ha of land under permanent irrigation for dairy farming, beef grazing and horticulture, with a total irrigable area of approx 30,000 ha. The irrigable area and value of output could be further increased with the introduction of an enhanced delivery system, improved irrigation technologies and new crops with support from new investors. Total GVAP from the irrigation area is estimated at $100 million per annum.

For most of the twentieth century the scheme was built, owned and managed by the State government through the Public Works Department, later the Water Authority of WA and then the Water Corporation. As a result of reviews of the operation of the scheme and Council of Australian Governments (COAG 1992) reforms on water management, the system was ceded to then South West Irrigation – an irrigator owned cooperative which took over ownership of the assets and management in 1996.

In forming the cooperative, irrigators accepted that they should pay for the upkeep of infrastructure that provided a direct benefit to them. Only three irrigators chose not to join the cooperative. A dual cooperative business structure was selected to provide security for the organization's assets. The operating business is owned by a management cooperative South West Irrigation Management Cooperative (SWIMCO), while the assets are owned by a separate mutual cooperative, South West Irrigation Asset Cooperative (SWIAC). For marketing reasons the trading name was changed to Harvey Water in July 2002.

This business structure enabled the ownership of entitlement to water to be separated from the land title and for entitlements to be traded *within the irrigation area* separately to the land. Irrigators own water in the form of shares in the cooperative plus a corresponding certificate of water entitlement.

4.2 Description of the irrigation scheme

4.2.1 Overview

Table 11 gives key statistics for the Harvey Water irrigation area. Water is released to Harvey Water from seven Darling Scarp dams controlled and maintained by the Water Corporation. A water storage fee is paid to the Water Corporation on the basis of the amount of water released (measured at five delivery points). Harvey Water has rights to its own water under its 3 licences and does not buy water from the Water Corporation.

The Harvey Water Irrigation Area is entirely gravity fed. This is possible because (i) the water is sourced from a large number of dams relative to the area served, (ii) the land area served is narrow compared to its length; and (iii) there are relatively steep grades across the width. Because the scheme cannot supply all properties at once, a daily allocation system is used to meet individual farmer's needs while maximising the efficiency of the distribution system and minimising water wastage.

Table 11: Key statistics for the Harvey Water area

Total Scheme Area	112,000 ha
Total Area of Farms	34,369 ha
Total Irrigated Area	9 800 ha
Number of Irrigators	703
Average Annual Sales Volume 1996-2005	77,218 ML
Annual Revenue	$11 m
Number of staff (FTE)	39
Lined Channels	149 km
Unlined Channels	283 km
Pipelines	173 km
Number of Supply Points	1,315

4.2.2 Land Use

From Table 12 it is seen that the dominant use of irrigated land within the Harvey Water area is pasture, used for dairy and beef production.

Table 12: Land use in the Harvey Irrigation Area (Ha)

Land use *	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Dairy pasture	4,149	4,709	3,757	3,841	3,291	2,992
Beef pasture	2,894	2,661	2,523	2,499	2,586	2,339
Early germination pasture	1,012	535	780	771	937	823
Horse pasture		101	154	167	253	267
Other pasture	51	184	65	120	83	65
Fodder crops	128	443	338	261	315	272
Vegetables	118	135	184	222	242	346
Grapes	143	246	246	246	285	285
Citrus	158	176	188	188	197	197
Aquaculture					2	2
Other crop	12	209		17	18	15
TOTAL AREA IRRIGATED	8,665	9,399	8,235	8,332	8,208	7,603

*Information provided by farmers. Categories for horse and other pasture introduced in 00/01

However, the proportion of irrigated land accounted by these two uses has declined from 81% in 2000-01 to 70% in 2005-06. The proportion of irrigated land that is used for vegetables, grapes, citrus, and other crops has increase from 5% to 11% over the

same period. This is evidence or a switch from "lower" to "higher" valued water uses. This trend is expected to continue, especially as competition for land for urban and development further north increases the opportunity cost of continuing horticultural production there.

4.2.3 Channel Replacement Strategy

Harvey Water is responsible for the delivery infrastructure - a network of channels and pipes: 149 km lined channels, 283 km unlined channels and 160 km of pipeline with a total of 1373 supply points. The Harvey district is partly piped and Waroona was converted to a piped system in 2003 that will allow 24 hour/day access to water under gravity pressure suitable for operating sprinklers. The aim is to convert most of the system to pipes. Customers order water and water controllers schedule water supply to all farms on the same delivery route. The 12-14 water controllers are based within the area and are responsible for their own clients. They operate the automated distribution system via computer using SCADA software to deliver the water as scheduled.

Historically, delivery losses have been over 30% between dam and farm and result from seepage into the ground, leaks in the channels and structures, filling of channels which have degraded to much larger than design, end of system outflows and with evaporation the smallest loss because of the short residence time the water is actually in the channels.

Since 1996 when Harvey Water took over the management and ownership of the business and its assets, $18 million of irrigators' funds have been invested to improve the system. There was no support available from the State government or private spheres for the piping but the Federal Department of Transport and Regional Services provided $275,000 through the Dairy Regional Assistance Program.

The major focus has been on improving the delivery efficiency between the dams and the farms in order to reduce losses. The Harvey Pipe Project will reduce water losses by replacing open water delivery channels with pipelines. The scheme will deliver water at gravity driven static head pressure of about 70m. The system will be capable of supporting surface irrigation with scheduling of delivery but, importantly, will also provide the ability for farmers to readily undertake on-farm improvements in water use efficiency.

One of the major objectives of installing a piped irrigation water delivery system under gravity head pressure is to facilitate the improvement of on-farm water use; specifically by moving away from reliance on surface irrigation towards higher technology and more water use efficient systems such as sprinkler and trickle. This development in infrastructure will facilitate the change from low value surface irrigated pasture production for dairy and beef production to high value horticultural enterprises.

Pipelines stimulate the fundamental changes in on-farm irrigation which will change the way the industry produces. In previous times the system was set up to deliver

large volumes of water infrequently for pasture irrigation by surface or flood methods. This was very efficient in terms of energy use since our system is totally fed by gravity.

Higher value uses of water and land such as horticulture require water in small volumes very frequently and this was hard to obtain under the old system except by building a large on-farm dam and installing a pump to deliver water as needed. The costs and inconvenience were a barrier to many irrigators.

With a pipe scheme where the water is under head pressure from the dams they now have access to water 24 hours a day 7 days a week and so have total control over the supply of water to their different crops. This system allows irrigators to easily connect much more water use efficient on-farm irrigation systems such as centre pivot and knocker sprinklers, trickle and T-tape drip systems. The resulting water savings can be used to extend the farm area irrigated each year, further increasing production and profitability.

Not only will there be a change in the type of agricultural output there will be an increase in diversity and a steady increase in area under production because of the access to water under pressure. Higher value farming uses higher technology equipment and methods, which, in turn, leads to an increase in the use of off-farm services and contractors.

Stage 1 of the project has commenced in Harvey South with all the necessary approvals and funding in place. Approvals and funding are currently being sought for piping Stage's 2 and 3 (Uduc & Harvey North). Funding is now being sought for Stage 4 of the project (Logue Brook).

4.3 Water Trading within the Harvey Water Area

4.3.1 Trading within the Harvey Water Area

Within the Harvey Water cooperative, individual irrigators hold a certificate of water entitlement that can be traded only within the Harvey Water area. The cooperative itself holds the RiWI Act licenses to withdraw water. An irrigator's entitlement to water can be leased for a season, or sold outright. This allows farmers flexibility to irrigate more of their existing land without having to buy another paddock, or sell the water and stay on the land.

Trade within the area may be temporary, by lease or may be permanent. Standard trade conditions apply. Trades are processed after the allocation for a season is decided, which is usually at the end of October each year.

Harvey Water runs a register of people expressing interest in trading water, but all negotiations are directly between buyers and sellers. It is optional to advertise a price. Most sellers advertise the volume they wish to trade. Harvey Water has also facilitated auctions each season to assist the trading process.

Harvey Water suggests to irrigators that there is little purpose in not using or trading their water, recognizing the risk that Harvey Water may not have as much water in future under WA's "use it or lose it" conditions for existing water licenses.

Over the ten years of trading since 1997-98, temporary trades have amounted 86.6GL (about 10% of annual water sales) and permanent trades totalled 5.8GL (less than 1% of annual water sales).

Three distinct markets have developed in each of the 3 irrigation districts within the Harvey Water area. This is related to geography, infrastructure layout and owner characteristics. Figure 8 and Figure 9 show the volumes of temporary and permanent trade in the Harvey Irrigation Area between 1996-97 and 2006-07 respectively. Figure 10 and Figure 11 show the prices recorded for these trades. The volume of traded water and its price have generally increased in dry years. Overall, however, the data show that very low prices have been paid. The average price of temporary trades has ranged between $5/ML and $20/ML (equivalent to $.005/kL and $0.02/kL respectively). The volume-weighted average price for permanent trades was $166.7/ML in Waroona, $517.3/ML in Harvey and a mere $33.5/kL in Collie. Annualizing these asset values (using 5% real discount over 15 years) gives equivalents of $.0161/kL for Waroona permanent trades, $.05/kL for Harvey permanent trades and $.003/kL for Collie permanent trades. These data serve to illustrate the point that the "farm-gate" value of water is extremely low in comparison with the delivery prices for potable water to the IWSS.

Figure 8: Volume of temporary trades within the Harvey Water cooperative 1996-7 to 2006-7

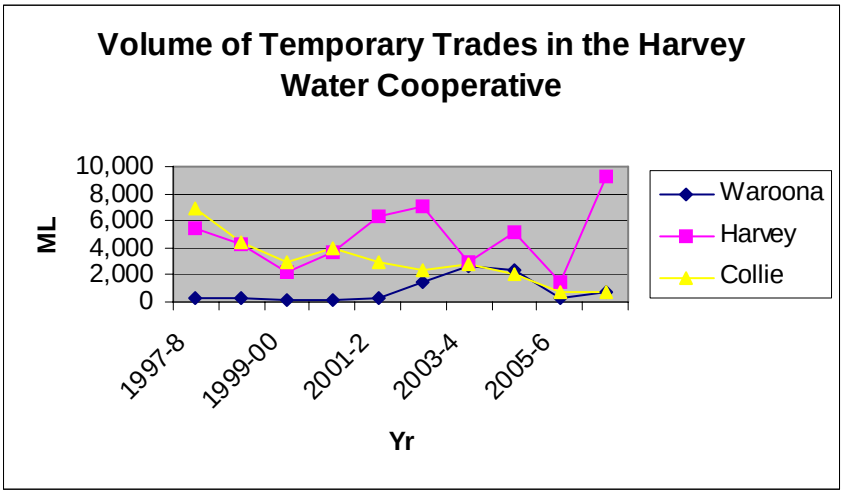


Figure 9: Volume of permanent trades within the Harvey Water cooperative 1996-7 to 2006-7

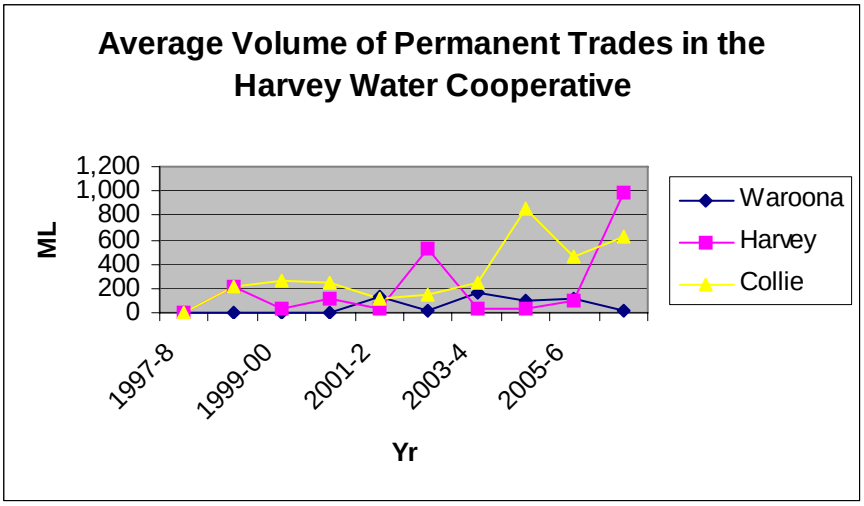


Figure 10: Average prices paid for temporary water trades within the Harvey Water cooperative 1996-7 to 2005-6

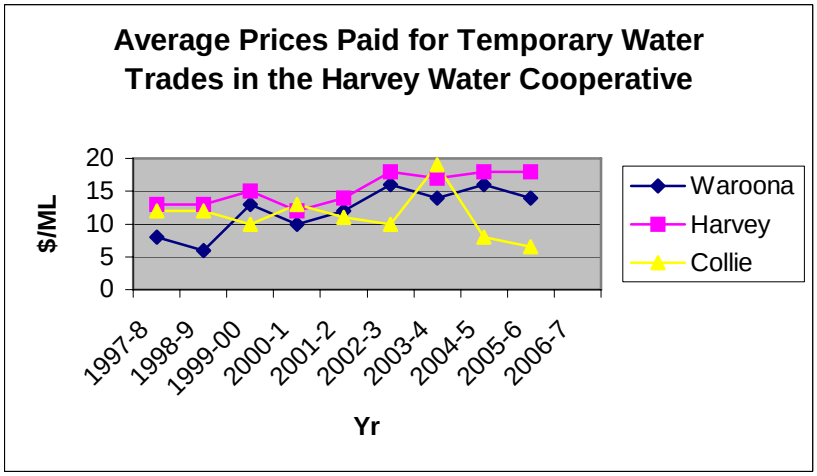
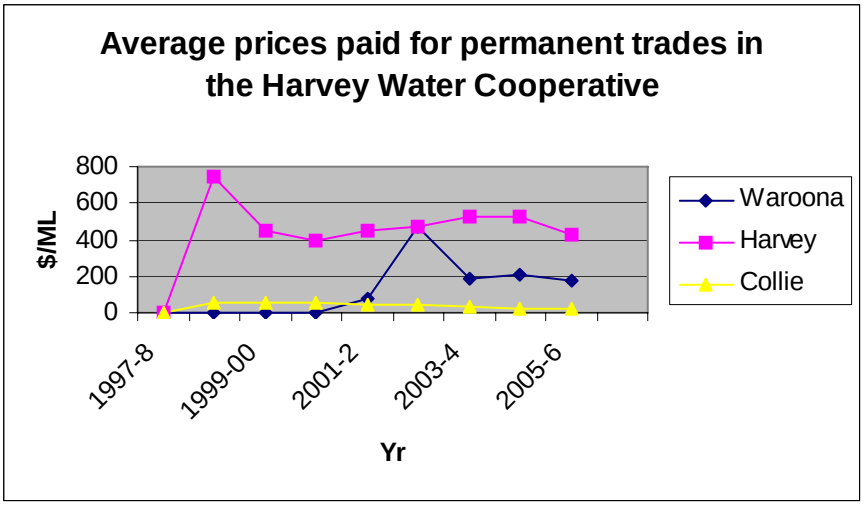


Figure 11: Average prices paid for permanent water trades within the Harvey Water cooperative 1996-7 to 2005-6



4.3.2 Trade of water to the IWDSS

The Channel Replacement Strategy described above is to estimated to eliminate 17.1 GL of irrigation system losses by the end of 2009 These water savings have been "traded" to the Water Corporation, under a negotiated arrangement.

The agreement involved a re-allocation of water from the Stirling and Harvey reservoirs, such that the Water Corporation would acquire 100% of the water available from the Stirling Reservoir, which has a closed catchment and produces water of potable quality. This left Harvey Water with the water available from the Harvey Reservoir, which has an open catchment and which produces water of sub-potable standard. Water licenses were re-assigned. The Water Corporation provided some $70 million to Harvey Water, over a three-year period, which has been used to finance the Channel Replacement Strategy. The agreement thus represented a "win-win" outcome for the two parties. Members of Harvey Water are receiving the benefits of the Channel Replacement Strategy, without any loss of the total volume of water that can be delivered to them. The Water Corporation acquired an additional input source for the IWSS, which ranks as a highly efficient source development, having a cost of $0.5/kL (low estimate) to $0.75/kL (high estimate), which is highly competitive in comparison with other source development options.

It is questionable, however, whether the Water Corporation would ever have entered into this arrangement had there not been a severe shortage of water at the time. The Kwinana Seawater Desalination Plant had not at that point come on stream, and catchment yields were historically low.

Nevertheless, negotiations are continuing, for a further expansion of the arrangement to cover Logue Brook reservoir. This could provide further irrigation system

efficiency savings and transfer to the IWSS of a further 5GL approximately. A major stumbling block is the required closure of the Logue Brook catchment area. At present there is free access for recreation.

It is considered that once the Logue Brook extension is completed, no further trades of water out of the northern part of the Harvey Water area to the IWSS will be feasible. The principal reason is that the quality of water available from the Harvey Reservoir is not adequate for potable supply.

Beyond the Waroona-Harvey-Logue Brook water trades, the next major possibility under consideration is a similar arrangement for the Collie part of the Harvey Water area. It is unlikely that this area could produce such a low-cost transfer as occurred in the Waroona-Harvey-Logue Brook water trades. There are a number reasons for this. Firstly, Harvey Water estimates that the costs of the Channel Replacement Strategy will be significantly higher the Collie irrigation district. Secondly, the available source water is further away from existing IWSS infrastructure than was the case for Waroona-Harvey-Logue Brook. Thirdly, several different options for management of the Collie cathment are currently being considered by the Department of Water, and this means that the details of a transfer project could be more complicated than the earlier negotiations.

Harvey Water is, however, actively pursuing possible trades of "fit-for-purpose" use particularly with industry. Examples could include transfer of brackish water for cooling purposes for a coal-fired power station. In this project the cooling water would be separated into a saline discharge, possibly to mine voids, while the fresh fraction could be returned either to Harvey Water or could be on-sold to another buyer. Other industrial plants or complexes are potential purchasers.

Harvey Water would resist any transfers out of its area beyond those available from irrigation system efficiency gains. Its members would view this as prejudicial to their interests, on both economic and social grounds. It is notable that the State Planning Strategy identifies the general region as continuing to be used for rural purposes, and is specifically against sub-division for urban or special rural uses.

5. CASE STUDY II: GNANGARA MOUND

5.1 Overview

5.1.1 Description

If Fraser Island is Australia's best-known sand island, the Swan Coastal Plain north of the Swan-Canning Estuary is probably the least recognized as such. The area, of some 2,100 km^2, is virtually an island, being hydraulically bounded by the ocean on the west, the Swan-Canning estuary to the south, Ellen Brook to the east, and the Moore River and its tributary Gingin Brook to the north. Like Fraser Island it contains a large unconfined mound-shaped freshwater sand aquifer, called the Gnangara Mound. At greater depth, generally more than 100m from the ground surface, and extending well below sea level, there are underlying confined or partly confined aquifers comprising mainly shales, siltstones and sand, described as the Leederville and Yarragadee formations. These formations are closer to the ground surface near the Darling Scarp, and much deeper near the coastline.

The Mound maintains many lakes, wetlands, and cave systems that are of ecological value. The groundwater in the caves supports ancient primitive species. In recent years the local groundwater has been artificially recharged to maintain the water in the caves. During the summers there is little precipitation or runoff, so the lakes and wetlands have special ecological significance. Thus, protection of lakes, wetlands and cave systems from declining water table levels in the superficial aquifer has been a prime constraint in management of water extraction from the Gnangara Mound.

5.1.2 Land Use

The Gnangara Mound area contains a mainly urban population of some 640,000 people growing by around 10,000 per year. As shown in Table 13 urban land, including residential, industrial, commercial, infrastructure, and public spaces, accounts for around 22% of the total area.

There is a large area of native *Banksia* woodland and coastal heath land (41%), a large area of pine plantations (12%), broad acre agriculture (19%) and intensive horticulture (4%).

Horticulture is now concentrated in three main areas, namely in the Swan Valley in the south east (mainly vineyards accounting for over a half of the total horticultural area), Gingin, to the north east, and at Wanneroo-Carabooda. It seems possible that less horticultural land will be converted to urban uses than has occurred in the past. Land use plans identify the Swan Valley as a special area of cultural significance, while the Gingin area is still relatively remote from the Metropolitan Area, and in less demand for a rural to urban change in land use. The Carabooda horticultural area lies close to the main road north from Wanneroo, and thus offers good accessibility to the

employment centres and metropolitan transport systems to its south. However, to the west of Carabooda there is also a large area of dryland agriculture running parallel to the coast. This lies on the development front and is potentially transferable to urban use.

Table 13: Approximate areas of land uses on the Gnangara Mound

Land Use	Approximate Area (km^2)	%
Urban	460	22
Native Vegetation	860	41
Pine Plantations	250	12
Broad Acre Agriculture	400	19
Horticulture	90	4
Open Water	40	2
Total	2,100	100

Native vegetation and pine plantations occupy most of the central parts of the Mound, north and north east of the urban area. This timbered and wooded land provides good water quality protection for the Water Corporation's groundwater borefields, but the evapo-transpirational demands of the pine plantations are a substantial use of the surficial aquifer: see Section 5.2.3 and Section 5.2.4.

5.1.3 Hydrogeology

It remains an unresolved scientific problem as to whether and to what extent pumping from the deep bores affects groundwater behaviour in the superficial aquifer. Modelling the aquifer system is complex.

Aquifer hydraulic conductivity (the rate of water movement through the aquifer matrix) varies across the Mound. It is lowest over much of the central coastal plain (from 5m/day to 20m/day). The equilibration of groundwater levels across the whole surface of the Mound following groundwater extraction is therefore a slow process. For this reason groundwater management areas are established sub-regionally. Groundwater pumping produces a "cone of depression" in the superficial water table. The lakes and wetlands act as evaporative sinks, and draw water towards the body of open water. These factors have led to the placement of Water Corporation bores at some distance from lake and wetland systems, and generally "up-stream" in terms of groundwater flow from horticultural areas.

5.1.4 Water Quality

Water quality is generally good throughout the Mound aquifers. However, urban and horticultural areas are generators of pollutants that may prevent use for potable supply. For example, spillages of petroleum from service station storage tanks infiltrate to the water table where they are carried by the groundwater flow. If a

production bore is located nearby its cone of depression may draw the contaminants towards the bore. This occurred near Gwelup, leading to the closure of Water Corporation bores in that area.

Similarly, phosphorus applied in horticulture can accumulate in areas of low aquifer permeability, while high nitrate concentrations were discovered near Gwelup. Toxic organochloride pesticides which are biologically non-degradable may also be found below market gardens.

The Water Corporation has planned its production bores to be at a distance from urban and horticultural activities. The bores reach varying depths, some as deep as the Yaragadee formation (artesian bores; i.e. water rises to the surface under its own pressure). The principal form of treatment of the groundwater is aeration, which precipitates irons. In other respects, the quality of extracted water is good.

5.2 Water Use

5.2.1 Overview

Uses of water on the Mound in 2005 are shown in Table 14. Total abstraction is around 336 GL. The Water Corporation is the largest user accounting for 45% of the total abstraction, with horticulture and agriculture next with 18%.

The Gnangara Mound supplies the Perth Metropolitan Area with about a half of its water requirements - even more in recent dry years when hills reservoirs have been severely depleted. This capacity to draw down groundwater in times of reduced rainfall and runoff into hills reservoirs has saved Perth from much more severe water use restrictions than it has actually experienced since the 1990s. However, the Mound supports many environmental values, and these have suffered during the period of low rainfall/recharge.

Table 14: Extractive uses of Gnangara Mound groundwater in 2005

	GL	%
Water Corporation	151	45
Horticulture and Agriculture	61	18
Industry and Services	15	5
Parks and Recreation	35	10
Domestic and Rural Lifestyle	16	5
Home Gardens	58	17
Total Use	336	100

Source: Department of Environment Consultancy Brief, June 2005

5.2.2 Horticulture

As described above, horticulture is concentrated in a few geographical areas on the Mound. Water allocation is generally provided on a 'first come first served' basis, and licences are issued for a maximum of 10 years (Irrigation Review Steering Committee 2005).

In areas such as Wanneroo and Carabooda, future water use may be affected by both the availability of the water resource and the availability/viability of land for horticultural and agricultural purposes. As already noted, export markets have sustained an increase in the volume and value of horticultural production, and horticulturalists who have sold land in the more southerly parts of the Gnangara Mound for urban development are seeking alternative land to continue their enterprises.

In its submission to the Inquiry the Department of Agriculture and Food states:

> "I*t has been proposed that if the wastewater segment of the water and wastewater industry was open to competition, then depending on the costs and benefits involved, a wastewater treatment plant(s) could be set up … and mine the organic waste streams from (sewage) pipelines, to provide irrigation water for ..(an expanded).. horticulture precinct at Carabooda. ….However, given wastewater costs more than $1,000/ML to treat… means that using treated wastewater for agriculture is generally unviable in purely financial terms….Despite (this)…public benefits (including health, lower transport costs, greenwaste recycling and employment opportunities) may provide a case for the WA Government to subsidise wastewater recycling services"* (Our parentheses)

The submission makes no mention of water trading in relation to this proposal. However, if re-cycled (medium quality) water were to be supplied to Carabooda as part of a trade involving the sale water access entitlements ***at*** Carabooda to the public water supply system, then the economics of any proposal to use treated wastewater would be changed. Under such a scenario a trade not unlike that which occurred between the Water Corporation and Harvey Water might be feasible. The relevant willingness to pay for the treated wastewater would be that of the bulk water supplier for the urban area, not horticulturalists. However, this would require competent organizations to arrange the trade. Not only would there be a need for a competitive wastewater supplier as suggested in the submission, but also there would need to be an irrigation cooperative supplying the area with piped recycled water, and negotiating trades with the Water Corporation working within a suitable system of exit fees. The Department of Water would need to assess the hydrological feasibility of ant proposal. Finally, as groundwater at Carabooda is already fully allocated the points made here would not apply to any proposal that aimed to facilitate an increase in total water use at Carabooda.

5.2.3 Pine Plantations

Not listed in Table 14 is the influence of pine plantations. These cover approximately 12% of the total land area of the Mound, and are a significant user of its water resource.

Recent research in South Australia (Schonfeldt, 2005) has suggested that a mature plantation forest can draw on average of 4.35ML/ha, and a range from 1.08ML/ha to 6.7ML/ha. The study concluded that "*direct extraction of water from the water table by plantation forest where it has access to shallow water tables is a potentially significant proportion of the water budget in some management areas.*"

Recent work at CSIRO in Perth has quantified the influence of selected stands of pine plantations on the Gnangara Mound (R.Silberstein, pers. comm). Water balances were estimated for five stands of *Pinus Pinaster* over the 19 months from mid 2004 to end 2005. Depths of groundwater beneath the stands ranged from 5m to 31 m. The study found that there was no groundwater use (zero recharge) beneath the two stands at 18m and 31m depth to water table. In other words, the trees were not accessing the groundwater, though they certainly intercepted rainfall and used water from the vadose zone (the zone above the groundwater table that is partially saturated). In the three stands with groundwater depth equal to or smaller than 15m there was a net discharge of 100mm/yr. In comparison with native vegetation (*Banksia* sp. woodlands) a broad indication of the hydrological (water balance) effect of the plantations is therefore as follows:

- Pine plantation: around 100 mm/yr discharge
- Banksia Woodland: around 100 mm/yr recharge to groundwater
- Net effect of a change from a pine plantation to Banksia woodland: around 200 mm of groundwater recharge.

There are issues in extrapolating Silberstein's results. Silberstein pointed out that there were differences between the plots, notably that (i) they were of different ages, with the older stands being located on areas of more shallow groundwater table; and (ii) there were differences in provenance of the trees, some stands originating in France, the others from Portugal. In addition, some estimate would need to be made of the areas and ages of different stands that might be considered for thinning or clear felling. Nevertheless, as a very broad indication of the potential magnitude of a change from pine plantations to native vegetation, if all of the plantations were clear felled and the land returned to *Banksia* woodland, then according to the CSIRO results above there could be a net increase in recharge of 42 GL/yr (area of 2.1 x $10^{\wedge 8}$ m^2 times 0.2m = 42 x $10^{\wedge 6}$$m^3$ = 42 GL).

The State of the Gnangara Mound Report (Department of Environment, 2005) identified possible actions for pine plantations each Management Zone. These are re-produced in Table 15.

In principle it seems that a plantation forest should be treated like any other user of water. There are, however, some practical difficulties in arranging this. One aspect is

the existence of an Agreement Act with a timber company for timber production from Gnangara Mound plantations. This raises the issue of compensation if plantation production plans need to be changed. Compensation may nevertheless remain worthwhile for particular plantation areas. Another issue is that if a Water Access Entitlement were to be created for a plantation forest a condition for its transfer would involve the clear felling of the plantation, whereas surrender of a "normal" water access entitlement would merely require a cessation of water use by the vendor. This could be overcome by taking account of the need to clear fell as a part of the "works" approval process. An associated issue is that the difference in groundwater recharge following clear felling depends on the subsequent land use, so there is no unique water quantity that could be associated with the entitlement in advance (i.e. at the time the water access entitlement was created). This could be overcome by allowing the regulatory agency (i.e. the Department of Water) to include limitations on the transferability of the water access entitlement at the time of its creation: either by including a covenant about the permissible land use following a transfer in the water access entitlement, or by considering this at the time a proposed transfer was being considered under the "works" provisions.

Table 15: Impacts, possible actions, barriers and drivers for changed management of pine plantations on the Gnangara Mound (from State of the Gnangara Mound Report)

Zone	Impacts	Relative Impact on GW Table	Possible Actions	Barriers/Drivers
Yeal	Pines have important ecological impacts in the west of the zone	-1		• Stands are young: "uneconomic" to remove
Pinjar	Pines have important ecological impacts in the west of the zone	-1	• Thinning 100% of pines to west of Pinjar borefield	• Currently monitoring impacts of thinning
Yanchep Caves	Pines have important ecological impacts in the east of the zone	-2	• Thinning & harvesting of pines. • Monitor effects	• Large depth to groundwater (slow recharge response) • Wesbeam compensation?
North Wanneroo	Impacts in the east of the zone	-1 or -2	• Accelerate harvest/total clear fell • Define subsequent land use	• "Economics" • LVL Agreement (State Agreement Act) • Desired water outcomes
South Wanneroo	Some impact along eastern boundary of the zone	-1	• Accelerate clear felling • Replace with suitable vegetation	• "Economics" • LVL Agreement (State Agreement Act)
Lexia	Pines have important ecological impacts in the west of the zone	-1 or -2	• Clear or thin	• Legislation • LVL MoU
Gwelup	N/A			
Mirrabooka	N/A			
Perth Metro	N/A			

Impact (+ or -) on groundwater table: 3 = large to 1= small

Despite the current barriers, shown in Table 15 the fact remains that under current institutional arrangements there is no direct signal to the forestry enterprise of the opportunity cost of its water use. If rectified this would change producer assessments of what plantations were "economic" or "uneconomic" to retain.

5.2.4 Native Vegetation

Management of the native vegetation in the State Forest, in particular the frequency of controlled burns, is another way of increasing recharge to the Mound. Table 16 summarises impacts, possible actions and barriers/constraints, from the State of the Mound Report.

Table 16: Impacts, possible actions, barriers and drivers for changed management of native vegetation on the Gnangara Mound

Zone	Impacts	Impact	Possible Actions	Barriers/Drivers
Yeal	Mainly in north and south east of the zone	-2	• Bring burning regime to < 10 yrs within 3 years, especially in areas with low risk of weed invasion	• Need a more efficient MoU with the Commonwealth to ensure the action is accepted as appropriate • Appropriate resourcing • Address Commonwealth's low priority for burning
Pinjar	Mainly in the east of the zone	-1.5	• Biodiversity and fire impacts research	• Vegetation nis already separated from the water table • Address Commonwealth's low priority for burning
Yanchep Caves	Mainly in west of the zone	-1	• Research required to asses impacts of burning on Threatened Ecological Communities • Maintain Tuart Woodlands • Regularly burn bushland to the east of the caves and wetlands	• Native vegetation is quite dense • Biodiversity issues • Presence of threatened Ecological Communities
North Wanneroo	Some large areas in the south of the zone	-0.5	• Increase frequency and extent of burning of native vegetation • Remove native vegetation	• Political • Public perception • Air pollution • Loss of ecologic values • Research needed before any action
South Wanneroo	Very little native vegetation remains	-1	•	• Aesthetics • Legislation
Lexia	Mainly in east of the zone	0	•	• Political • Public perception • The area has high conservation values on the east side of the Swan Coastal Plain • Resources ($) for managing an altered fire regime
Gwelup, Mirrabooka, Perth metro	N/A	0		

Impact (+ or -) on groundwater table: 3 = large to 1= small

The *Banksia* woodlands are naturally subject to fire, particularly as a result of lightning strikes, and are subject to periodic controlled burns by the Department of Environment and Conservation. The Department of Water has recently commissioned research into the water balance management aspects of the burning of native vegetation on the Gnangara Mound.

It is notable from Table 16 that "resourcing" is viewed as a barrier to changed management practice. The lack of a clear pricing signal plays a part in deficient resourcing. This matter is probably best addressed by applying benefit cost analysis to support decisions on management practice for native vegetation, rather than developing trading mechanisms across public agencies.

5.3 Water Trading

From the above discussion, it is clear that the Gnangara Mound is a critical source of water for Perth and that there is potential for transfers allowing greater use for public water supply or for environmental purposes. As was shown in Section 3.4, users on the Gnangara Mound have shown willingness to trade water on a permanent and temporary basis. As was demonstrated in Table 3, Gnangara Mound water users accounted for approximately two thirds of all permanent groundwater trades between 2002-03 and 2006-07. The Gnangara Mound trades amounted to over 2 GL during the period. This is not a particularly large volume, but it has to be remembered that the Water Corporation was not active in the Gnangara water market during the period, and agricultural returns were rising.

A number of factors complicate the operation of a potential water market:

- Transfer of pumping needs to take place within relatively small areas to maintain the system state, and there are important environmental constraints.
- The raw groundwater may be unsuitable for potable use if located near urban areas or former horticultural areas, limiting the potential water market.
- Following a change of land use from horticulture to urban or special rural use, new residents install bores; meanwhile, the original owner also sells his water entitlement to another horticulturalist. The net effect is therefore an increase in groundwater extraction unless developers are required to purchase water entitlements and pass them in effect to the new residents via the developers.
- The pine plantations are a major water user, and their staged removal would be a significant contribution. There are, however, legislative and other impediments to be overcome before a tradeable instrument could be put in place.
- Similar comments could be made in relation to controlled burning practices for the native vegetation within the State Forest.

- The scope for trading water both into and away from horticulture could be facilitated by the formation of irrigation cooperatives, operating under similar arrangements to the four existing surface water cooperatives.
- Until Government gives a clear indication of environmental water allocation policy for the Mound, the value of water access entitlements will be uncertain, discouraging the Water Corporation from entering the market.

6. ISSUES FOR FURTHER DEVELOPMENT OF WATER TRADING

6.1 Overview

During this study a number of issues for future development of water trading in Western Australia were identified. These may be listed as:

- Breadth of application
- Pace of reform
- Resolution of management issues concerning Collie catchment and Wellington Dam
- The role of irrigation cooperatives
- Suspected potential for water hoarding
- Land use and water planning for the Gnangara Mound
- Pine plantations
- Influence of the water and wastewater sector

These are discussed in the following sub-sections.

6.2 Breadth of application

A key question about the proposed reforms is "how broadly will they be applied?" It is worth mentioning a number of important water resources management issues in Western Australia that do not figure so prominently in eastern Australia, and do not fit the "riverine flow exchange" model that so strongly influences the prescriptions of the National Water Initiative.

The existing licensing system under the RiWI Act will be carried through to the new legislation with some amendments. This system will continue to apply state wide where there is no Statutory Water Management Plan and defined consumptive pool. Thus, large areas of the State will continue under a basically similar regime to that under the RiWI Act. Specifically, the provisions under the RiWI Act to take water for stock and domestic purposes will continue as a basic right. Thus, much of water used the wheat-sheep zone will continue to be used under a non-tradeable right. This will not extend to raising stock under intensive purposes.

Statutory Water Management Plans are likely to be established in some mining areas. Nevertheless, mining companies could be granted a traditional water licence for a defined volume of water for a defined time and specified purpose, within a Statutory Management Plan. This is acknowledged in National Water Initiative Paragraph 34, and also in Recommendation 17 of the Government Response.

Issues regarding mine dewatering discharges, return of water from hydroelectric plants, discharges of cooling water, managed aquifer recharge, and the use of water

from other than natural sources are situations requiring further detailed consideration. It is proposed that regulation of the *use* of water should include the application or discharge of water to the terrestrial environment, including by injection or infiltration for managed aquifer recharge, and the re-use of water that is obtained from desalination or other water treatment processes. At present, ownership of discharges to the natural environment reverts to the Crown. Any entity that is able to pipe a discharge to a purchaser is free to trade it. This will continue.

6.3 Pace of reform

During the interviews it became clear that water trading can easily be relegated in the agenda for reform, dependent as it will be on the passage of new legislation, development of Statutory Water Management Plans, establishment of a suitable high-technology registry, training of staff within the Department of Water, and so on. The slow pace of progress with natural resource management issues such as the Gnangara Mound and alternatives in the Collie catchment hinders progress with water trading. There is enough evidence in this paper to show that the costs and benefits associated with water trading can far outweigh the costs involved in accelerating these issues in natural resource management wherever possible. The Government's response to the *Blueprint for Water Reform* emphasises the need to act prudently as suggested by the Precautionary Principle for environmental management. This is not contested. But the same logic can also be applied in the area of economic management, when there are strong theoretical and empirical grounds for believing there are positive benefits from speedy uptake of the recommendation of the *Blueprint*.

6.4 Influence of irrigation cooperatives

There has been much interest in the Murray-Darling Basin states in the potential for anti-competitive practices on the part of irrigation cooperatives with respect to water trades. Within many cooperatives there has been a pre-disposition to accept trade with the irrigation cooperative area but to resist wider regional trades. A key concern was the possibility of assets being "stranded": in other words, if water left the area there would be fewer and fewer farmers left to meet the costs of running the irrigation system. To protect remaining members and to discourage exports of water irrigation cooperatives have levied exit fees. Both efficiency and equity issues are involved here. Exit fees generally dampen the incentive for irrigation water suppliers to rationalise and are a barrier to trade from lower to higher water use values.

In response to their dilemma South Australia, Victoria, New South Wales and Queensland asked the Australian Competition and Consumer Commission to provide advice on a method for calculating and implementing the "exit, access and termination fees" charged by irrigation water delivery businesses in the southern Murray-Darling Basin.

The Commission reported in November 2006 (Australian Competition and Consumer Commission, 2006). It proposed a regime with the following principal characteristics. Readers are advised to consult the ACCC's document for precise details.

- Unbundling of water rights and delivery rights was proposed as a way of better aligning charges with the cost structure of the supplier. Generally, the ACCC considers that access charges are too low and water delivery charges are too high. ACCC proposes that there should be no exit fees levied on the sale of water entitlements out of an irrigation district. The delivery entitlement should also be tradeable, subject to the infrastructure operator's approval to allow it to consider the implications of any proposed transfer on its overall delivery operations. In other words, the water entitlement would be traded, necessitating an adjustment to the delivery rights. Termination fees would then be linked to access fees (see below).
- A delivery entitlement should be able to be terminated upon payment of a termination fee, after which the operator would no longer be obliged to deliver water, and any obligation to pay on-going access fees would be terminated.
- Security over collection of ongoing access fees: no security to be provided by irrigators the value of whose remaining water entitlements is les than 50% of the termination fee.
- Calculation of access fees: all fixed costs should be included, all costs that vary with the amount of water delivered such as Bulk Water charges and variable operating costs should be excluded.
- Termination fees should then be based on a multiple of actual access fees levied on the delivery entitlement at the time of termination. A schedule ranging from 12 times access fee for terminations in 2007-08 to 8 times access fee by the year 2016-16. Several interim measures are proposed. Particular circumstances, including tax issues, use of shadow access fees, and accounting future fixed costs were also addressed.
- Options for reducing termination fees over time were foreshadowed.

From the discussion of the benefits of the Harvey-Waroona trade in Section 3.5.3 it is seen that members of the irrigation cooperative have resisted water transfers out of their area. They are even backed in this by a State Planning Policy. However, it is also clear that the linkage of the channel replacement project to the water transfer may have been sub-optimal as compared with some mixture of water release by irrigators, combined with some investment in irrigation system improvement. It is also clear that under current arrangements irrigators are offered a "shareholder" choice about the cooperative's strategy rather than an individual choice based on their enterprise economics.

In moving towards a new system for water trading in Western Australia that will reveal the true opportunity cost of water use, a mechanism needs to be found that: (i) preserves the important skills in strategy development and irrigation system operation

that clearly reside in the management structure of WA's four irrigation cooperatives, and (ii) provides a more liberal trade regime than is available to individual members of irrigation cooperatives at present.

6.5 Potential for water hoarding

Concern has been expressed about the possible incentive to hoard water access entitlements once the current license system of "use it or lose it" is replaced in consumptive pools. It has been suggested that the "use it or lose it" approach to licensing employed by the Water and Rivers Commission actually gave farmers an incentive to over-use water. Such an incentive will not exist under the proposed perpetual water access entitlements system.

The main circumstance under which some accumulation of entitlements might occur could be if a water broker or similar agency sought to accumulate entitlements in order to on-sell them at a later date to a single purchaser as a "job lot". This would save the ultimate purchaser time and effort in obtaining the volume of water sought through trade. Such activity would therefore serve a useful purpose and should not be considered to be anti-competitive.

The holding of water in the expectation of rising prices might also delay the transfer of water and therefore bypassing low-value trade gains in favour of later transfers to even higher value uses. This is an empirical issue to be judged on a case-by-case basis.

It is concluded that there is little substance to concerns about water hoarding. Moreover, should circumstances arise where anti-competitive behaviour is shown to exist, the Department of Water has determined that existing trade practices legislation is sufficient to deal with it.

6.6 Influence of the water and wastewater sector

It is clear that the Water Corporation has espoused water trading as a part of its source development strategy for the IWSS. There is no evidence that it has been anti-competitive in its dealings in that regard. However, water trading is not high on its agenda for source development. The selection of the Harvey-Waroona trading option occurred primarily as a stopgap measure at a time of great stress on the water supply system.

It is also evident that the Corporation's preference is for large projects with predictable outcomes in terms of timely project implementation and acceptable water quality over smaller projects that present multiple stakeholders, institutional barriers, or complex changes in natural resource management practices. Despite these difficulties it is clear from this paper that efficient outcomes can nevertheless be obtained. Since the separation of the former Water Authority into the Water Corporation and then Water and Rivers Commission (now Department of Water) the Corporation has had resources to undertake detailed feasibility studies of source

development options that have not been available within the Department. Observing the slow pace at which natural resources management issues are being resolved, and the inherently inefficient water pricing regime, it is little wonder that high-cost options have been selected.

6.7 Collie Catchment and Wellington Dam

From discussions with all agencies contacted it is apparent that there are several strategic issues pertaining to natural resource management in the Collie River basin that need prompt resolution if water trading is to proceed. These include specifically:

- Future of the Wellington Dam pump-back scheme: this involves the refurbishment of pumps previously used for the Great Southern Towns Water Supply Scheme, for use in pumping water to Harris Dam and on to Stirling Dam.
- The future for water-based recreation on Wellington Reservoir.
- Determination of the acceptability to the energy industry of projects involving return of brines from cooling towers to mine voids.
- The future of several proposals involving desalination and disposal to mine voids, or through the existing pipeline for diversion of saline flows. The issue of methods for disposal of discharges out of the Collie basin is ongoing.
- Progress with catchment land use and salinity management.

Under these circumstances it is difficult for potential vendors of water access entitlements (or current licenses) to enter into negotiations with potential purchasers.

6.8 Land use and water planning for the Gnangara Mound

The Department of Water has two activities relating to planning of the Gnangara Mound:

- the Statutory Water Management Plan, and
- the Gnangara Sustainability Strategy

It is envisaged that the provisional Statutory Water Management Plan will eventually be up-dated when the results of the Sustainability Strategy become available. This could take a number of years. The Draft Strategy is not due until 2009, and it will be followed by an un-specified period for community consultation, feedback and ultimate decision taking. As water trading already occurs on the Mound, and is an ongoing process and because the Mound is a low-cost source of strategic significance for the Water Corporation and Perth's water supply, the development of the Statutory Water Management Plan should not delay the introduction of new mechanisms for water transfer.

It appears to be a presumption of land use planning that existing irrigators should be found a space with the Gnangara Mound area in future as they move out after selling

existing areas for urban development. The Department of Agriculture and Food has provided a submission to the ERA's current inquiry advocating the use of treated wastewater to recharge an area of the Mound at Carabooda proposed to be dedicated as a horticultural precinct. There is little doubt that horticultural enterprises would not be able to pay the full cost of such a scheme. The author has no prejudice against the use of land for horticulture, but it will be economically inefficient for horticulture to be located within the Mound if enterprises cannot pay the opportunity cost of their water. Section 5.2.2 has suggested an alternative trade-based approach involving a chain of transfers leading to a gain to the IWSS.

6.9 Pine plantations

The Department considers that there may be special circumstances where a statutory management plan defines a consumptive pool where a water access entitlement is not appropriate. The issue of plantation forestry is of particular note here. Both pines on the Gnangara Mound and blue gum plantations throughout the southwest use more groundwater water than either coastal native vegetation or cleared land. There are complicated issues of principle here, because *all* land uses and land management practices have some effect on the water balance. For example, controlled burning practices change runoff in Darling Range catchments.

The position with regard to the pine plantations can and should be resolved as a matter of urgency. In South Australia a permit system has been adopted in relation to plantation forestry (Schonfeldt, 2005). Under this system there is an exclusive dedication of a share of the regional water budget to the plantations, but it is not tradeable. Proposals that exceed regional water shares are required to be accompanied by offsets. The South Australian system is one approach for managing water in a situation where forestry activity is growing. However, it is not appropriate for a situation where the investment in forestry is sunk and the main issues concern (i) the timing of felling and possibly (ii) whether plantations are re-planted after felling. For the first situation holding a tradeable water entitlement would present the forestry operator with a different commercial choice than where no tradeable water entitlements are held. For the second situation, it seems highly desirable from an economic efficiency point of view that investment decisions should take account of the opportunity cost of the water that would be extracted by the proposed plantation.

The National Water Initiative and Blueprint Recommendation 24, which is supported by the Government response with some qualifications, proposes that statutory management plans may require that water used by plantation forestry be licensed where there is a significant adverse impact on the future management of a water resource. Therefore, in areas where interception of water by forestry plantations is a significant water resource management issue, a standard water licence for a defined volume outside of the consumptive pool and for a defined term up to equivalent to the expected term of the forestry plantation land use may be issued.

In our view it would seem that where a consumptive pool is established the taking of water by a plantation should be treated like any other abstractive use. Our argument is

that the issue of a water access entitlement changes the economics of the plantation enterprise at the margin. If there is a potential purchaser of the plantation's water access entitlement within the consumptive pool this may influence the owner's decision about the sale price of timber, how soon the plantation should be felled, and when land might be returned to an alternative use. This would also reveal the true opportunity cost of retaining the plantation.

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