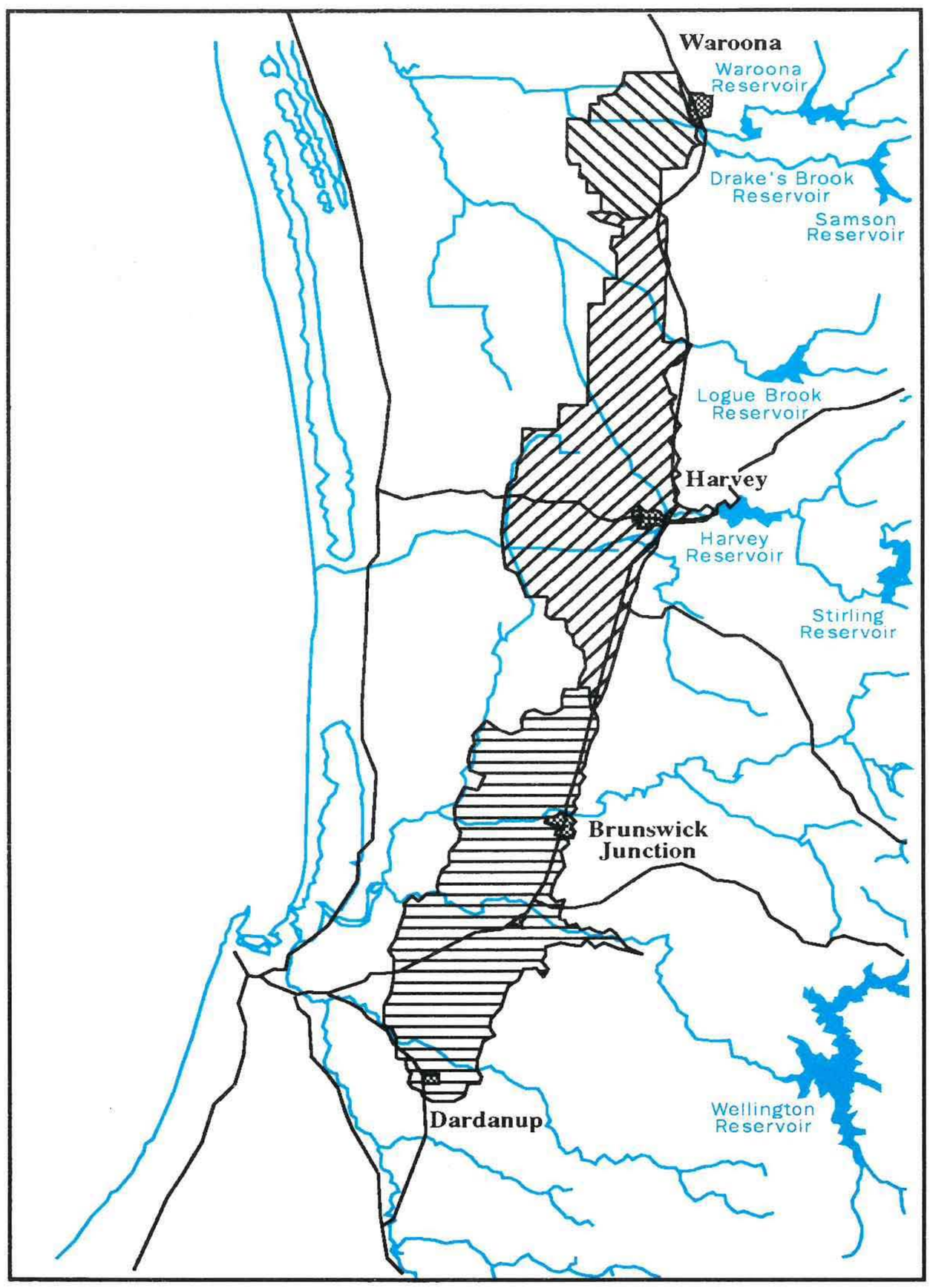
THE SOUTH-WEST IRRIGATION AREA STRATEGY STUDY

PHASE 2 OPTIONS REPORT

An evaluation of options for the future South-West Irrigation Service in Western Australia



The Consultative Committee to
The South-West Irrigation Area Strategy Study

November 1992

THE SOUTH-WEST IRRIGATION AREA STRATEGY STUDY

PHASE 2 OPTIONS REPORT

An evaluation of options for the future South-West Irrigation Service in Western Australia

The Consultative Committee to
The South-West Irrigation Area Strategy Study

Report No. WP170
Water Authority of Western Australia

November 1992

Produced and available from

Water Authority of Western Australia
Water Resources Directorate
John Tonkin Water Centre
629 Newcastle Street
Leederville, WA 6007

Report No. WP170
IBSN 0 7309 5246 0

FOREWORD

The South-West Irrigation Area Strategy Study was initiated by the Water Authority of Western Australia in 1989 to assist the State Government, the Water Authority of Western Australia and irrigation farmers to develop a strategy for the future operation and rehabilitation of the South-West Irrigation Service for the Waroona, Harvey and Collie Irrigation Districts.

Phase 1 involved collecting background data to provide information on the Irrigation Area and identified issues to be studied in more detail in Phase 2.

Phase 2 involved the development and evaluation of options for the future operation, rehabilitation and modernisation of the South-West Irrigation Service. Options were identified by irrigators and other stakeholders following a round of consultative workshops conducted at the start of Phase 2. The options evaluated were selected to cover the possible range of future demands for the Irrigation Service. The analysis of the options was carried out by a Technical Working Group on behalf of the Irrigation Strategy Consultative Committee.

The Consultative Committee does not recommend a particular option. This is a matter for decision by Government following review of submissions from irrigators and other stakeholders.

This is a report on the economic, financial, social and environmental evaluation of the options undertaken in Phase 2 of the Study. More detailed information is available in the Phase 2 Technical Report.

Mr B. Sadler
Chairperson
The Consultative Committee
South-West Irrigation Area Strategy Study
November 1992

THE CONSULTATIVE COMMITTEE

A consultative committee of irrigation farmers and government agency representatives was appointed to oversee the running of consultative workshops and the preparation of the Phase 1 and Phase 2 reports.

The members of the Consultative Committee were:

Mr B. Sadler	- Water Authority of Western Australia (Chairperson)
Mr I. Loh	- Water Authority of Western Australia (Project Manager)
Sir D. Eckersley	- South-West Development Authority
Mr D. Norton	- Irrigation Farmer
Mr C. Rigg	- Irrigation Farmer
Mr G. Edwards	- Irrigation Farmer
Mr C. Capogreco	- Irrigation Farmer
Mr L. Snell	- Irrigation Farmer
Mr G. Luke	- Department of Agriculture
Mr G. de Chaneet	- Department of Agriculture
Mr H. Ventriss	- Water Authority of Western Australia
Mr R. Harvey	- Water Authority of Western Australia (*up to November 1991*)
Mr C. Elliott	- Water Authority of Western Australia
Mr G. Holtfreter	- Water Authority of Western Australia
Mr L. Werner	- Water Authority of Western Australia
Mr I. Longson	- Project Consultant

INDEX

INDEX

LIST OF TABLES

LIST OF FIGURES

THE KEY FINDINGS

INTRODUCTION

The main purpose of the Phase 2 Options Report is to provide information on the outcome of adopting different options for the future operation of the South West Irrigation Area.

A total of 45 different options were identified for evaluation. These options were derived from various combinations of four different factors:

- different land areas based on land productivity, environmental and likely enterprise demand criteria;
- on-farm irrigation and scheme engineering strategies for water delivery, draining and salinity mitigation;
- high and low water demand scenarios; and,
- the water charging policy adopted.

A summary of how these options were derived is provided on the last page of this report. Easy reference to the description of options can be made by folding out this sheet so that it can be viewed while reading the main text of the report.

The most important factor defining the different options is the area of land to be irrigated in the future.

In total 8 different sets of future operational area options were identified. Schematic maps of the areas are shown in Figures 3, 4, and 5.

Each of the 45 options was evaluated for the three irrigation districts of Waroona, Harvey and Collie as well as for the Irrigation Area as a whole.

In the course of conducting an analysis of the economic, financial, social and environmental impacts of each option the following conclusions were reached.

ECONOMIC AND FINANCIAL IMPACTS

1. **The future demand for irrigated agricultural land will control the nature and size of the rehabilitation/maintenance program of the Irrigation Scheme.**

   If an optimistic market outlook is assumed, and prices for irrigation water do not increase at a greater rate than inflation, then demand for irrigated agricultural land will be high and all current irrigation channels, drains and structures will need to be maintained.

   If a pessimistic market outlook is assumed and prices for irrigation water rise to meet the full cost, then demand for irrigation land will decline and only parts of the distribution system will need to be maintained in the medium to longer term (after 10 years).

   The actual demand level is likely to lie somewhere in between these two extremes.

2. **The current Irrigation Area and standard of service could be maintained without increasing real water prices to irrigators, but only if the Government is prepared to subsidise it directly or ask other water rate payers to continue to financially support it.**

   The current charges for irrigation water do not meet the full cost of providing the service.

   A renewals accounting approach (with a zero rate of return on assets) was used to compare the financial outcome of different Phase 2 Options for the future operation of the Irrigation Service.

   Using this renewals accounting approach, the current Service could be expected to make an annual loss of at least $1.5 million if water charges remained at 1989/90 real price levels. Under the current accounting procedures used by the Water Authority (including the interest on past borrowed funds and current cost depreciation) the annual loss is currently $5.2 million.

3. **It is economic for the State to maintain an Irrigation Service to the most profitable enterprises on the most productive soils and in areas where the future costs of maintaining the Service are low.**

   Options which reduce the area served to about 70% of the current size over 15 years, and which result in water use declining to 50% of current levels, would have similar economic benefits to the State as closing the Service down and reverting to dryland farming.

   Options that further reduce the area served, particularly in the northern portion of Irrigation Area, to about 50% of the current size, and which result in water use declining to about 35% of current values, would result in an 18% greater economic benefit to the State than closing down the Irrigation Scheme.

4. **Irrigation is not economic to the State in the medium and low productivity regions, but could be financially profitable for individual dairy and horticulture farms.**

   The use of irrigation water in the medium and low productivity regions would yield lower economic returns than reverting to dryland farming if the full costs of water supply are taken into account. The opportunity costs of water (the additional cost of reserving the water for irrigation and not being able to use it for other higher value purposes in the future), the cost of maintaining the Irrigation Service and the low average pasture productivity from these regions all contribute to this conclusion.

   Based on a renewals accounting approach to the rehabilitation and continued operation of the Service, it could be profitable for individual dairy and horticulture farmers to continue irrigating in the medium and low productivity regions and meet full cost-recovery water charges provided they adopt improved on-farm irrigation and drainage practices.

   However, when the opportunity cost of using the water for other purposes is included, the irrigation of the medium and low productivity regions would not be as economic to the State as dryland production from these regions.

5. **Improved on-farm irrigation practices (Strategy 2) are expected to be cost-effective for the farmer.**

   The adoption of improved on-farm irrigation practices can lift profits by a minimum of 8 per cent.

6. **On current estimates, the real price of water would need to at least double to meet the full cost of supplying water for irrigation.**

   The price of water in the year 2000 would need to be at least twice the 1989/90 price (in real terms) to meet full operating costs and capital costs on a renewals accounting basis for even the minimum maintenance options. At this price, whilst the demand for irrigation land and water would fall, the Phase 2 analysis shows the remaining irrigators would be able to operate profitably.

   A doubling of real water prices implies that instead of the current charge equivalent of $24.30 per megalitre, the average price for water in 1989/90 would have been $48.60 per megalitre. For a farmer paying $8,000 for irrigation water in 1989/90 a bill for $16,000 would have been received if a full cost-recovery policy had been in place.

   If the charges for irrigation water rose to meet full costs over a 10 year period the Water Authority should achieve a zero rate of return on its remaining irrigation assets in about 15 years.

7. **If a full cost-recovery water pricing policy is instituted, the profitability of average size irrigation farm enterprises are likely to be affected in the following ways:**

Horticulture

- Horticulture would continue to be profitable.

THE KEY FINDINGS

Dairy

- Irrigated dairy farms should be more profitable than dryland farms on high productivity land.

- Irrigated dairy farms should be more profitable than dryland farms on medium productivity (marginally salt affected) land, but only if Strategy 2 on-farm irrigation productivity improvements are adopted.

- Irrigated dairy farms should be less profitable than dryland dairy farms on low productivity (salt affected) land.

- The adoption of Strategy 3 would not be profitable for dairy farms, compared to dryland dairy farming at a regional level. However, if the majority of the area continued to be irrigated, it could pay individual farmers to irrigate marginally productive land.

Other Grazing Enterprises

- Irrigation for non-dairy grazing enterprises would be less profitable than dryland farming. Income would have to be above average or the individual farm enterprise able to capture out-of-season market premiums for livestock before irrigation was more profitable than dryland grazing.

These results are for the average irrigation farm. It is impossible to predict the impact on each individual farm. The financial impact on each individual farm will depend on: farm size; dependence on irrigation; management options available; management ability of the individual farmer; and, willingness to change farming practices. It may well be financially profitable for individual irrigators to continue to irrigate, depending on their management techniques, financial situation and property characteristics (even on low productivity land).

8. **Unless it is for an intensive horticultural scheme, it would not be economic to install piped irrigation schemes (Strategy 3) in the South West Irrigation Area.**

   The provision of piped schemes would result in water charges at 3 to 5 times 1989/90 levels to meet full costs.

   There is a higher return from adopting best irrigation practices on-farm whilst maintaining a minimum maintenance strategy for the irrigation scheme.

9. **The provision of water to the Darling Scarp foothills and to the Myalup Sands for horticulture should be profitable.**

   Preliminary investigations confirm that the provision of water for horticultural enterprises from existing channels on the foothills and the provision of water to horticultural developments on the Myalup sands would have a net positive benefit after allowing for full costs of water supply. Proposals to move water allocations from within the current Irrigation Area to these areas are worthy of further examination on a case by case basis.

10. **The introduction of transferable water entitlements is considered desirable to enable irrigation farmers to adjust their irrigation water entitlement to match the profitable use of water on their property.**

    To enable resource security for irrigation farmers, and to facilitate the re-allocation of water to areas of demand from areas where an irrigation service is no longer wanted, it will be essential to have a system of transferable water entitlements in place.

11. **The economic benefits of irrigation vary between the Waroona, Harvey and Collie districts.**

    This is due to the different amounts of capital expenditure required in each district and to differences in opportunity cost of the water in each district.

THE KEY FINDINGS

SOCIAL IMPACT

12. **The population of the South-West Irrigation Area is expected to grow even if the area irrigated reduces.**

    As the demand for irrigation water shrinks due to increased real water prices and improved productivity, the number of irrigation farm households and hence farm population will fall. However, most irrigation farm enterprises will be replaced by dryland farm enterprises albeit with larger average areas and hence fewer people.

    The decline in the number of people on farms as irrigation farms convert to dryland enterprises is likely to be offset to some extent by an increase in the number of horticultural enterprises, which tend to be more labour intensive, and a general trend to increased populations in the three irrigation shires due to the growth in other industries.

13. **The adoption of any of the options, other than maintaining the current Scheme and Area, will result in varying degrees of change for irrigation farmers during the next 15 years. The extent of the change will depend on the option adopted and the strategy used to implement the option.**

    Options that have a financial effect on farm businesses produce a social impact on individual farm households. The low demand options will therefore affect every farm household to some degree, while the high demand options only affect those outside the selected area boundaries for the future operation of the service.

    The strategy used to implement any option can significantly reduce the social impact of any necessary adjustments. Once the final strategy is determined each individual farmer will be able to reassess the extent to which they use irrigation water and the implications this has on the farm business and the family.

ENVIRONMENTAL IMPACT

14. **Salinity of groundwater in the high productivity (Eastern) region should not increase significantly.**

    Studies on the likely changes in groundwater salinity indicate that increased regional groundwater salinity in the high productivity (Eastern) region is unlikely in the next 30 years.

    The groundwater salinity and high water table levels in the Central and Western regions are reducing the current average productivity of the land. However, further significant productivity decline due to salinity is not expected to occur in the Central and Western regions of the Harvey and Waroona Districts. In the Collie District significant productivity decline is also not expected, provided improved on-farm irrigation practices are introduced.

15. **Nutrient export from the Irrigation Area draining the Peel-Harvey Catchment can be reduced by 50% but only if major on-farm nutrient management practices are undertaken. The degree of improved management necessary is a function of the area that is irrigated.**

    If there is a high water demand then a 90% reduction in nutrient discharge from farm dairies and associated holding areas and a 15% reduction of nutrient discharge from farm grazing paddocks would be required to achieve the overall 50% reduction in nutrient export.

    If there is a low water demand then a 65% reduction in nutrient discharge from farm dairies and associated holding areas would be required to achieve the overall 50% reduction in nutrient export. If improved watering practices and other nutrient controls are introduced which reduce nutrient discharge from paddocks by 15%, then dairy discharge only needs to be reduced by 50% to achieve the overall 50% reduction in nutrient export.

Option E, which restricts the area irrigated to the Dardanup Loams in the Peel-Harvey Catchment, would require a 30% to 40% reduction in nutrient discharge from farm dairies and associated holding areas to achieve the overall 50% reduction in nutrient export. If improved watering practices and other nutrient controls are introduced which reduce nutrient discharge from paddocks by 15%, then discharge would only need to be reduced by 15 to 20% to achieve the overall nutrient reduction.

Option D, H and P could achieve a 50% reduction in overall nutrient export without additional on-farm nutrient management measures being taken.

16. **The overall area of salt affected pastures in the Irrigation Area should decline if irrigation contracts to the high productivity (Eastern) regions.**

    If all the low productivity (Western) and medium productivity (Central) areas reverted to dryland, regional groundwater levels would decline. Averaged over the whole area, dryland pasture productivity should increase as root zone soil salinity reduces in response to the water table decline. However, there could be some paddocks where soil salinity will increase as fresh irrigation water is no longer available to flush away salts which could still accumulate in root zones from the deeper groundwater.

MANAGEMENT

17. **There are positive benefits from considering alternative management structures which more directly involve irrigators in financial and management decisions associated with running the irrigation distribution system.**

    According to an independent review conducted by Kinhill Engineers, cost savings should result from adjusting levels of services provided to match the levels of services required by irrigators.

    However, according to the Kinhill review, it is unlikely that changes in the management structure or the privatising of the Irrigation Service would significantly alter the economics of irrigation or result in large savings.

OBJECTIVES AND PROCESS OF THE STUDY

INTRODUCTION

The Irrigation Strategy Study was initiated in response to a recognition by the Water Authority of Western Australia of the need to plan for the replacement and maintenance of aging capital structures.

Significant capital investment would be necessary to maintain the Scheme into the next century. This need arises at a time when the water industry is expected to improve its financial performance. With corporatisation and privatisation on the agenda, re-investment in uneconomic services would be inappropriate. However, it was also recognised that any major decision to invest significant capital in irrigation goes well beyond the scope of the Water Authority alone. Agricultural, economic, environmental and social aspects, as well as engineering aspects, are involved.

Ultimately the future nature of the public irrigation service is a government decision. A study process was developed to assist Government to establish a long-term strategy for the future of the Irrigation Service in the Waroona, Harvey and Collie Irrigation districts.

THE OBJECTIVE OF THE STUDY

The primary objective of the Study is to develop a long-term strategy for the rehabilitation and/or modernisation of current irrigation systems and practices, subject to the constraints of:

- economic sustainability;
- financial feasibility; and
- social and environmental acceptability.

The study provides a basis for on-going planning of:

- redevelopment, operation and maintenance of the Water Authority's irrigation supply systems; and
- farm redevelopment and operations.

THE STUDY PROCESS

The Strategy Study is divided into six phases.

Phase 1: Background data gathering and identification of issues.

Phase 2: Development and evaluation of options for the future operation of the Irrigation Service.

Phase 3: Public review of the Phase 2 Options Report and preparation of stakeholder submissions.

Phase 4: Review of public submissions and preparation of draft strategy.

Phase 5: Review of draft strategy by the Environmental Protection Authority (EPA) and stakeholders before preparation of the final strategy report.

Phase 6: Final adoption by Government and the Water Authority of the long-term irrigation strategy.

A multi-disciplinary public participatory process was established in early 1990 to progress the Study. A Consultative Committee to the Director of Water Resources of the Water Authority was established to guide the direction of the Study through its first two phases. This committee was supported by a Technical Working Group comprised of staff from relevant government agencies and consultants.

PHASE 1

The Consultative Committee published a Phase 1 Report and Background Papers in July 1990. These provided background information on the Irrigation Area and the Irrigation Scheme and identified issues to be studied in more detail in Phase 2.

Phase 1 provided preliminary evidence that the rehabilitation and continued operation of the South-West Irrigation Scheme is an economic proposition. However, the continua-

tion of the Scheme cannot be guaranteed without further major capital expenditure and revenue from water sales was just meeting operating costs at the time of the study. The main questions raised in Phase 1 were what size irrigation scheme would be required in the future and what were the different engineering, management and financing options for the rehabilitation and continued operation of the Scheme.

PHASE 2

Phase 2 involved the development and evaluation of options for the future operation, rehabilitation and modernisation of the Irrigation Scheme.

As in Phase 1 of the Study, the Consultative Committee actively sought the input of irrigators and stakeholders likely to be affected by the strategy outcome.

Options were identified by irrigators and other stakeholders following a round of consultative workshops conducted at the start of Phase 2.

Workshops were held for farmer groups and Water Authority personnel during July/ August 1990 to discuss the Phase 1 Report and define possible future options for the Irrigation Service. Discussions were also held with other special interest groups (for example horticultural groups, Environmental Protection Authority, and so on) to establish a comprehensive range of future options that consider the major concerns raised by all stakeholders.

The workshop outcomes and related discussions were combined into an approach to the Phase 2 analysis that was presented to an invited group of stakeholders in November 1990. The outcomes of that workshop formed the basis for developing the options reported here.

The analysis of the options was carried out by the Technical Working Group on behalf of the Irrigation Strategy Consultative Committee.

Options were evaluated for:

- economic benefit;
- financial profitability;
- environmental impact; and
- social impact.

This Report summarises the evaluation of options.

THE REMAINING PHASES OF THE STUDY

Phase 3 of the Study will involve the promotion and public discussion of the evaluation of the options and the subsequent preparation by stakeholders of their proposals for the future of the Irrigation Service. Phase 3 begins with the publication of this report.

Phase 4 of the Study will involve review of stakeholder submissions by an independent Government Task Force and the preparation of a Government Draft Strategy. The Draft Strategy will be reviewed by the Environmental Protection Authority, irrigators and stakeholders (Phase 5) before final adoption by Government (Phase 6).

THE CURRENT IRRIGATION SERVICE

AREA SERVICED AND LAND USE

To enable additional data collected during Phase 1 to be used in the Phase 2 analysis the base year for Phase 2 of the Study was maintained as 1989/90.

In 1989/90 the South-West Irrigation Area covered a total land area of 34,370 hectares with an estimated 445 farm enterprises using the service for dairy, horticulture and other grazing activities.

The number of farming enterprises and the area of land irrigated in each of the Irrigation Districts is shown in Table 1 below. The District boundaries are shown in Figure 5.

Table 1 *Details of Irrigation Activity in Irrigation Districts (1989/90)*

Irrigation District	Waroona	Harvey	Collie	Total
Number of farms	55	209	181	445
Area (ha)				
- Horticulture	76	245	53	374
- Dairy Permanent Pasture	366	3,589	3,255	7,210
- Dairy Early Germinated Annual Pasture	137	1,141	1,177	2,455
- Other Grazing Enterprises				
- Permanent Pasture	908	748	892	2,548
- Other Grazing Enterprises - Early Germinated Annual Pasture	340	238	322	900
- Total Area Irrigated	1,827	5,961	5,699	13,487
Total Agricultural Area (ha)	4,475	14,650	15,245	34,370

Source: Water Authority of Western Australia

THE CURRENT IRRIGATION SERVICE

THE IRRIGATION SCHEME

The engineering assets that service the Irrigation Area are summarised in Figure 1.

Like all engineering assets, the dams and distribution system needs to be maintained and ultimately rebuilt when the cost of ongoing maintenance exceeds their replacement cost.

With the exception of the earlier development of the central Harvey area, most of dams and irrigation distribution system were originally constructed in the 1930's and expanded and/or replaced to meet demands during the period 1950 to 1970.

The average age of the channel linings in the Waroona, Harvey and Collie Districts are 50, 45 and 25 years respectively. Much of this lining is no longer effective in preventing seepage, and leakage from the system is increasing. Periodic failures of the channel lining currently occur and require immediate repair to keep the service operational. As the lining continues to age these patching tasks become more frequent until it becomes cost effective to implement a systematic program of replacement before failure occurs. In addition, many of the structures are nearing the end of their effective lives. A high priority is for modification of many of the dams to meet new Australian design standards for spillway capacity and earthquake resistance.

The maintenance cost of the Irrigation Service will therefore increase substantially in real terms over the next 30 years. Deciding the scale of the maintenance/rehabilitation program, and how it is to be funded is a major issue for the Irrigation Strategy.

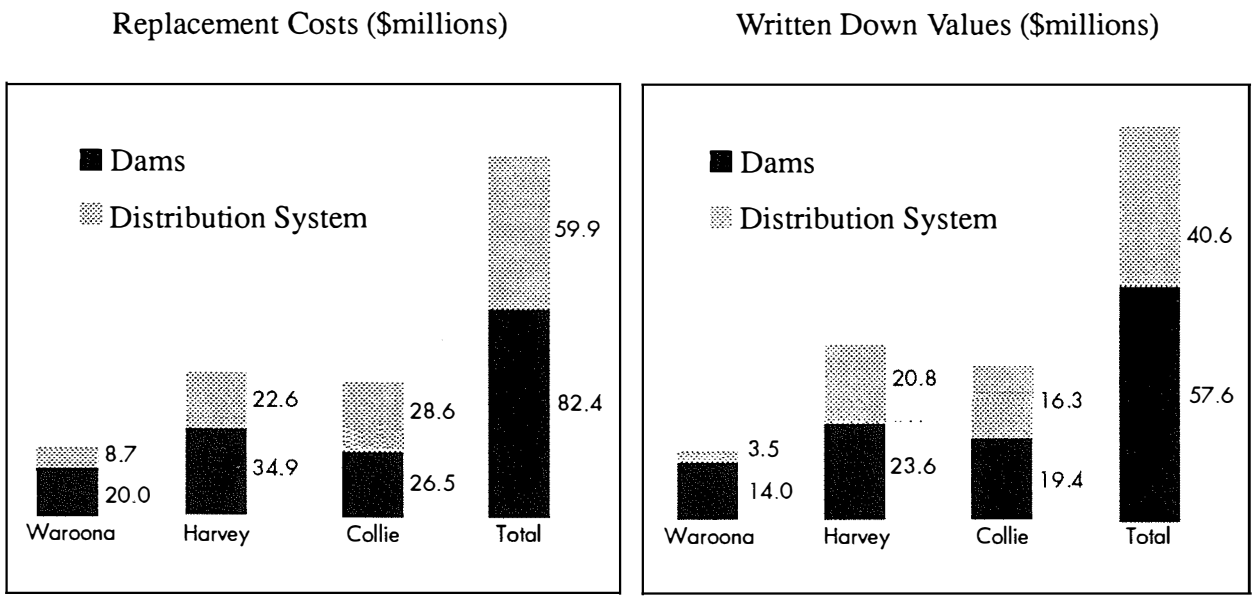


Figure 1 *Summary of Water Authority's Financial Assets in the South-West Irrigation Area*

FINANCIAL PERFORMANCE OF THE SOUTH-WEST IRRIGATION SERVICE

The current financial performance of the Irrigation Service is summarised in Table 2. The format used in Table 2 reflects the standard accounting procedures which the Water Authority is required to use in reporting on it's financial performance to the State Government. It shows the relationship between revenue received and expenditure by both the Water Authority and Government over the past three years.

Revenue raised in 1990/91 exceeded operating costs but did not cover total costs. Note the large cost for depreciation and the interest on the previous capital that was used to construct the Scheme.

From the State perspective, and under currently accepted accounting practices, the Irrigation Service is losing over $5 million per year. Even without allowing for Government interest on past borrowings, the Water Authority is losing over $2.7 million per year.

The Water Authority is no longer a recipient of any Government Funds. Indeed as from 1991/92 it is required to pay to the Government a 4% levy (up from 3% in 1990/91) on it previous year's revenue.

The Water Authority's shortfall is therefore met by cross subsidies from other Water Authority customers. As the cost of maintaining the scheme increases the level of this cross-subsidy will increase.

Table 2 *Comparison of Costs and Revenues from South-West Irrigation Service using Standard Water Authority Accounting Procedures*

($ millions)

	1988/89	1989/90	1990/91
TOTAL REVENUE	1.929	2.220	2.702
COSTS			
Operational Costs			
Operating & Maintenance	1.723	1.632	1.688
Salaries & Admin	.510	.557	.630
Total Operating	2.233	2.189	2.318
Depreciation			
Historic	.592	.601	.619
Replacement Provision	1.572	1.753	1.903
Total Depreciation	2.164	2.354	2.522
Interest on Past Borrowings			
Water Authority Borrowings	.330	.510	.488
Government Borrowings	2.317	2.341	2.419
Total Interest	2.647	2.851	2.907
Statutory Levy (3% on previous year's revenue)[1]	.055	.059	.067
TOTAL COSTS	7.099	7.453	7.814
NET RESULT	-5.170	-5.233	-5.112
TOTAL WATER SOLD (Megalitres)	88,700	84,900	91,700

SOURCE: *Water Authority of Western Australia*

NOTES: Costs as calculated by current Water Authority financial accounting method.

[1] This has increased to 4% as from 1991/92.

RENEWALS ACCOUNTING

An alternative way of measuring the cost of maintaining the Service into the future, is to use a 'renewals accounting' approach.

A variation on a renewals accounting method has been used to measure the costs associated with each of the options for continuing to operate the South-West irrigation districts. The objective of using this measure was to calculate the cost of continuing to provide the service into the future, rather than the total cost of providing the service, including past capital expenditure, as is provided by conventional accounting.

The renewals accounting approach used is based on making an annual provision for the future capital expenditure. Projected replacement expenditure for the South-West Irrigation Scheme will vary considerably from year to year. To avoid the need for large fluctuation in prices that would result from a standard renewals accounting approach, the approach was modified by projecting the capital expenditure required over the next 80 years and discounting it back to Net Present Value (NPV). The renewals replacement provision represents the annual amount required to match this NPV, and thus service future capital requirements.

Table 3 shows a comparison of the profit and loss outcomes for operating the Irrigation Service in 1989/90 (the base year for the Study), using the standard accounting procedure used by the Water Authority and the renewals accounting approach.

Further information on the use of the renewals accounting approach used to measure the financial impact of different Phase 2 Options can be found on Pages 21 and 22.

Table 3 *South-West Irrigation Service Annual Profit and Loss Statement*

Comparison between the current Water Authority Accounting Procedure and the Renewals Accounting Approach for 1989/90

Current Accounting Procedure (Standard Water Authority Method)		**Renewals Accounting Procedure** (Used in the Phase 2 Analysis)	
	$'000		$'000
Revenue	2,220	Revenue	2,220
Operating Costs	2,189	Operating Costs	2,189
Net Operating Costs	31	Net Operating Profit	31
Statutory Levy (3%)	59	Statutory Levy (3%)	NA
Depreciation			
- Historic	601	Renewals Replacement	
- Replacement provision	1,753	Provision	1,519
Interest on Past Borrowings		Rate of Return on Assets (0%)	-
- Water Authority	510		
- Government	2,341		
Total Costs	7,453	Total Costs	3,708
Net Loss	**- 5,233**	**Net Loss**	**- 1,488**

NOTES: This comparison is based on continuing to supply the existing Irrigation Area with a minimum maintenance strategy for the dams and distribution structures and the current mix of fixed rating and volume charges.

NA - Not Applicable

THE OPTIONS EVALUATED

The scale of any rehabilitation program for the South-West Irrigation Area should be governed by the expected demand for irrigated land. This, in turn, is a complex function of market demands, government policy for the Dairy Industry, on-farm productivity improvements and water prices.

The demand for future irrigated land will, in part, be influenced by the final outcome of this Study. Consequently a wide range of possible options was developed with input from the farming community and other stakeholders.

A total of 45 different options were identified for evaluation The options were derived from various combinations of four different factors:

- different land areas based on land productivity, environmental and likely enterprise demand criteria;
- on-farm irrigation and scheme engineering strategies for water delivery, drainage and salinity mitigation;
- high and low water demand scenarios; and
- the charging systems policy adopted.

Figure 2 provides a summary of the factors used to define the options. A brief description of these factors follows. More detailed information on the definition of the options can be found in the Phase 2 Technical Report. Each of the 45 options was evaluated for the three irrigation districts of Waroona, Harvey and Collie as well as for the Irrigation Area as a whole.

AREA OF THE IRRIGATION SCHEME

In total 8 alternative areas were identified for the future operational area of the Irrigation Scheme. Schematic maps of the areas are shown in Figures 3, 4 and 5.

A survey conducted by the Department of Agriculture in 1986 provided a delineation of three broad land productivity classifications. These were used as a base to identify Area's A, B and C.

Area A: Existing area of Service

B: Cease servicing the low productivity region (generally on the Western edge of the existing area of service) which tends to have considerable areas of salt affected land.

C: Cease servicing the low and medium productivity regions (Western and Central areas) which tend to have considerable areas of marginally salt affected and salt affected land.

Areas D & E minimise nutrient export from irrigated areas to the Peel-Harvey Estuary. Environmentalists and EPA staff considered that any long-term strategy for irrigation should specifically investigate ways of reducing nutrient discharge into the estuary.

Area D: Area D further restricts irrigation to the Dardanup loams which remain in the Peel-Harvey Estuary following drainage modifications. The option involves extending the Mangosteen Drain approximately 10 kilometres to the north and east to redirect the headwaters of the Harvey Main Drain to the Leschenault Inlet and/or the Harvey Diversion Drain. The drain extension enables 2,100 ha of current irrigable land in the heavy soils of the Plain Paddocks Channel region to be retained while reducing the catchment area of, and nutrient input to, the Peel-Harvey Catchment.

Area E: Area E adopts the same environmental constraint as Area D but excludes modifications to the Mangosteen Drain and thereby restricts irrigable land by a further 2,100 ha.

Under the Area E option no irrigation is considered acceptable north of the Harvey Main Drain except on the Dardanup loams in the core of the Waroona Irrigation District.

THE OPTIONS EVALUATED

Area H: This is a hypothetical area option as it assumes the contraction of the irrigation area to the Dardanup loams in Harvey and Waroona and the sole land use being horticulture. Area H therefore represents a scenario in which there is a large demand for horticulture. This 'horticulture only' scenario would require the development of large export markets.

Area P: Area P models the retention of the existing Harvey piped scheme and the closing down of all the remaining irrigation area.

Area CD: The Close down Area option shows the impact of gradually closing down the Scheme altogether (over a 15 year period).

THE OPTIONS EVALUATED

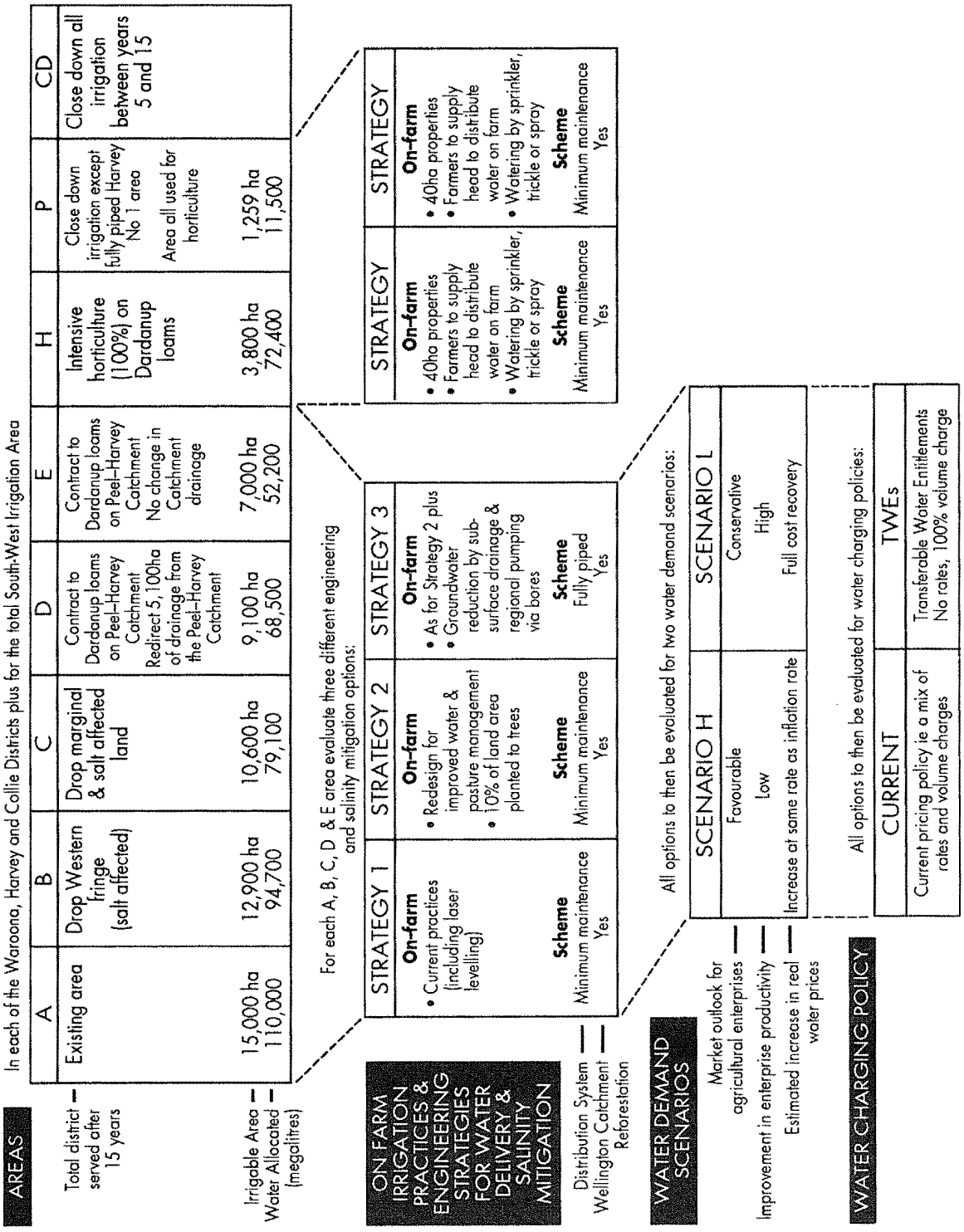


Figure 2 *Description of the Options for the Future Operation of the South-West Irrigation Service*

THE OPTIONS EVALUATED

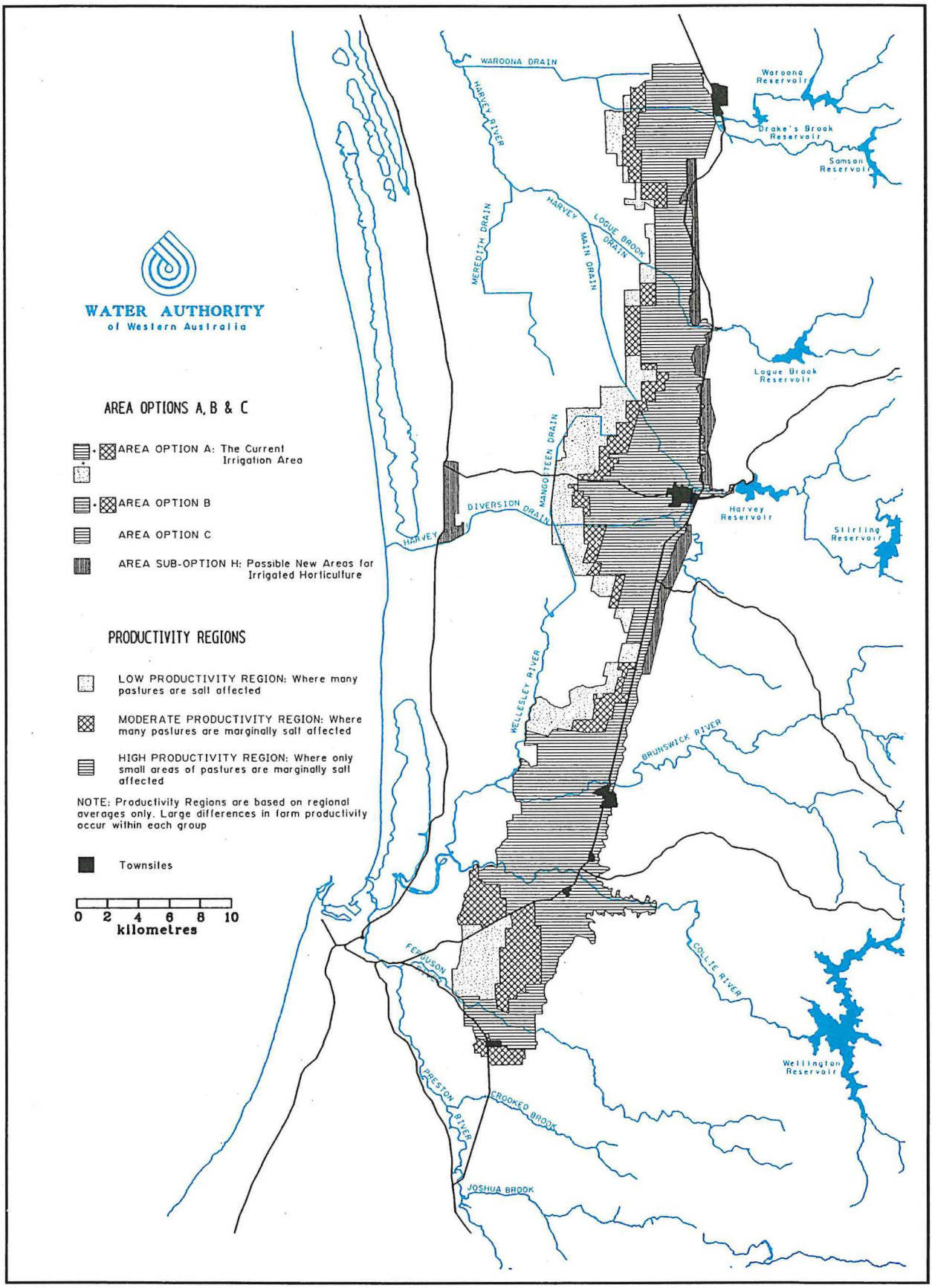


Figure 3

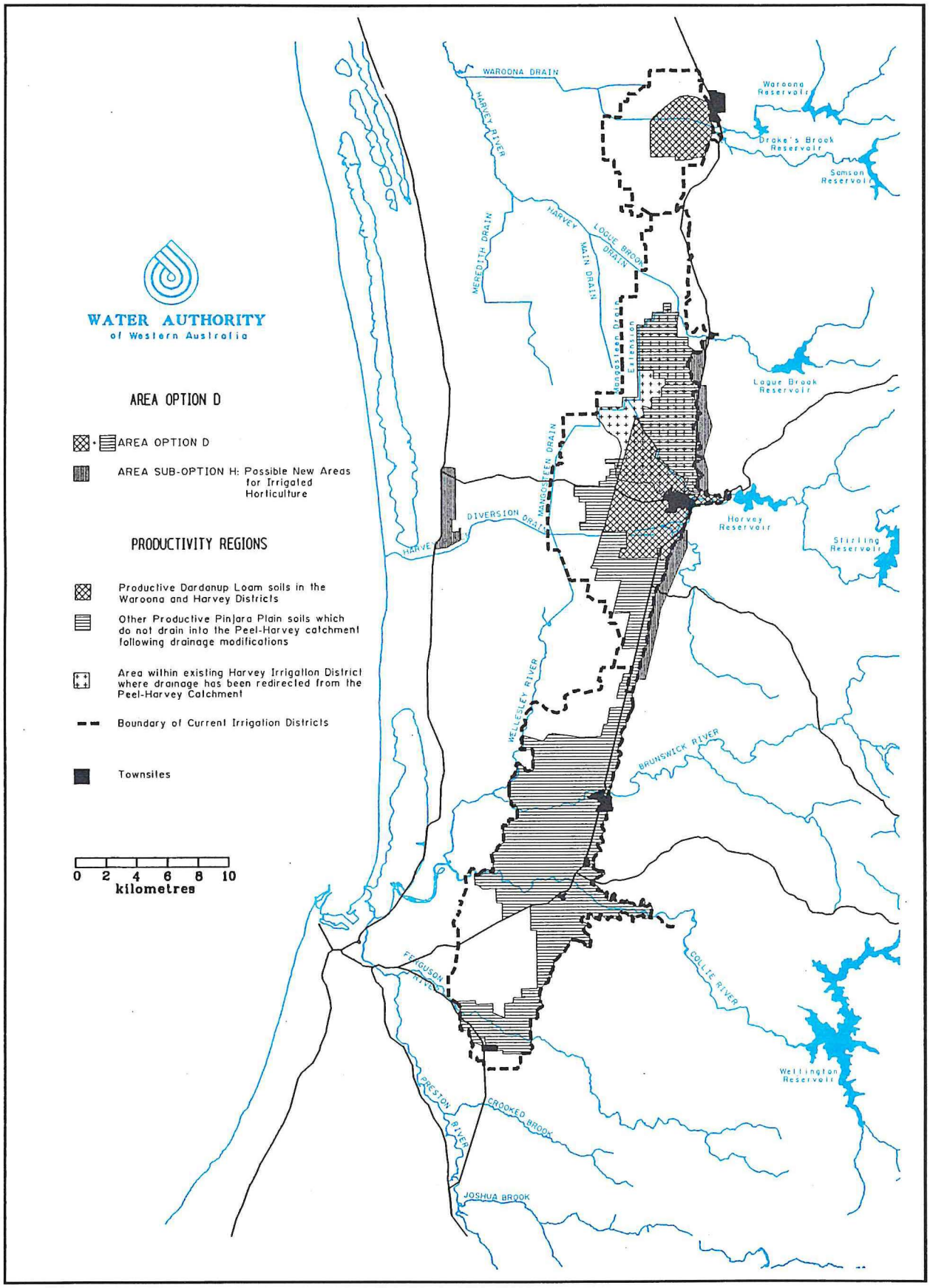

WATER AUTHORITY
of Western Australia
AREA OPTION D
AREA OPTION D
AREA SUB-OPTION H: Possible New Areas for Irrigated Horticulture
PRODUCTIVITY REGIONS
Productive Dardanup Loam soils in the Waroona and Harvey Districts
Other Productive Pinjara Plain soils which do not drain into the Peel-Harvey catchment following drainage modifications
Area within existing Harvey Irrigation District where drainage has been redirected from the Peel-Harvey Catchment
Boundary of Current Irrigation Districts
Townsites
0 2 4 6 8 10
kilometres
WAROONA DRAIN
HARVEY RIVER
MEREDITH DRAIN
HARVEY MAIN DRAIN
LOGUE BROOK DRAIN
Mangoleen Drain Extension
MANGOLEEN DRAIN
DIVERSION DRAIN
HARVEY
WELLESLEY RIVER
BRUNSWICK RIVER
FERGUSON RIVER
PRESTON RIVER
CROOKED BROOK
JOSHUA BROOK
COLLIE RIVER
Waroona Reservoir
Drake's Brook Reservoir
Samson Reservoir
Logue Brook Reservoir
Harvey Reservoir
Stirling Reservoir
Wellington Reservoir

Figure 4

THE OPTIONS EVALUATED

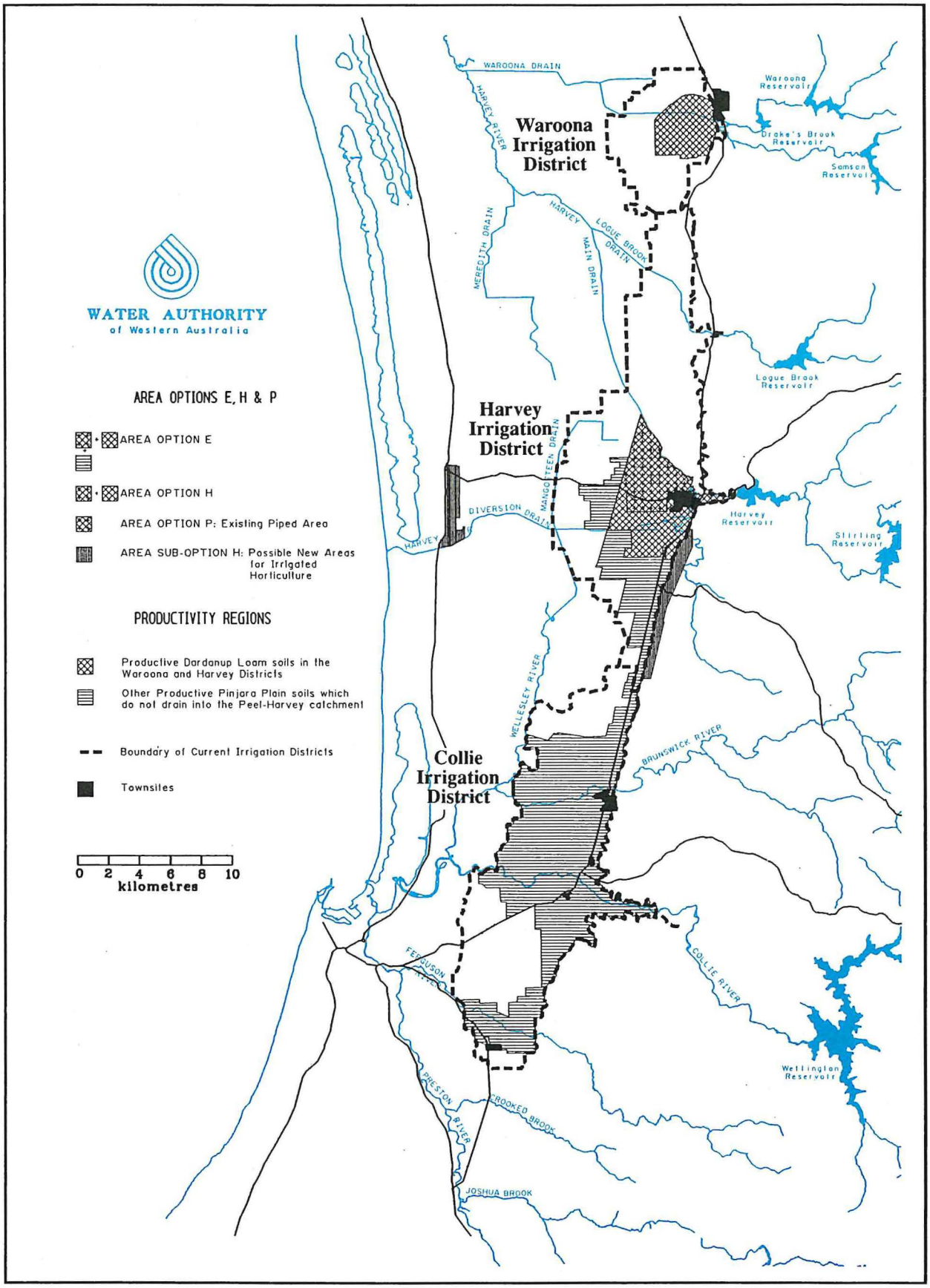


Figure 5

THE OPTIONS EVALUATED

ON-FARM IRRIGATION PRACTICES AND ENGINEERING SALINITY MITIGATION STRATEGIES

The importance of salinity mitigation to the future of the Irrigation Service was established in Phase 1 and discussed at the workshops. Following detailed investigations of the salinity issues, two approaches to improving pasture productivity were proposed. The first involves redesign of on-farm irrigation infrastructure to maximise water efficiency and pasture productivity and the second involves additional sub-surface drainage in the medium and low productivity regions of the district.

Three combinations of on-farm irrigation practices and distribution engineering strategies for water delivery and salinity mitigation were evaluated:

Strategy 1

Minimum Maintenance of Scheme and Current On-farm Practices.

The desirability of minimising costs was recognised and a minimum maintenance program, similar to that used in the Phase 1 Study was proposed for evaluation.

Irrigation Scheme

- minimum maintenance of current distribution system
  - in 10 years time (Year 2000) commence a program of channel patchup and replacement of all channels 50 to 55 years of age with the aim of covering 50 per cent of the Area over 20 years;
  - conduct essential replacements of Dethridge wheels and control structures;
- dam safety upgrades.

On-farm

- current irrigation practices, including laser levelling, but no additional salinity mitigation work.

Strategy 2

Minimum Maintenance of Scheme and Improved On-farm Practices

Irrigation Scheme

- minimum maintenance of current distribution system (as for Strategy 1); and
- dam safety upgrades.

On-farm

- re-design irrigation layout for improved water and pasture management incorporating:
  - whole farm planning;
  - bay, head ditch and tail drain reforming;
  - 6 to 8 day watering capability; and
  - surface ripping and mole draining;
- shade, shelter and limited recharge control by 10% tree planting adjacent to drains and channels;
- the net result would be a 10% improvement in water efficiency (i.e. 10 per cent less water applied).

Strategy 3

Fully Piped Scheme and 'Best' On-farm Practices

Farmers expressed the view that a comprehensive piped scheme should be investigated. Although capital intensive, piped systems reduce operating and maintenance costs, have low losses relative to channel systems and therefore save water and reduce groundwater recharge.

The aim would be to achieve water savings from both on-farm practices and a reduction of seepage loss from the distribution scheme.

Irrigation Scheme

- fully piped scheme; and
- dam safety upgrades.

On-farm

- as for Strategy 2 plus groundwater reduction in the marginal and salt affected regions by installing subsurface drainage and de-watering bores. Assume adoption of most profitable option depending on the situation:
  - subsurface drainage at 15 metre spacing beneath permanent pasture; or
  - aquifer de-watering by 'Yoganup Bores' every 15 hectares.

The adoption of new farm management strategies often takes many years to achieve. This is particularly the case where costs are high and benefits are uncertain. However, optimistic adoption rates for the proposed practices were used in the Phase 2 analyses to ensure that the effects of the different approaches were readily apparent.

The adoption rates used in the Phase 2 analysis are shown in Figure 6.

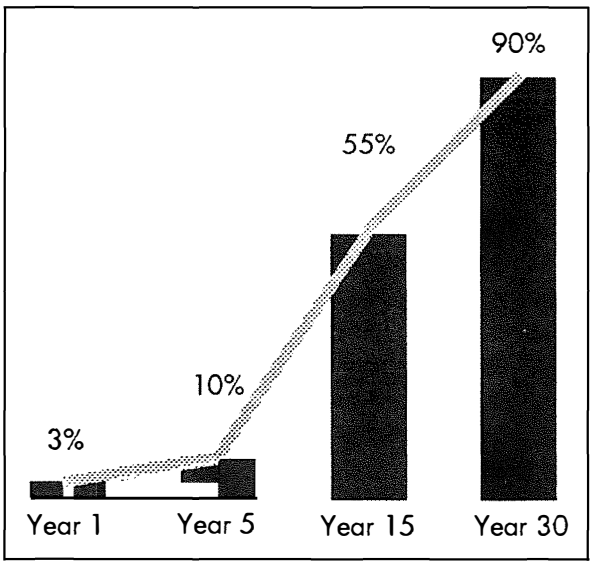


Figure 6 *Adoption Rate for On-farm Irrigation Practices*

Linear interpolation was used between the years up to Year 30 after which the adoption rate was set at 90%.

DEMAND SCENARIOS

The workshop discussions with irrigation farmers highlighted the need to specifically address the impact of high and low water demand scenarios based on different future market demand outlooks for enterprises conducted on irrigated land and the impact of the price of water on the demand for irrigation water.

In this way the extremes of high and low future demands for irrigated land were evaluated. The actual demand level is likely to lie somewhere in between these two extremes.

High Demand

- Favourable (optimistic) market outlooks for dairy, beef and horticulture.
- Water prices to only increase at inflation rate.

Low Demand

- Conservative market outlooks for farm enterprises.
- Water prices to increase over a ten year period to full cost recovery levels so that by the Year 2000 water prices are meeting:
  - operational costs
  - capital costs of distribution system
  - 85% of capital costs for dams and headworks.

The low water demand scenario incorporates a water pricing policy of meeting the full recovery of the cost of operating and rehabilitating/modernising the irrigation service. For options with a minimum maintenance strategy for the Irrigation Scheme (Strategies 1 and 2) the price of water would need to at least double to meet full costs. For the construction and operation of a fully piped scheme (Strategy 3) the price of water would need to at least treble. As a result of higher water prices the adoption of Strategy 3 would result in further reductions in the area of land irrigated and a reduced demand for irrigation water when compared to the adoption of Strategy 2.

The low demand scenario is based on the expected level of demand for irrigation water on the average farm. However, it may well be financially profitable for individual irrigators to continue to irrigate, depending on their management techniques, financial situation and property characteristics (even on low productivity land).

WATER CHARGING POLICIES

Two water charging policies and related rating systems were evaluated.

Current

The current water charging policy, which is a mix of rated area and volumetric charges, was evaluated for all options.

This means there is a fixed allocation of the water available from the reservoirs based on the total rated area. Water not sold to irrigators would not be made available to alternative users.

Transferable Water Entitlements

The second water charging policy evaluated was based on Transferable Water Entitlements (TWEs) being introduced.

A range of charging policies based on water entitlement and water used each year is possible with a Transferable Water Entitlement Market in place. An average charge per megalitre was adopted in this analysis. Other approaches are discussed in the Phase 2 Technical Report.

Water charging policies which incorporate a TWE market would enable water to be re-allocated to other irrigators and to other uses including industrial and domestic purposes.

TIME SCALES FOR IMPLEMENTATION OF OPTIONS

Area Options and Engineering Strategies

Expenditure on dam safety upgrades and on the replacement of some Dethridge Wheels and waterway structures will need to be completed within the next 10 years. Some increased expenditure on channel maintenance will be required but major expenditure on planned replacement programs of old structures and channel lining will not have to commence until the next century (after the Year 2000).

Consequently there is a period in which restructuring is possible to reshape the districts before major expenditure on the distribution system is required. To reflect this available time, the options which involve a reduction in the area served were assumed to be implemented over a 15 year period. Small reductions were considered between Years 1 and 5 with the major reductions being implemented between Years 6 and 15.

Water Charging Policies

The low water demand scenario involves an approximate doubling of water charges to cover the full cost of maintaining the existing channel scheme, and at least a trebling of the price to cover the full cost of a piped distribution scheme.

These real price increases were assumed to be introduced in equal annual steps over a ten year period.

The demand for irrigated land and water is expected to decline in response to these price increases. The adopted time frame of significant reductions in the area irrigated and the area served between years 5 and 15 is appropriately consistent.

ANALYSING THE OPTIONS

Each option was analysed for its

- economic benefit to Western Australia;
- financial impact on the Water Authority and Irrigation farmers;
- impact on the environment; and
- social impact.

A brief description of the evaluation methods used to analyse the options is described below. More detail on the analysis techniques can be obtained from the Phase 2 Technical Report.

ECONOMIC BENEFITS TO WESTERN AUSTRALIA

The objective of the economic benefit analyses is to indicate whether investment in the rehabilitation and continued operation of an irrigation option is economically justifiable from the State Government's perspective.

The assessment is made in comparison to the 'Base Case' to show the net economic benefit of the option being evaluated. The base case represents a realistic 'Close Down' scenario to a dryland farming situation with no irrigation taking place. In this Study the base case or Close Down (CD) option is achieved by maintaining current irrigation activities for five years (until July 1995) and then closing down the Irrigation Scheme in 10 equal annual steps to zero irrigation activity by Year 15 (2005). In closing down the scheme, account is taken of the close down costs to the Water Authority and the costs for irrigation farmers of developing on-farm water supplies and converting irrigated pastures to annual species.

The evaluation technique used enables the additional value of agricultural output from irrigated land to be compared with the additional costs of water supply and the on-farm irrigation practice and engineering salinity mitigation costs for the different Irrigation Scheme rehabilitation/modernisation options.

As the size and timing of these cashflows vary, standard cost/benefit project evaluation techniques have been used to place them on a comparable basis. The Net Present Values (NPVs) of the benefits and costs over 80 years are calculated and compared.

NPVs are obtained by discounting cashflows to take account of when they occur. Discounting recognises that money spent or received early in a project's life has a greater value than money received or spent later, and reduces future benefit and cost streams to their NPV. For the purposes of this study, a 6% real discount rate has been used, reflecting the rate of return the Water Authority uses in evaluating its capital works projects.

To compare the options, the NPV for the Base Case is subtracted from the NPV of the option being evaluated to get the additional benefit obtained by adopting the rehabilitation option. If this is greater than zero, then the rehabilitation case is economic; if it is less than zero then it is not. In comparing alternative rehabilitation options, the larger the additional benefit, the more economically attractive the option.

FINANCIAL IMPACT

The financial analysis is a related, but separate, evaluation to the economic assessment. The purpose is to provide an indication of the cost of each option to the Water Authority and irrigation users.

The capital components of each option were calculated using a 'renewals accounting' approach. The main difference between conventional accounting and renewals accounting is that instead of accounting for the cost of an asset over its expected life through an annual depreciation charge, renewals accounting brings the full cost of asset replacement to account in the year in which it occurs. Renewals accounting then accounts for the past investment in assets through a rate of return on the full initial cost of the assets.

The objective of this approach is to avoid the uncertainty involved in estimating asset lives and replacement values for annual depreciation. It works well for an industry in a 'steady state' where maintenance and replacement are fairly consistent from year to year. Renewals accounting is used in a number of privatised water companies, particularly in the United Kingdom.

The objective of using a renewal based approach for the Study, however, was to calculate the cost of continuing to operate the irrigation districts under each of the options examined rather than to calculate the full cost of providing the Irrigation Service, including the past capital expenditure. For the Study, the return on existing assets has been set to zero, effectively writing-off past investment. With a zero rate of return, only future expenditure is taken into account and therefore provides the cost of continuing to operate the Service.

Projected replacement expenditure for the South-West Irrigation Area will vary considerably from year to year. To avoid the need for large fluctuations in prices, the renewal accounting approach was modified by projecting the expenditure required for the next 80 years and discounting it back to a NPV. The prices were then calculated to ensure future revenue recovered costs with constant real prices.

The results from this approach do not give the full cost of providing the Service as the cost of interest and depreciation on past investment are ignored. The conventional financial accounts that include operating expenses, depreciation and interest provide the total cost which must be funded, and the Water Authority must recover this amount either from the irrigators, through cross-subsidy from other customers or through government grants. The renewals accounting approach provides the minimum cost to be recovered to make it financially worthwhile continuing to operate the Irrigation Services.

Water costs for each option can be divided into operating costs, capital costs for the irrigation distribution system and capital costs for the headworks. Eighty five percent of the cost for the headworks (dams) has been considered in calculating the required irrigation water price. The remaining 15% has been allocated to other beneficiaries - recreational use of the reservoirs and the Harvey town water supply drawn from the Harvey Reservoir.

The financial evaluation of the impact of the adoption of the different options on the Water Authority and irrigation farmers is designed to identify the cost to the Water Authority of the various options compared to expected revenue and the likely cost to irrigators.

The financial impact on the State, irrigation farmers and the Water Authority is reported in four ways:

- an annual net deficit between revenue required and expected revenue (at 1989/90 water prices);
- water charges necessary to meet full cost recovery for the irrigation service on a 'beneficiaries pay' principle;
- the additional financial benefit to a farmer over dryland farming after taking into account the full cost of water; and
- profit and loss statements for the Water Authority's Irrigation Service for a zero and 4% rate of return on assets.

The methodology for calculating the financial results is described in more detail in the Phase 2 Technical Report.

ENVIRONMENTAL IMPACT

The options were examined for their impact on groundwater salinity levels and nutrient discharge. The impact of different salinity mitigation strategies also feeds back into the measurement of economic and financial benefits through its impact on pasture productivity.

The impact on nutrient discharge is largely external to the measurement of economic and

financial benefits. In general, the environmental impact of all the options and scenarios examined (other than the continuation of the current area and pricing regime) would result in improvements to salinity mitigation and nutrient discharge.

Improved on-farm management is expected to reduce nutrient export from the area. However, target reductions of 50% in the nutrient discharge to the Peel-Harvey Catchment have been established and will be difficult to achieve.

The degree of improved management necessary to achieve this target for the different options is compared.

SOCIAL IMPACT

The main social impact identified during the consultative workshops at the commencement of Phase 2 of the Study was the potential reduction in the number of people in the Irrigation Shires if the Irrigation Area decreased in size or was to close down.

The social impact of the different options was examined by estimating the number of farming enterprises likely to be operating in 30 years time under each option, and by implication the numbers of households and people on farms in the Irrigation Area.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

The economic and financial analysis results of selected options are summarised in this Section of the Report to illustrate the impact of the different factors which were used to develop the options evaluated in Phase 2.

A full set of results for all the options evaluated is contained in Attachment 1 to this report.

WATER DEMAND SCENARIOS

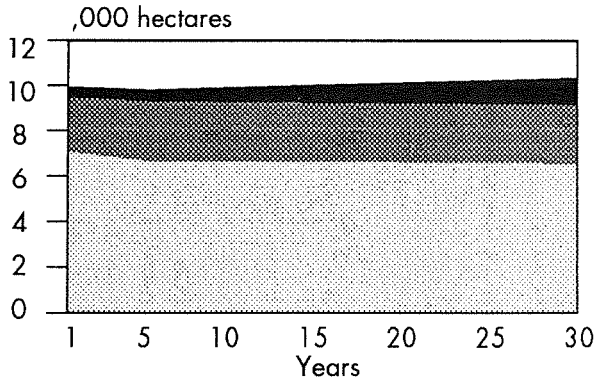
Two scenarios were calculated for the demand for water. These are shown in Figure 7 below and represent the expected demand for irrigation water in the South-West Irrigation Area over the next 30 years. The top line in each graph represents the cumulative demand from the component demands for water by the horticulture, dairy and the other grazing industries.

Even under the high water demand scenario, the demand for irrigation water is not expected to go much above current demand levels and could be easily catered for by the existing Irrigation Service.

Under low water demand conditions the demand for water for dairying would fall by more than 50 per cent over 30 years due to improved productivity and a shift of dairying out of the Irrigation Area. The demand for water for non-dairy grazing activities would also fall by 50 per cent. The demand for water for horticulture would rise but not at the same rate as for the high market demand scenario.

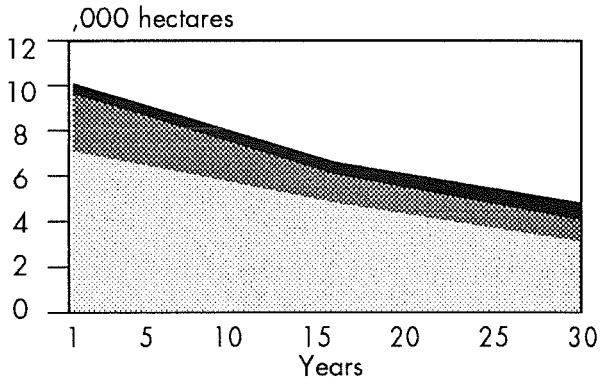
Table 4 shows the area of permanent irrigation expected to be required in 30 years time under the different scenarios.

High Water Demand Scenario



- Optimistic market demand
- Water prices do not increase in real terms (increase at or below inflation rate)

Low Water Demand Scenario



- Pessimistic market demand
- Water prices rise to meet full cost recovery

■ Horticulture ▩ Other Grazing ▩ Dairy

NOTES: Assumes minimum maintenance strategy is followed by the Water Authority for maintaining the Scheme.

Figure 7 *Area of Permanent Irrigation Land Required*

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

Table 4 *Expected Demand for Permanent Irrigation Land by Year 30*

(hectares)

Water Demand	Current	High	Low Market Effect plus impact of price doubling	Low Market Effect plus impact of price trebling
Horticulture	374	1,250	750	750
Dairy	7,210	6,866	3,280	2,668
Other Grazing	2,548	2,548	1,274	713
TOTAL	10,132	10,664	5,305	4,131

The economic and financial impact of the two different demand scenarios is shown in the table below for the existing area of irrigation, current on-farm irrigation practices, the minimum maintenance of the Irrigation Scheme and for the current charging policy.

Whilst the low demand scenario generates lower economic benefits and an increased annual deficit, the impact is not large. This is because the area dropped from irrigation first is the least productive land.

Table 5 *Economic and Financial Impact of High & Low Water Demand for the Existing Area*

(Area Option A, Strategy 1 - minimum scheme maintenance, current on-farm irrigation practices and current water charging policy)

Water Demand	High	Low
• Net Economic Benefits ($m)	6.8	6.4
• Economic Benefit relative to Closedown ($m)	-40.0	-40.4
• Annual Net Deficit ($m)	1.5	1.6
• Increase in Charges in Year 11 required to meet deficit	NA	2.1

NOTES: The Net Economic Benefit and the Economic Benefit relative to Closedown are expressed in terms of the net present values in millions of dollars from the operation of the Service over the next 80 years.

Annual Net Deficit - This is the equivalent annual loss of adopting this option under the water charges applicable in 1989/90.

The increase in charges is the required multiple of the 1989/90 water charges to meet the annual net deficit.

Year 11 is selected to illustrate the real increase in charges in the full year, following a gradual increase in the water charges to full cost-recovery levels. An increase in charges is not applicable (NA) for high demand scenarios as by definition this scenario assumes water charges will not increase in real terms.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

WATER CHARGING POLICIES

The options were evaluated under two alternative water charging policies:

Current

- assumes the continuation of the current policy of a fixed rate area charge and a volumetric charge for water used

TWE

- this approach assumes a TWE market is operating and that water is charged per megalitre.

The result of adopting these two water charging policies is shown in Table 6 for the total South-West Irrigation Area. With a TWE market operating, water can be transferred to higher economic uses. There are two components to the resulting increased economic benefit. Firstly, agricultural benefits from irrigation should increase as irrigation moves from lower to higher productive enterprises and areas. Secondly, if water is sold out of the irrigation sector, to the domestic and industrial sector, increased benefits would accrue to the State from reductions in future water source development costs.

The financial impact of the two charging policies is also shown in Table 6. The cost per megalitre of water sold is lower when a TWE market is operating. This is because, although there are higher fixed costs per unit of water sold to maintain the distribution system, the headworks costs attributable to the irrigation service are reduced. That is, if water entitlement is sold out of the irrigation sector then a corresponding proportion of headworks costs is no longer charged to the remaining irrigators. The net effect is a small reduction in irrigation costs per megalitre.

Also shown are the increases in charges which would be necessary to attain full cost recovery relative to the charges in the base year of 1989/90.

Increases of 2.5 to 2.6 times the 1989/90 average volumetric charge ($24.30 per megalitre) would be required. If the current fixed rate component and volumetric components of charging were maintained each component would have to increase by a factor of 2.1. Under this approach the smaller water users would pay a higher percentage of the overall costs.

With a TWE marketing operating a fixed component and variable charge based on volume used could be established but has not been analysed here. Further discussion of the effect of the water charging policies with or without a TWE market operating is included in the Phase 2 Technical Report.

Table 6 ***Economic and Financial Impact of Water Charging Policies Under the Current and TWE Market Approach***

(Area Option A, Low Demand Scenario, Strategy 1 - minimum scheme maintenance and current on-farm irrigation practices)

	Current	With TWE Market
• Net Economic Benefits ($m)	6.3	38.4
• Economic Benefit relative to Closedown ($m)	-40.4	-8.4
• Average water price required to cover full costs ($ per megalitre)	64.3	59.7
• Increase in charges in Year 11		
- volumetric charge only	2.6	2.5
- rates and volumetric charge	2.1	NA

NOTES: The Net Economic Benefit and the Economic Benefit relative to Closedown are expressed in terms of the net present values in millions of dollars from the operation of the Service over the next 80 years.

Annual Net Deficit - This is the equivalent annual loss of adopting this option under the water charges applicable in 1989/90.

The increase in charges is the required multiple of the 1989/90 water charges to meet the annual net deficit.

Year 11 is selected to illustrate the real increase in charges in the full year, following a gradual increase in the water charges to full cost-recovery levels. An increase in charges is not applicable (NA) for high demand scenarios as by definition this scenario assumes water charges will not increase in real terms.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

DIFFERENT ON-FARM IRRIGATION AND SCHEME ENGINEERING STRATEGIES

Three different on-farm and Scheme engineering strategies were evaluated.

Table 7 shows the impact of adopting the three rehabilitation strategy options for the current Irrigation Area under current and TWE market water charging policies. This shows that the economic benefits would be generally maximised by adopting Strategy 2 which is characterised by 'improved' on-farm irrigation practices with a minimum maintenance approach to the rehabilitation/ modernisation of the Irrigation Scheme.

Table 7 *Economic and Financial Impact of Different On-farm Irrigation Practices and Scheme Engineering Strategies for the South-West Irrigation Area*

(Low Demand Scenario and Area A)

Strategy	1		2		3	
On Farm practices	Current practices		Improved practices		Best practices, improved drainage	
Engineering Scheme	Minimum Maintenance		Minimum Maintenance		Fully piped Scheme	
Rating Policy	Current	With TWE Market	Current	With TWE Market	Current	With TWE Market
• Net Economic Benefits ($m)	6.3	38.4	19.0	43.1	–31.0	17.9
• Economic Benefit Relative to Closedown ($m)	–40.4	–8.4	–27.8	–3.6	–77.7	–28.8
• Annual Net Deficit ($m)	1.6	1.7	1.6	1.7	5.1	3.7
• Average Price per megalitre required to recover full cost ($ per megalitre)	64.3	59.7	67.3	62.7	179.3	130.1

NOTES: The Net Economic Benefit and the Economic Benefit relative to Closedown are expressed in terms of the net present values in millions of dollars from the operation of the Service over the next 80 years.

Annual Net Deficit - This is the equivalent annual loss of adopting this option under the water charges applicable in 1989/90.

The increase in charges is the required multiple of the 1989/90 water charges to meet the annual net deficit.

Year 11 is selected to illustrate the real increase in charges in the full year, following a gradual increase in the water charges to full cost-recovery levels. An increase in charges is not applicable (NA) for high demand scenarios as by definition this scenario assumes water charges will not increase in real terms.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

THE AREA OF LAND IRRIGATED

Table 8 shows the economic and financial impact of the reduction in the size of the South-West Irrigation Area.

As the area of land irrigated is reduced, dropping off the lowest productivity land first, the net economic benefit increases and the price increase to meet full costs declines.

Table 8 *Impact of Reduction in the Irrigation Area Serviced*

(Low demand, Strategy 2 - improved on-farm practices and minimum scheme maintenance, and with a TWE market operating)

Area Option	A	B	C	D	E	H	P
• Net Economic Benefits ($m)	43.1	44.4	46.6	50.5	55.0	60.9	60.9
• Economic Benefit relative to Closedown ($m)	-3.6	-2.3	-0.1	3.8	8.2	14.2	14.2
• Water Charges in Year 11 required to meet full costs ($ per megalitre)	62.7	59.7	56.3	52.9	51.0	40.4	31.0
• Increase in Charges in Year 11 required to meet full costs (Volume charge only)	2.6	2.4	2.3.	2.2	2.1	1.7	1.2

The results vary from district to district. Table 9 below shows the difference in economic and financial impact between the districts as the area irrigated is reduced. The differences are largely due to the different amounts of capital required to rehabilitate the Scheme and the amount of land of different productivity class within each Irrigation District.

Table 9 *Impact of Reduction in Irrigation Area Serviced - Comparison of Results for Different Districts*

(Low demand, Strategy 2 - improved on-farm practices and minimum scheme maintenance, and with a TWE market operating)

Area Option	A	B	C	D	E	H	P
• Net Economic Benefits ($m)							
- Waroona	6.0	6.1	6.1	9.8	10.0	10.8	6.4
- Harvey	15.4	16.0	17.3	17.0	21.3	29.7	34.1
- Collie	21.7	22.3	23.2	23.7	23.7	20.4	20.4
Total	43.1	44.4	46.6	50.5	55.0	60.9	60.9
• Economic Benefit relative to Closedown ($m)							
- Waroona	-0.4	-0.4	-0.3	3.4	3.5	4.4	0.0
- Harvey	-4.5	-3.9	-2.6	-2.9	1.4	9.8	14.2
- Collie	1.3	1.9	2.8	3.3	3.3	0.0	0.0
Total	-3.6	-2.3	-0.1	3.8	8.2	14.2	14.2
• Increase in Charges in Year 11 required to meet full costs							
- Waroona	3.6	3.5	3.5	3.4	3.4	3.4	1.0
- Harvey	2.9	2.7	2.6	2.6	2.4	1.7	1.2
- Collie	1.9	1.8	1.6	1.5	1.5	1.0	1.0
Total	2.6	2.4	2.3	2.2	2.1	1.7	1.2

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

THE ADDITIONAL BENEFIT TO THE FARM FROM IRRIGATION

The objective of this measure is to show the additional financial benefit to an average irrigation enterprise over a dryland enterprise under the different Phase 2 options evaluated. This measure assumes irrigation farmers are required to pay full cost recovery rates for water.

A positive result indicates irrigation of the average farm pays. A negative result implies that it would not pay the average farm to irrigate if it was required to pay full cost recovery rates.

Four sets of results were provided for each low demand option. High demand options were not analysed because these automatically assume the current price paid for water in real terms would continue and so, by definition, all existing irrigation would continue to be profitable.

The four situations for which results were calculated for each low demand option are:

- Irrigation farm returns compared to dryland farm returns if all farms in the area ceased irrigation (this regional dryland situation incorporates expected improvements in pasture productivity of 25 per cent for marginal land and 50 per cent for salt affected land).
- Irrigation farm returns compared to dryland returns for the marginal farm (this assumes only the farm in question reverts to dryland production and there are no regional improvements in pasture productivity for marginal and salt affected land).

and each of the above for two time periods:

- 80 years - assumes the continued operation of the farm as an irrigation farm, and
- 15 years - enables the relative return from continuing with irrigation for 15 years prior to phase out of irrigation activities on the farm to be estimated.

On high productivity land, irrigated dairying would be more profitable than dryland dairying even with existing on-farm irrigation practices (Strategy 1) and full cost recovery pricing of irrigation water. On medium productivity land, the adoption of improved on-farm practices (Strategy 2) would be necessary to ensure higher returns from irrigated dairy enterprises compared to dryland enterprises.

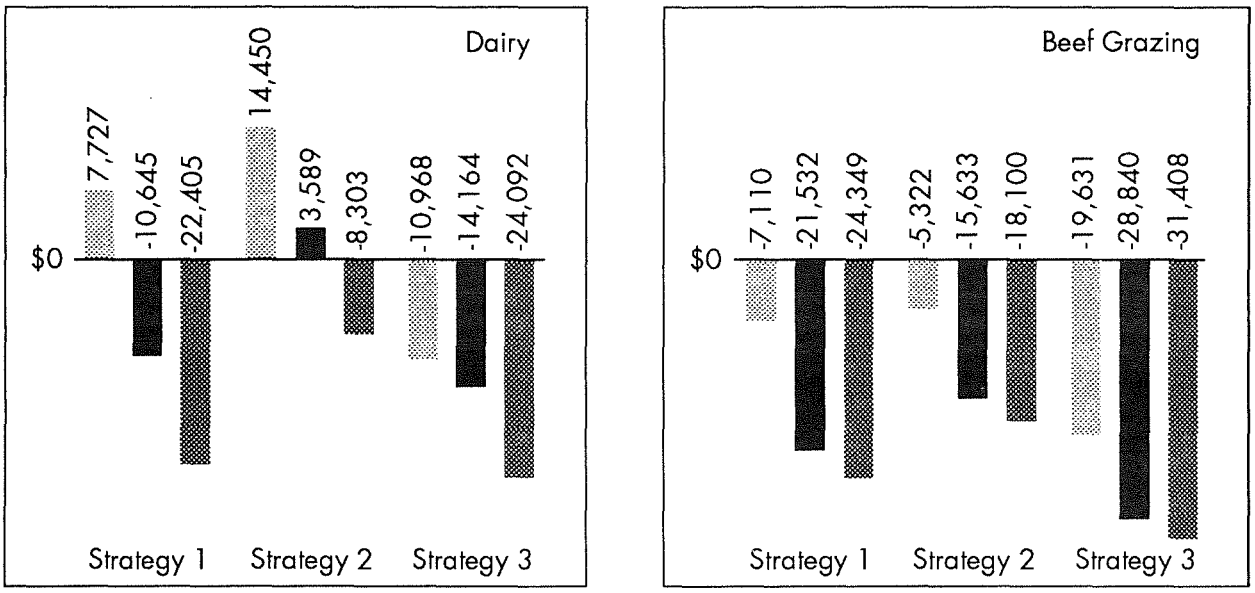
The adoption of Strategy 3 would not be profitable for dairy farms, compared to dryland dairy farming at a regional level. However, if the majority of the area continued to be irrigated, it would still be more profitable for the individual to irrigate high and medium productivity land under Strategy 3 than produce from a dryland farm.

The use of irrigation for grazing enterprises would be less profitable than dryland farming under all three strategies. This implies that if full cost recovery for irrigation water is introduced, most non-dairy grazing enterprises would cease to purchase water. The exception would be some commercial enterprises which were extremely proficient at capturing seasonal livestock premiums or specialty horse properties and part-time or hobby farms with an interest in having green pasture feed all year round.

Horticulture would continue to be profitable under a full cost recovery water pricing policy.

The on-farm profitability from applying different on-farm and scheme engineering strategies for dairy and beef grazing enterprises are shown in Figure 8 below. The results illustrated are for annual average profitability of irrigation farms compared to dryland farms taken over 80 years and based on the whole of the district either remaining irrigated or reverting to dryland production. Full results for all options are shown in Attachment 1.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS



NOTE: Results illustrated above are for comparing situations where the whole region either remains irrigated or goes dryland.

Figure 8 *Average Additional Returns from Irrigation*

Comparison between irrigated dairy & beef grazing farms and total dryland farms (Additional net return after meeting cost of water and averaged over 80 years)

WATER AUTHORITY PROFIT AND LOSS STATEMENTS

The objective of this measure is to present the implications of different pricing policies on the Water Authority's financial statements for operating the South-West Irrigation Service. In the example below, values are quoted for a 4% and 0% rate of return on assets for selected options in the Collie District. Values are quoted for years 5, 10, 20 and 30. The Profit and Loss Statements include the following:

- Revenue

Less

- Operating Costs
- Depreciation
- Asset Write Off
- % return on Assets

Leaves

- Profit (Loss)

The financial Profit and Loss statements shown in Table 10 indicate that for Collie, the most economically viable district, even with the price increases identified (Low Water demand cases), the Water Authority would not be able to achieve a 4% return on its irrigation assets. However, following the ten years of price increases in the low demand cases a zero return on assets can be achieved.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

Table 10 *Annual Water Authority Profit and Loss Statements for the Collie Irrigation District*

(Values are either the bottom line profit [positive] or loss [negative] and are in units of $millions)

4% Return on Assets

Area Option and Strategy Demand Scenario Water Charging Policy	A1 High Current	Al Low TWE	A3 High Current	A3 Low TWE	D1 High Current	D1 Low TWE	D3 High Current	D3 Low TWE
Year 5	-1.9	-1.7	-1.9	-1.0	-1.9	-1.8	-1.9	-1.4
Year 10	-1.8	-1.6	-1.8	-0.7	-1.9	-1.7	-1.8	-1.7
Year 20	-1.3	-1.0	-3.3	-2.2	-0.9	-0.7	-1.9	-1.4
Year 30	-1.3	-1.0	-3.0	-1.9	-0.9	-0.7	-1.7	-1.2
Price increase by Year 11	1.0	1.9	1.0	4.1	1.0	1.7	1.0	2.8

0% Return on Assets

Area Option and Strategy Demand Scenario Water Charging Policy	A1 High Current	Al Low TWE	A3 High Current	A3 Low TWE	D1 High Current	D1 Low TWE	D3 High Current	D3 Low TWE
Year 5	-0.5	-0.2	-0.6	-0.2	-0.6	-0.2	-0.6	-0.2
Year 10	-0.5	-0.3	-0.6	-0.3	-0.7	-0.2	-0.7	-0.2
Year 20	-0.3	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1
Year 30	-0.3	0.0	-0.2	0.0	-0.2	0.1	-0.2	0.1
Price increase by Year 11	1.0	1.9	1.0	1.8	1.0	1.7	1.0	1.4

EXTENDING THE IRRIGATION SERVICES

During the Phase 2 workshops the question was asked whether it would be profitable to extend the Irrigation Service to the Myalup Sands to the West of the main Irrigation Area and the foothills of the Darling Scarp (East of the South West Highway).

Two sub-options were developed to evaluate these ideas. These sub-options were subjected to the same economic cost/benefit analysis as the main options.

Myalup Sands

The Myalup sub-option involves pumping water from the Main Harvey Drain to an area of approximately 600 hectares on the Myalup Sands, west of Harvey. This requires the release of extra quantities of water down the drain to ensure a sufficient supply for pumping through a piped scheme servicing fifteen 40 hectare blocks. In total, 502 hectares of usable land were estimated as available for permanent irrigation (net of roads, infrastructure, set backs). The value of the net agricultural benefits for horticulture, dairying and other non-dairy grazing activities were calculated.

The costs of supplying water to 15 supply points was then calculated.

THE ECONOMIC AND FINANCIAL ANALYSIS RESULTS

The Foothills

The pumping of water from existing irrigation channels into farm storage dams on foothills properties with suitable soils adjacent to the channels was also examined. This sub-option requires pumping of water every 7 days into the storage dam and then gravity fed irrigation of the additional permanent irrigated area.

Summary of Results

The cost/benefit analysis shows that the development of these two sub-options would be profitable for horticulture but not for dairying or other grazing enterprises.

Both these sub-options would require the movement of water allocations from existing users. The most efficient way for this to happen would be through a Transferable Water Entitlement (TWE) system.

The development of these areas for horticulture would have a positive net economic benefit, even after taking into account full cost recovery and an additional charge of 5% return on capital for new irrigation schemes (as recommended by the Industries Commission in their draft report on Water Resources and Waste Water Disposal in March 1992). The further investigation of these sub-options on a case by case basis is therefore warranted.

ENVIRONMENTAL IMPACT RESULTS

NUTRIENT DISCHARGE

The shallow, poorly flushed estuaries and wetlands of the South-West of Western Australia are very susceptible to major algal blooms when their streamflow input is enriched by nutrients. The process of nutrient enrichment (eutrophication) has become a major problem in most of the western and southern coastal estuaries where vegetation on sandy coastal soils has been cleared for agricultural development.

The worst affected is the Peel-Harvey Estuary. However, real concerns also exist for the Leschenault Estuary.

All of the Waroona District and 50% of the Harvey District drain to the Peel-Harvey Estuary. All of the Collie District and 35% of the Harvey District drain into the Leschenault Estuary. Consequently nutrient discharge from the irrigation districts is a major environmental factor to be considered in the future of the Irrigation Service.

Investigations into the cause of eutrophication of the Peel-Harvey Estuary commenced over 15 years ago. The final outcome has been the adoption of a major Government restoration program to significantly reduce the frequency of algal blooms in the estuary.

The program has two components. The first is the construction of the Dawesville Channel, a new channel between the ocean and the estuary to promote increased flushing of nutrients from the estuary, each tidal cycle. The second is a catchment management program to reduce nutrient discharge from the coastal plain catchment to the estuary by 50%. Both components are necessary if algal blooms in the estuary are to be controlled.

Investigations into the sources of nutrients, commenced in the late 1970s and early 1980s showed that phosphorus was the limiting nutrient for algal growth.

Major improvements in the management of irrigated lands are required if the reduction of 50% in the nutrient load to the Peel-Harvey catchment is to be achieved.

Phase 2 of the Study included an analysis of the future phosphorus discharge from the Irrigation Area under the different options proposed for the future of the Scheme.

The key conclusions from this analysis were:

- A trend towards conversion of irrigated agriculture to dryland grazing will reduce nutrient inputs to the Peel-Harvey and Leschenault Estuaries from the South-West Irrigation Area.
- Given a low demand for irrigation land, and no other nutrient control measures, then nutrient loads from the current Irrigation Area are likely to reduce to at least 72% of current levels (options A1 Low to C1 Low).
- A major effort to improve nutrient management, particularly of dairy effluent, has commenced in recent years. In fifteen years time, significant reductions in nutrient export from irrigated and dryland farms are likely. In fact improvements will be necessary if the target of 50% reduction in nutrient export from the Irrigation Area draining the Peel-Harvey catchment is to be achieved. The degree of improved management necessary is a function of the area that is irrigated.
- If there is a high water demand, then a 90% reduction in nutrient discharge from farm dairies and associated holding areas, and a 15% reduction of nutrient discharge from farm grazing paddocks, would be required to achieve the overall 50% reduction in nutrient export.
- If there is a low water demand, then a 65% reduction in nutrient discharge from farm dairies and associated holdings areas would be required to achieve the overall 50% reduction in nutrient export. If improved watering practices and other nutrient controls are introduced which reduce nutrient discharge from paddocks by 15%, then discharge only needs to be reduced by 50% to achieve the overall 50% reduction in nutrient export.

- Option E restricts irrigation to the Dardanup Loams in the Peel-Harvey Catchment, and would therefore require about a 30 to 40% reduction in nutrient discharge from farm dairies and associated holding areas to achieve the overall 50% reduction in nutrient export. If improved watering practices and other nutrient controls are introduced, then dairy discharge would only need to be reduced by 15 to 20% to achieve the overall nutrient reduction.
- The extension of Mangosteen Drain (Option D in Harvey) would reduce nutrient loads to the Peel-Harvey Estuary by over 50% and maintain about 65% of the original area of the Harvey District.
- Option H and P could achieve a 50% reduction in overall nutrient export without additional nutrient management.

SALINITY

The Phase 1 report highlighted the significance of a salinity mitigation strategy to the long-term future of the Irrigation Area. In the Phase 1 preliminary analysis, a comprehensive salinity mitigation strategy was costed at over $51 million.

The Phase 1 economic analysis indicated that, if such a program was required to maintain current pasture productivity levels, then the Irrigation Scheme would be uneconomic. The need for a much more detailed investigation of the salinity issue in Phase 2 was clearly highlighted.

Mackie Martin & Associates were engaged to integrate the collective hydrological knowledge of the area and the effect of irrigation on regional groundwater flow systems. Estimates were made of groundwater recharge from both upslope (the Darling Scarp) and within the Irrigation Area and model runs carried out to evaluate the regional impact of different salinity strategies. The drain spacing necessary to achieve a 1.5 metre reduction in regional water tables was also studied using drainage theory and outputs from the model.

This work showed that the control of upslope recharge from the Irrigation Area would have only a small effect on the groundwater levels in the critical western and central regions of the Irrigation Area. Spending large sums of money to reduce recharge from either channel leakage or upslope cleared areas would therefore not be very cost effective.

However, there is scope for lowering water tables by improving irrigation watering practices. A 50% reduction in groundwater recharge throughout the region could lower regional water tables at the end of summer by about 0.3 of a metre.

The phasing out of irrigation in the low productivity portion of the current irrigation districts (mainly in the salinity prone Western edge of the current Irrigation Area) could reduce regional water tables in that area by 0.6 to 0.7 metres. The impact of recharge control is effectively limited to the region over which the control occurs.

The results suggest that the Harvey Irrigation Area is close to equilibrium with respect to salt inputs and outputs. Only gradual increases in salinities are expected in the Collie District over the next thirty years.

The overall picture is that pasture productivity is already affected by high saline groundwaters in the western portions of the Irrigation Area, but that the situation will not deteriorate greatly, particularly in the Harvey District.

The model developed by Mackie Martin was also used to simulate the regional impact of different drainage strategies. They concluded that water tables could be lowered to a minimum depth of 1.2 metres with 2 metre deep drains spaced at between 50 and 100 metres.

However, following review by the Technical Working Group, it was decided that the hydraulic conductivity appropriate for regional scale modelling was not appropriate for the local shallow drain scale spacing design. The adopted design specification for inclusion in Strategy 3 is for sub-surface drains at 2.3 metre depths every 15 metres.

IMPROVED ON-FARM WATER AND PASTURE MANAGEMENT

Phase 1 of the study highlighted the scope to improve pasture productivity by adopting better surface water management and pasture management practices.

Many farmers are implementing more frequent watering, laser levelling and surface ripping/mole draining to improve their pasture productivity.

These approaches have three main benefits. Firstly they minimise water logging and promote pasture growth. Secondly they promote uniform watering and enable better control of drainage overflow. Thirdly they minimise recharge to the underlying groundwater.

To evaluate the benefits and costs of these practices the Technical Working Group developed a set of on-farm 'improved' practices measures to form the basis of Strategy 2 including:

- whole farm planning;
- bay length and slope forming, head ditch and tail drain reforming; and
- surface ripping/mole drainage to existing surface drainage.

The concept of the Strategy 2 option is to develop a suite of practices, that would be practical and affordable to the farmer and would improve overall productivity. They would not completely eliminate reduced productivity from high water tables but should be cost effective.

The Strategy 3 case represents the 'Rolls Royce' approach to salinity mitigation. It includes full piping of the distribution system, a comprehensive program of water table control in the western and central portions of the districts and the adoption of 'best' on-farm practices for surface water and pasture management throughout the area. As noted earlier, piping of the irrigation distribution systems, particularly the main supply channels, will have limited benefit for salinity control. However, the water saved could be used for other purposes. Piping also reduces operating costs substantially and its evaluation was specifically requested by the farming community.

The intoduction of Stratgey 2 would reduce the area of salt affected land, particularly in the Central and Western regions. Average perennial irrigation pasture productivity is expected to increase between 30 and 35% in these regions. However, all salt affected land would not be eliminated.

In the Collie District, the expected productivity improvements should offset any gradual decline in productivity due to increased groundwater salinity generated from salt accumulation.

The comprehensive program of groundwater control under Strategy 3 should have a major impact on the amount of salt affected pastures throughout the area. Irrigated pasture productivity improvements are expected to exceed 100% in the Central and Western regions if Strategy 3 was adopted.

All irrigation development and groundwater control strategies are expensive to the farmer. They are nonetheless financially attractive in all cases if water prices do not increase further. The financial benefits of Strategies 2 and 3 are discussed on page 29 for different farm enterprises. The Strategy 2 on-farm practices are very effective in improving productivity, and therefore important in assisting farmers to meet any increases in water costs. However, the practicalities and appropriateness of adopting Stratgey 3 and constructing expensive drainage (at 15 metres spacings to depths of 2 to 2.5 metres) in low productivity areas (generally the Western salt affected area) must be questioned until there is very clear evidence that the productivity gains estimated can, in fact, be obtained.

The adoption of Strategies 2 and 3 also assumes significant on-farm productivity gains would be possible. These need to be thoroughly researched and further refined before the most appropriate forms of on-farm redevelopment can be formulated.

It would be timely if this work could proceed over the next 5 years prior to any major changes to the Irrigation Scheme infrastructure.

DECLINE IN FARMING ACTIVITIES IN THE AREA

The main social impact resulting from the adoption of options with reduced demand for irrigation water is expected to be a decline in the number of farm businesses and density of irrigated farms. The number of irrigation farm households and hence farm population will fall. However, most irrigation farm enterprises will be replaced by dryland farm enterprises albeit with larger average areas and hence fewer people.

The impact of the different options on the number of commercial farm businesses, other than for the Close Down option or the 'P' option (closing down the Irrigation Scheme with the exception of the Harvey No. 1 Piped Scheme), is likely to be small - resulting in at most a 12 per cent decline in the number of commercial farm enterprises in the Irrigation Area over the next 30 years. The Close Down option would mean a reduction of nearly one third in the number of commercial farms in the Irrigation Area. The retention of the Harvey No. 1 Area Piped Scheme (Option P) would result in a decline of 25 per cent in the number of commercial farms.

The expected number of commercial farms in the Irrigation Area in 30 years time is shown in Figure 9 for the high and low water demand scenarios.

It is more difficult to predict what will happen to the number of part-time and hobby farm operators in the Irrigation Area. It is likely that the number of these (139 in 1989/90) will continue to increase as the population of the region increases, whether or not the Irrigation Area shrinks in size.

Any drop in resident farm population due to the decline in commercial farm enterprises is expected to be more than offset by increases in population flowing on from increased retirement settlement and increased resource processing industrial activity in the Perth to Bunbury strip resulting in more employment options in the region.

The population in the three irrigation shires of Waroona, Harvey and Dardanup grew by 42 per cent over the last decade to 1991. During the same period the area irrigated has fallen by 18 per cent.

Whilst the nature of the population mix may well change (in terms of occupation and age), the region is expected to undergo further population growth regardless of which irrigation strategy option is adopted.

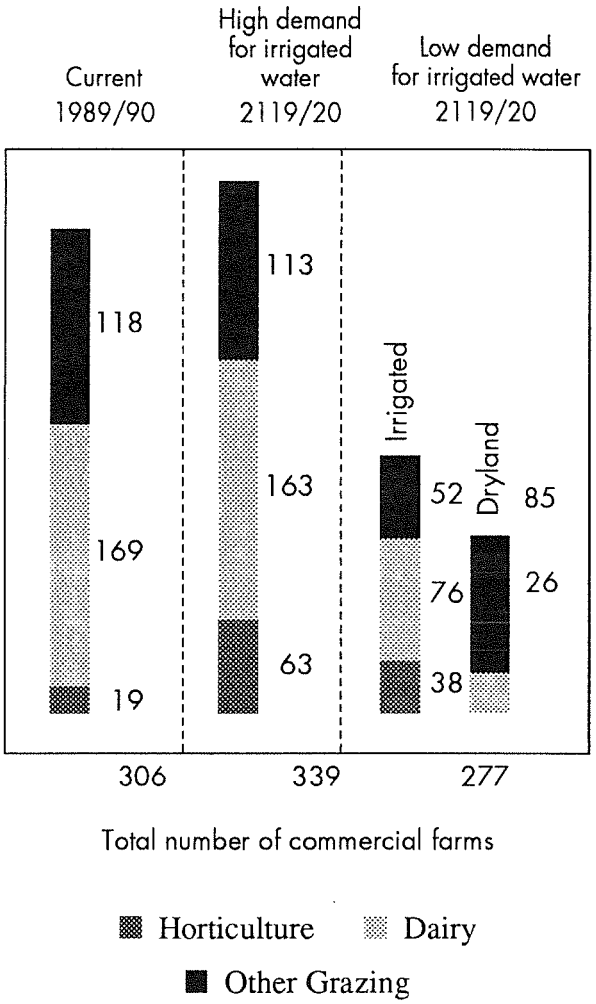


Figure 9 ***Expected Change in the Number of Commercial Irrigation Farms Over the Next 30 Years.***

SOCIAL IMPACT RESULTS

During Phase 1 of the Study a number of people expressed a concern about urban encroachment and industrial development in the Irrigation Area.

Whilst it was not a major concern (it ranked seventh in a survey of concerns of irrigators during the Phase 1 survey) farmers are fearful that farming will be 'over run' by other industry. Whilst farmers are divided in their opinion on whether increasing population due to urban development or industry is a problem, the commonly expressed concerns are:

- downgrading of the agricultural importance of the area;
- possible loss of jobs;
- wasting of highly productive agricultural land; and
- the loss of tourist and aesthetic value of green fields in summer.

The Consultative Committee concluded that the major social changes in the Irrigation Area will continue to be due to factors other than the Irrigation Strategy adopted. Planners should be mindful of the concerns expressed by farmers and in particular about the impact of urban and industrial encroachment onto high productivity land.

THE IMPACT ON INDIVIDUAL FARMERS

All options, other than maintaining the current Scheme and Irrigation Area, imply varying degrees of change for irrigators. Options that have a financial effect on farm businesses produce a social impact on individual farm households. The low demand options will therefore affect every farm household to some degree, while the high demand options only affect those outside the selected area boundaries for the future operation of the Irrigation Service.

There may be significant disruptions to households from decisions to cease irrigation activities and revert to dryland production. In some cases the financial assessment of the outcome of the strategy may lead to the decision to relocate to another district or leave farming altogether.

The Consultative Committee recognises that there will be a considerable social impact on the individual farm family from the adoption of different options. The strategy used to implement any option can significantly reduce the social impact of any necessary adjustments. If, for example, a full cost recovery approach is adopted the final strategy could provide for long lead times to enable individuals to plan their futures and to make adjustments to minimise the impact on their business, families and themselves.

FUTURE MANAGEMENT OF THE IRRIGATION SERVICE

During the consultative workshops conducted in Phase 1 and 2 of the Study, irrigators questioned the Water Authority's efficiency in running the Scheme and clearly stated their wish to have a greater input into the future management of the scheme. This was particularly the case if they were to be asked to pay a higher contribution to the total costs of irrigation water.

To provide background for further discussion of management options, Kinhill Engineers were commissioned to:

- review recent trends in irrigation management in Australia;
- review Water Authority irrigation management and cost efficiencies since 1985;
- compare Water Authority costs with other private and public irrigation schemes in Australia; and
- propose alternative management arrangements for further discussion and evaluation in Phase 3 and Phase 4 of the Study.

CURRENT MANAGEMENT AND TRENDS IN MANAGEMENT OF IRRIGATION SERVICES

The main findings from the Kinhill review are summarised below.

- With the exception of Queensland, there is an Australia wide move for greater farmer involvement in irrigation management and/or greater financial responsibility for the operation and maintenance of the distribution systems.
- Comparisons of costs of self management of individual districts with costs of continued Government or Water Authority management indicate that costs would not necessarily be lower.
- Pressures are on government water agencies providing irrigation services to improve their financial performance. Major changes are being introduced in Victoria by the Rural Water Commission of Victoria. By July 1993 it is proposed there will be six regional irrigation corporations. Each should be managed by a separate board and operate as a discrete business - setting prices, determining levels of services, operating their own irrigation scheme including relevant headworks, and taking initiatives to control costs.

Kinhill also reviewed the Water Authority's management and financial performance and compared it with other public and private irrigation agencies. The following conclusions were drawn:

- The Water Authority's direct operational and maintenance costs have dropped $400,000 in real terms over the 4 years between 1985/86 and 1989/90. This represents a decrease of 20% or a 5% improvement in efficiency per annum. The combined salary and administrative costs have declined $18,000 or 0.8% over the same period.
- Further improvements in efficiency have been implemented through centralising the management of the Irrigation Service at the Harvey office. Additional efficiencies of between 10 to 15% have been proposed. However, these savings would be accompanied by some reductions in the levels of service provided.
- Comparison of performance indicators between irrigation agencies in Australia proved inconclusive. The Water Authority compared well on some measures and poorly on others. Large differences in the characteristics of irrigation systems make such comparisons fraught with difficulty.
- Regardless of the management structure proposed, the large number of

dams, the high gradients on channels and the long length of drainage channels are cost burdens that are unavoidable in the South-West Irrigation Area.

- The integration of an irrigation service with drainage of non-irrigated land, town water supply and sewerage means that the share of regional overheads assigned to the Irrigation Service is lower than it would otherwise be.

- Water Authority salary staff and administration overheads do not appear to be in excess of those that would be incurred if the operation were being managed by a private board.

- However, scope exists to improve the allocation of salaries between the different irrigation regions in the State with the development of regional profit and loss statements.

ALTERNATIVE MANAGEMENT OPTIONS

While the Kinhill review was relatively favourable to the current management performance by the Water Authority, many farmers have a different perception. At the July/ August 1990 workshops, many expressed strong views in favour of private Water Boards running the Irrigation Service.

A brief summary of the three main alternative management options is provided here.

Private Irrigation Boards

A private Irrigation Board would be fully responsible for:

- the operation, maintenance and long-term refurbishment of all channels and associated structures and drains in the irrigation districts;

- the financial viability of the enterprise (including paying for bulk water and drainage costs); and

- satisfying environmental responsibility associated with the irrigation service.

The Water Authority would continue to operate and maintain dams and raise charges to the irrigation board for water delivered to the irrigation district boundary. If averaged over the three districts, bulk water charges would be between 18% (E2 - Water charging with a TWE Market) and 31% (A2 Current Water Charging Policy) of current charges depending on what portion of the reservoir yields were taken and which Irrigation Strategy Option was adopted.

The Water Authority would also remain responsible for operating and maintaining the non-irrigated land drainage outside the irrigation districts.

The adoption of a user pays principle would imply that the Water Authority should also charge the irrigation board for conveying the winter drainage flows from the irrigation districts to the estuaries, and for the cost of the additional maintenance of drains that convey irrigation water in summer.

Increased User Input through a Management Board with Farmer Majority

This option involves the creation of a management board consisting mainly of irrigation farmers with power to make recommendations or take decisions on standards of service, maintenance and capital expenditure, and water charges. The recommendations/ decisions would have to conform with cost recovery guidelines established by Government. The Water Authority would continue to provide the staff and run the irrigation districts as at present.

This approach is a significant extension of the current Advisory Committee role. It would allow farmers a say in the formulation of capital expenditure programs of their district, the level of maintenance carried out and the service provided. This is not on a day-to-day basis but rather through considerable input into developing the district's annual operation and financial plan each year.

This approach would allow farmers to gain an appreciation of the physical and financial factors involved in running an irrigation district and would put them in a better position to judge the future merits of privatising all or part of the operation at some later date. At the same time this option maintains the expertise of the Water Authority and its technical backup.

Maintaining Current Water Authority Management

Under this option, management by the Water Authority would be much the same as at present with the Advisory Committee having a role in water distribution policy but not in other management issues. In recent years there has been a move to involve the Advisory Committee in scheme maintenance and other policy issues. However, decision making power remains with the Water Authority.

FACTORS TO CONSIDER IN DEVELOPING THE FUTURE IRRIGATION STRATEGY

This report has discussed options for the future operation and rehabilitation/modernisation of the South-West Irrigation Service.

The Governement will establish a vision or long-term goal for the Irrigation Service from a review of these options and their economic, financial, social and environmental impacts. A strategy for achieving that goal then needs to be developed, reviewed by the Environmental Protection Authority and Stakeholders and finally adopted by Government.

Any group, individual or organisation with an interest in the South-West Irrigation Service is encouraged to use this Phase 2 Report as background information to prepare a submission which:

- establishes a vision or long-term goal for the Irrigation Service in terms of:
  - the area to be serviced
  - the approach to water pricing
  - the management of the Service;
- discusses the reasons for the establishment of this goal; and
- proposes a strategy for achieving that goal and addresses the economic, financial, social and environmental effects of the proposed strategy.

In preparing your strategy for achieving your vision or long-term goal you could consider:

- your preferred option for rehabilitating/modernising of the Irrigation Service;
- how to pay for the rehabilitation;
- how can irrigation costs be minimised;
- who should operate the Irrigation Service in the future;
- whether water charges should be based on the current mix of rates and volume charges;
- whether irrigation charges should be the same in all districts;
- whether a system of water entitlements should be introduced to enable the transfer of water to areas of high demand; and
- if established, what conditions should be set on a Transferable Water Entitlement market.

Any other comments and suggestions you may wish to make on the future of the South-West Irrigation Area would also be welcome.

SUBMISSIONS

Submissions are invited from any person, group or organisation who have an interest in the future operation of the South-West Irrigation Service.

Submissions and enquiries can be to:

Executive Officer
South-West Irrigation Review Taskforce
629 Newcastle Street
LEEDERVILLE WA 6007

The closing date for submissions is the 26 March, 1993.

FURTHER INFORMATION

Further details on the methodology used to evaluate the options can be found in the accompanying Phase 2 Technical Report. Copies of this report can be accessed: at offices of the Water Authority (Bunbury, Harvey and Perth); offices of the Department of Agriculture (Bunbury and Harvey); and Shire libraries at Harvey, Dardanup, Waroona; or through the Western Australian Farmers Federation.

In addition, the following supplementary papers were prepared as part of the technical research program during the Phase 2 analysis.

1. An Estimation of the Economic Benefits of Recreation Activities occurring at Waroona and Logue Brook Reservoirs. S. Lucas, Water Authority of Western Australia, May 1991.
2. The Dairy Industry in the South West Irrigation Area. J.Connell, Dairy Industry Authority, July 1991.
3. Groundwater Investigations for the Irrigation Strategy Study. Mackie Martin and Associates, June 1991.
4. Water and Salt Balances for an Irrigated Coastal Plain Catchment near Bunbury, Western Australia. C.G. Jeevaraj, Report No. WS81, Water Authority of Western Australia, April 1991.
5. Management Alternatives Study. Kinhill Engineers, June 1991.
6. Agricultural Gross Margins Used in Phase 2 Analysis. P. Eckersley, Department of Agriculture, June 1992.
7. Future Options for the Irrigation Service: Outcomes from Workshop Discussions. Irrigation Strategy Study, Water Authority of Western Australia, September 1990.
8. Options for Analysis in Phase 2, Background for November 28th Workshop, Technical Working Group, Irrigation Strategy Study, Water Authority of Western Australia, November 1990.

If you require your own copy of the Phase 2 Technical Report or any of the Supplementary Papers they can be mailed to you for $5 per copy.

Please send your cheque and request to:

Mr. Ian Loh
Water Resources Planning Branch
Water Authority of Western Australia
PO Box 100
LEEDERVILLE WA 6007

Make cheques payable to the

"*Water Authority of Western Australia*".

ATTACHMENT 1

SUMMARY OF THE COST BENEFIT ANALYSIS OF THE PHASE 2 OPTIONS

The tables in this attachment summarise the results of the economic and financial analyses conducted for the 45 options evaluated in Phase 2.

The tables show the results for the total South-West Irrigation Area and for each of the Waroona, Harvey and Collie Districts.

The following notes are designed to assist the reader to interpret the tables. The reader may find it useful to refer to the last page (fold out sheet) as a guide to the explanation of each option.

Each option is described by 4 factors.

e.g. A2L / TWE

- A — designates the Area to be irrigated (A, B, C, D, E, H, P or CD).
- 2 — designates the On-farm Irrigation Practice and Engineering Scheme Strategy for salinity mitigation (Strategies 1, 2 or 3).
- L — designates the water demand scenario, in this case the low demand scenario (High or Low).
- TWE — designates the applicable water charging policy adopted. In this case the introduction of TWEs and a volumetric charge per megalitre of water used (Current or TWE).

ECONOMIC ANALYSIS

Values in these tables are expressed in net present values (NPVs) and in:

- millions of dollars;
- 1989/90 dollar values terms;
- with a discount rate of 6 per cent; and
- measured over 80 years.

Agricultural Benefits

Net Agricultural Returns (NAR)

- This is the sum of the value of agricultural output from permanent irrigated land, early germinated annual pasture and dryland for the designated option less the variable costs (net of water costs) and overhead costs needed to obtain that output.
- The NAR represents the amount available to pay water costs, service farm capital costs and provide a return on capital invested.

Extra on-farm stock water costs due to reduction in the irrigation service

- Covers the cost of providing stock water to paddocks and to dairy sheds previously serviced from irrigation channels.

Net Agricultural Benefit

- Net agricultural return less extra on-farm costs of providing stock water.

Net Agricultural Benefit Relative to Close Down

- The net agricultural benefit of the option less the net agricultural benefit of the Close Down Option.

Water Costs

Headworks

- All costs associated with maintaining and rehabilitating of the dams and dam offtakes.

Operating Costs

- The operating costs of maintaining the dams.

Capital Costs

- The capital costs of dam upgrades and maintenance. This mainly involves works to ensure the ongoing safety of the dams.

ATTACHMENT 1

SUMMARY OF THE COST BENEFIT ANALYSIS OF THE PHASE 2 OPTIONS

Distribution Costs

- All costs associated with maintaining and rehabilitating of the channels and water control structures up to and including metering devices (Dethridge Wheels) onto farms.

Operating Costs

- The operating costs of providing the distribution service and maintaining the channels, waterway structures and additional drainage costs associated with irrigation.

Capital Costs

- The capital cost of replacement, rehabilitation and modernising of the distribution system including channels, drains, check structures and metering devices.

Close Down Costs

- Costs to the Water Authority if parts of the distribution system are closed down. These mainly include staff redundancy costs and costs associated with the removal of water control structures, bridges and the filling in of dangerous channels.

Opportunity Costs

Costs to Metro consumers

- this represents the additional costs to metropolitan consumers of not being able to use water from irrigation storages when it becomes the cheapest water to use for Perth, Mandurah and the Goldfields Water Supply Scheme.

  The opportunity cost falls as the area irrigated shrinks reflecting that the irrigation water that is no longer needed is freed up and available for metropolitan consumption.

Contribution of metro consumers to head - works

- this is an offset amount against the opportunity cost of water and represents the share of the headworks cost the metropolitan consumers would have to pay if water used for irrigation was to be made available for metropolitan consumption.

Net Benefit to the State

- The net agricultural benefits less water costs and less opportunity costs.

Net Benefit Relative to Close Down

- The net benefit to the State of the option less the net benefit to the State of the Close Down Option.

FINANCIAL ANALYSIS

Data in these tables, unless otherwise specified, are expressed in net present values at 6 per cent over 80 years and in millions of dollars at 1989/90 real values.

Expected Revenue

- Expected volume of water sales under the specified option multiplied by the charges in place for the 1989/90 season.

Required Revenue

- The revenue required to meet the full cost of water supply for the specified option. The required revenue includes all operating costs, the Government's required levy on Water Authority revenue, the full capital costs of maintaining and rehabilitation of the distribution system and 85 per cent of the capital cost of the headworks, (15 per cent is assumed as a cost to be met by recreation users and for the use of the headworks to supply some water supplies to a few small towns serviced from the dams).

ATTACHMENT 1

SUMMARY OF THE COST BENEFIT ANALYSIS OF THE PHASE 2 OPTIONS

Net Deficit

- The difference between the expected and the required revenue.

Net Deficit (Annual Equivalent)

- This is the equivalent annual amount of the NPV of the deficit expressed in thousands of dollars. This is the annual shortfall over costs recovered from irrigators which must be met by funding from some other source.

Water Costs

- The financial analyses assume that the prices will increase in ten equal annual steps from Year 1 to Year 10 such that by Year 11 the price structure as shown in this section will apply if the objective was to obtain full cost recovery.

Required Water Charge to Meet Actual Costs by Year 11

- These show the costs in dollars per megalitre of water sold in Year 11 under each option assuming a 100 per cent volume charge (i.e. no water rates). These are not shown for high water demand options. An average real charge of $24.30 per megalitre would apply in all high water demand options. For high water demand cases it is assumed that the current charge structure would remain and water prices would not increase by more than the rate of inflation.

  The costs per megalitre are also shown here for the current fixed rating approach to water charging to enable a comparison with the cost of the water charging approach considered with a TWE market operating.

Increase over 1989/90 Prices

- These figures represent multipliers that would need to be applied to 1989/90 prices by Year 11 to achieve full cost recovery for the specified options.

  The high demand options all show a multiplier of 1.0 reflecting that under this demand scenario the price of water is constrained to increase by no more than the rate of inflation.

Multipliers are provided for both the current water charging approach (fixed and volumetric charge components) and a volumetric charge only, associated with the introduction of a TWE Market.

THE ADDITIONAL BENEFIT TO THE FARMER FROM IRRIGATION

The objective of this measure is to show the additional benefit to the average enterprise of irrigation over dryland production under the different Phase 2 options evaluated. This measure assumes irrigators are required to pay full cost recovery rates.

A positive result indicates irrigation of the average farm pays. A negative result implies that it would not pay the average farm to irrigate if it was required to pay full cost recovery rates.

Four sets of results were provided for each low demand option. High demand options were not analysed because these automatically assume the current price paid for water would continue and so, by definition, all existing irrigation would continue.

The four situations for which results were provided for each low demand option were:

- Irrigation farm returns compared to dryland returns with all farms ceasing to irrigate (this regional dryland situation incorporates expected improvements in pasture productivity of 25 per cent for marginal land and 50 per cent for saline affected land).

SUMMARY OF THE COST BENEFIT ANALYSIS OF THE PHASE 2 OPTIONS

- Irrigation farm returns compared to dryland returns for the marginal farm (this assumes only the farm in question reverts to dryland production as there are no regional productivity improvements).

Then each of the above for two time periods:

- 80 years - assumes the continued operation of the farm as an irrigation farm, and
- 15 years - enables the relative return from continuing with irrigation for 15 years prior to phase out of irrigation activities on the farm to be estimated.

INCREMENTAL BENEFITS OF AN IRRIGATED DAIRY FARM OVER DRYLAND FARM OF SAME SIZE

(After paying full cost of water)

Option Description

Area / Water Charging Policy	A Current	A TWEs	B Current	B TWEs	C Current	C TWEs	D Current	D TWEs	E Current	E TWEs
1. IRRIGATED DAIRY FARM VERSUS DRYLAND FARM - TOTAL REGIONAL SHUTDOWN OF IRRIGATION Over 80 Years (Improved productivity of dryland: +25% for marginal and +50% for salinity affected dryland)										
Strategy 1										
High	7,727	4,258	8,595	5,125	9,462	6,860	10,330	7,727	10,330	8,595
Medium	-10,645	-14,114	-9,777	-13,247						
Low	-22,405	-25,874								
Strategy 2										
High	14,450	10,547	15,231	12,108	16,011	12,889	16,792	13,669	16,792	14,450
Medium	3,589	-314	4,370	1,247						
Low	-8,303	-12,206								
Strategy 3										
High	-10,968	-15,652	-3,942	-7,846						
Medium	-14,164	-18,848	-7,138	-11,042						
Low	-24,092	-28,776								
2. IRRIGATED DAIRY FARM VERSUS DRYLAND FARM - TOTAL REGIONAL SHUTDOWN OF IRRIGATION Over 15 Years (Improved productivity of dryland: +25% for marginal and +50% for salinity affected dryland)										
Strategy 1										
High	7,727	4,258	8,595	5,125	9,462	6,860	10,330	7,727	10,330	8,595
Medium	-10,645	-14,114	-9,777	-13,247						
Low	-22,405	-25,874								
Strategy 2										
High	14,326	10,423	15,107	11,984	15,887	12,765	16,668	13,545	16,668	14,326
Medium	3,465	-438	4,246	1,123						
Low	-8,427	-12,330								
Strategy 3										
High	-14,449	-19,133	-7,423	-11,327						
Medium	-17,644	-22,328	-10,618	-14,522						
Low	-27,572	-32,256								
3. IRRIGATED DAIRY FARM VERSUS DRYLAND FARM - THE MARGINAL FARM (i.e. Other farms in the area remain irrigated) Over 80 Years (No improved productivity of dryland)										
Strategy 1										
High	7,727	4,258	8,595	5,125	9,462	6,860	10,330	7,727	10,330	8,595
Medium	2,799	-670	3,667	197						
Low	2,232	-1,237								
Strategy 2										
High	14,450	10,547	15,231	12,108	16,011	12,889	16,792	13,669	16,792	14,450
Medium	17,033	13,130	17,814	14,691						
Low	16,334	12,431								
Strategy 3										
High	-10,968	-15,652	-3,942	-7,846						
Medium	-720	-5,404	6,306	2,402						
Low	545	-4,139								
4. IRRIGATED DAIRY FARM VERSUS DRYLAND FARM - THE MARGINAL FARM (i.e. Other farms in the area remain irrigated) Over 15 Years (No improved productivity of dryland)										
Strategy 1										
High	7,727	4,258	8,595	5,125	9,462	6,860	10,330	7,727	10,330	8,595
Medium	2,799	-670	3,667	197						
Low	2,232	-1,237								
Strategy 2										
High	14,326	10,423	15,107	11,984	15,887	12,765	16,668	13,545	16,668	14,326
Medium	16,909	13,006	17,690	14,567						
Low	16,210	12,307								
Strategy 3										
High	-14,449	-19,133	-7,423	-11,327						
Medium	-4,200	-8,884	2,826	-1,078						
Low	-2,935	-7,619								

KEY: Strategy - refers to the on-farm and Scheme salinity mitigation and engineering strategy adopted

: High, Medium and Low refers to the land productivity type

INCREMENTAL BENEFITS OF AN IRRIGATED BEEF FARM OVER DRYLAND FARM OF SAME SIZE

(After paying the full cost of water)

Option Description

Area / Water Charging Policy	A Current	A TWEs	B Current	B TWEs	C Current	C TWEs	D Current	D TWEs	E Current	E TWEs
1. IRRIGATED BEEF FARM VERSUS DRYLAND FARM - TOTAL REGIONAL SHUTDOWN OF IRRIGATION Over 80 Years (Improved productivity of dryland: +25% for marginal and +50% for salinity affected dryland)										
Strategy 1										
High	-7,110	-9,131	-6,605	-8,626	-6,100	-7,615	-5,594	-7,110	-5,594	-6,605
Medium	-21,532	-23,553	-21,027	-23,048						
Low	-24,349	-26,370								
Strategy 2										
High	-5,322	-7,596	-4,867	-6,686	-4,413	-6,232	-3,958	-5,777	-3,958	-5,322
Medium	-15,633	-17,907	-15,178	-16,997						
Low	-18,100	-20,374								
Strategy 3										
High	-19,631	-22,359	-15,538	-17,812						
Medium	-28,840	-31,568	-24,747	-27,021						
Low	-31,408	-34,136								
2. IRRIGATED BEEF FARM VERSUS DRYLAND FARM - TOTAL REGIONAL SHUTDOWN OF IRRIGATION Over 15 Years (Improved productivity of dryland: +25% for marginal and +50% for salinity affected dryland)										
Strategy 1										
High	-7,110	-9,131	-6,605	-8,626	-6,100	-7,615	-5,594	-7,110	-5,594	-6,605
Medium	-21,532	-23,553	-21,027	-23,048						
Low	-24,349	-26,370								
Strategy 2										
High	-5,394	-7,668	-4,939	-6,758	-4,485	-6,304	-4,030	-5,849	-4,030	-5,394
Medium	-15,705	-17,979	-15,250	-17,069						
Low	-18,173	-20,447								
Strategy 3										
High	-21,661	-24,389	-17,568	-19,842						
Medium	-30,870	-33,598	-26,777	-29,051						
Low	-33,438	-36,166								
3. IRRIGATED BEEF FARM VERSUS DRYLAND FARM - THE MARGINAL FARM (i.e. Other farms in the area remain irrigated) Over 80 Years (No improved productivity of dryland)										
Strategy 1										
High	-7,110	-9,131	-6,605	-8,626	-6,100	-7,615	-5,594	-7,110	-5,594	-6,605
Medium	-8,965	-10,986	-8,460	-10,481						
Low	-9,865	-11,886								
Strategy 2										
High	-5,322	-7,596	-4,867	-6,686	-4,413	-6,232	-3,958	-5,777	-3,958	-5,322
Medium	-3,066	-5,340	-2,611	-4,430						
Low	-3,616	-5,890								
Strategy 3										
High	-19,631	-22,359	-15,538	-17,812						
Medium	-16,273	-19,001	-12,180	-14,454						
Low	-16,924	-19,652								
4. IRRIGATED BEEF FARM VERSUS DRYLAND FARM - THE MARGINAL FARM (i.e. Other farms in the area remain irrigated) Over 15 Years (No improved productivity of dryland)										
Strategy 1										
High	-7,110	-9,131	-6,605	-8,626	-6,100	-7,615	-5,594	-7,110	-5,594	-6,605
Medium	-8,965	-10,986	-8,460	-10,481						
Low	-9,865	-11,886								
Strategy 2										
High	-5,394	-7,668	-4,939	-6,758	-4,485	-6,304	-4,030	-5,849	-4,030	-5,394
Medium	-3,138	-5,412	-2,683	-4,502						
Low	-3,689	-5,963								
Strategy 3										
High	-21,661	-24,389	-17,568	-19,842						
Medium	-18,303	-21,031	-14,210	-16,484						
Low	-18,954	-21,682								

KEY: Strategy - refers to the on-farm and Scheme salinity mitigation and engineering strategy adopted

: High, Medium and Low refers to the land productivity type

TOTAL COST BENEFIT

ECONOMIC ANALYSIS

(All units $million unless specified) SCENARIO / Water Charging Policy	A1 H Current	A2H Current	A3H Current	A1L Current	A1L TWE's	A2L Current	A2L TWE's	A3L Current	A3L TWE's	B1H Current	B2H Current	B3H Current	B1L Current	B1L TWE's	B2L Current	B2L TWE's	B3L Current	B3L TWE's	C1 H Current	C2H Current	C3H Current	C1L Current	C1L TWE's	C2L Current	C2L TWE's	C3L Current	C3L TWE's
NET AGRICULTURAL RETURNS	103.4	106.3	107.3	97.5	97.5	100.4	100.4	99.0	99.0	103.2	106.6	108.6	97.5	97.5	100.4	100.4	99.1	99.1	101.3	104.7	106.4	97.5	97.5	100.4	100.4	99.1	99.1
Extra on farm stock water costs due to reduction in irrigation service										0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
NET AGRICULTURAL BENEFIT	103.4	106.3	107.3	97.5	97.5	100.4	100.4	99.0	99.0	102.9	106.2	108.2	97.2	97.2	100	100	98.7	98.7	100.5	104	105.7	96.8	96.8	98.7	99.7	98.3	98.3
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	35.9	38.9	39.8	30.0	30.0	32.9	32.9	31.5	31.5	35.4	38.7	40.7	29.7	29.7	32.6	32.6	31.2	31.2	33.0	36.5	38.2	29.3	29.3	32.2	32.2	30.8	30.8
WATER COSTS																											
Headworks	1.0	1.0	1.0	0.7	0.4	1.0	0.4	1.0	0.6	0.9	0.9	0.9	0.9	0.4	0.9	0.4	0.9	0.5	0.8	0.8	0.8	0.8	0.3	0.8	0.3	0.8	0.5
Operating costs	10.5	10.5	10.7	10.5	6.5	10.5	6.5	10.7	4.8	9.1	9.1	9.3	9.1	6.5	9.1	6.5	9.3	4.7	8.1	8.1	8.2	8.1	6.5	8.1	6.5	8.2	4.7
Capital costs	11.5	11.5	11.7	11.1	6.9	11.5	6.9	11.7	5.3	10.1	10.1	10.2	10.1	6.9	10.1	6.9	10.2	5.2	8.9	8.9	9.0	8.9	6.9	8.9	6.9	9.0	5.2
Distribution																											
Operating costs	36.1	36.1	30.7	31.9	32.5	31.9	32.5	25.4	25.8	33.6	33.8	29.4	30.3	30.9	30.3	30.9	25.2	25.6	31.0	31.0	25.8	28.2	28.7	28.2	28.7	22.8	23.1
Capital costs	15.4	15.4	77.3	14.5	13.8	14.5	13.8	77.2	51.2	14.6	14.6	55.7	13.9	13.5	13.9	13.5	55.6	38.9	13.5	13.5	44.2	13.1	12.9	13.1	12.9	44.1	32.8
Total distribution costs	51.5	51.5	108.0	46.4	46.3	46.4	46.3	102.6	77.1	48.4	48.4	85.1	44.2	44.3	44.2	44.3	80.8	64.5	44.5	44.5	70.0	41.3	41.5	41.3	41.5	66.9	55.9
Close down costs										0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.57	0.57
TOTAL WATER COSTS	63.0	63.0	119.7	57.6	53.2	57.9	53.2	114.3	82.4	58.8	58.8	95.7	54.6	51.6	54.6	51.6	91.4	70.1	54.0	54.0	79.6	50.8	49.0	50.8	49.0	76.5	61.7
AG. BENEFITS LESS WATER COSTS	40.4	43.3	-12.4	39.9	44.3	42.5	47.2	-15.3	16.6	44.1	47.4	12.5	42.6	45.6	45.5	48.5	7.3	28.6	46.6	50.0	26.1	46.0	47.8	48.9	50.7	21.9	36.7
OPPORTUNITY COST (Includes $11.55m spillway cost)																											
Contribution of metro consumers to headworks	-11.6	-11.6	-11.6	-11.6	-7.2	-11.6	-7.2	-11.6	-5.0	-10.1	-10.1	-10.0	-10.2	-7.2	-10.2	-7.2	-10.1	-5.0	-8.9	-8.9	-8.8	-9.0	-7.2	-9.0	-7.2	-8.8	-5.0
Cost to metro consumers	45.2	35.1	27.2	45.2	13.2	35.1	11.3	27.2	3.7	30.3	25.3	20.5	30.3	13.2	25.6	11.3	20.5	3.7	24.1	20.3	16.4	24.1	13.2	20.3	11.3	16.4	3.7
TOTAL OPPORTUNITY COST	33.7	23.6	15.7	33.7	6.0	23.6	4.1	15.7	-1.3	20.2	15.2	10.5	20.2	6.0	15.5	4.1	10.5	-1.3	15.2	11.4	7.6	15.2	6.0	11.4	4.1	7.6	-1.3
NET BENEFIT TO THE STATE	6.8	19.8	-28.1	6.3	38.4	19.0	43.1	-31.0	17.9	23.9	32.2	2.1	22.4	39.6	30.0	44.4	-3.1	29.9	31.4	38.6	18.6	30.9	41.8	37.5	46.6	14.3	37.9
NET BENEFIT RELATIVE TO CLOSE DOWN	-40.0	-26.9	-74.8	-40.4	-8.4	-27.6	-3.6	-77.7	-28.8	-22.8	-14.5	-44.7	-24.3	-7.1	-16.7	-2.3	-49.8	-16.8	-15.4	-8.1	-28.2	-15.9	-4.9	-9.2	-0.1	-32.5	-8.8

SCENARIO / Water Charging Policy	D1 H Current	D2H Current	D3H Current	D1L Current	D1L TWE's	D2L Current	D2L TWE's	D3L Current	D3L TWE's	E1 H Current	E2H Current	E1L Current	E1L TWE's	E2L Current	E2L TWE's	H TWE's	P Current	Close down Current
AGRICULTURAL BENEFITS																		
NET AGRICULTURAL RETURNS	99.3	102.7	104.5	97.4	97.4	100.3	100.3	99.1	99.1	96.1	99.1	95.7	95.7	98.5	98.5	102.6	85.5	70.2
Extra on farm stock water costs due to reduction in irrigation service	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.33	1.33	1.33	1.33	1.33	1.33	2.06	2.41	2.69
NET AGRICULTURAL BENEFIT	98.4	101.7	103.6	96.4	96.4	99.3	99.3	98.2	98.2	94.7	97.8	94.3	94.3	97.2	97.2	100.5	83.1	67.5
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	30.9	34.2	36.1	28.9	28.9	31.8	31.8	30.7	30.7	27.2	30.3	26.8	26.8	29.7	29.7	33.0	15.6	
WATER COSTS																		
Headworks																		
Operating costs	0.8	0.8	0.8	0.8	0.3	0.8	0.3	0.8	0.5	0.7	0.7	0.7	0.3	0.7	0.3	0.3	0.5	0.5
Capital costs	5.5	5.5	5.6	5.5	4.7	5.5	4.7	5.6	4.2	4.2	4.2	4.2	4.1	4.2	4.1	6.7	1.6	
Total headworks	6.3	6.3	6.4	6.3	5.1	6.3	5.1	6.4	4.7	4.8	4.8	4.8	4.5	4.8	4.5	7.0	2.1	0.5
Distribution																		
Operating costs	29.0	29.0	24.2	27.0	27.4	27.0	27.3	21.8	22.1	27.2	27.2	25.5	25.9	25.5	25.8	19.0	17.8	17.1
Capital costs	13.9	13.9	35.9	13.7	13.5	13.7	13.5	36.1	28.6	11.8	11.8	11.6	11.6	11.6	11.6	8.9	2.1	1.9
Total distribution costs	42.8	42.8	60.1	40.6	40.8	40.6	40.8	57.9	50.7	39.0	39.0	37.1	37.4	37.1	37.4	27.9	19.9	19.0
Close down costs	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.79	0.79	0.79	0.79	0.79	0.79	1.14	1.29	1.37
TOTAL WATER COSTS	49.8	49.8	67.1	47.6	46.6	47.6	46.5	64.9	56.0	44.6	44.6	42.7	42.7	42.7	42.6	36.0	23.3	20.8
AG. BENEFITS LESS WATER COSTS	48.6	5.0	36.5	48.9	49.9	51.8	52.9	33.3	42.2	50.1	53.2	51.6	51.6	54.5	54.6	64.5	59.8	46.7
OPPORTUNITY COST (Includes $11.55m spillway cost)																		
Contribution of metro consumers to headworks	-6.2	-6.2	-6.0	-6.2	-5.2	-6.2	-5.2	-6.0	-4.4	-4.7	-4.7	-4.7	-4.5	-4.7	-4.5	-7.5	-1.8	
Cost to metro consumers	14.6	12.3	9.1	14.6	9.0	12.3	7.5	9.1	2.9	5.4	4.3	5.4	5.1	4.3	4.1	11.1	0.7	
TOTAL OPPORTUNITY COST	8.4	6.1	3.1	8.5	3.9	6.2	2.4	3.1	-1.5	0.8	-0.4	0.8	0.6	-0.4	-0.4	3.6	-1.1	
NET BENEFIT TO THE STATE	40.2	45.8	33.4	40.4	46.0	45.6	50.5	30.2	43.7	49.4	53.5	50.9	51.0	54.8	55.0	60.9	60.9	46.7
NET BENEFIT RELATIVE TO CLOSE DOWN	-6.6	-0.9	-13.3	-6.3	-0.7	-1.1	3.8	-16.5	-3.0	2.7	6.8	4.2	4.3	8.1	8.2	14.2	14.2	

NPV @ 6% over 60 years: Units $ million (1989/90); 15 June 1992

COLLIE COST BENEFIT

ECONOMIC ANALYSIS

(All units $million unless specified) SCENARIO / Water Charging Policy	A1 H Current	A2H Current	A3H Current	A1L Current	A1L TWE's	A2L Current	A2L TWE's	A3L Current	A3L TWE's	B1H Current	B2H Current	B3H Current	B1L Current	B1L TWE's	B2L Current	B2L TWE's	B3L Current	B3L TWE's	C1 H Current	C2H Current	C3H Current	C1L Current	C1L TWE's	C2L Current	C2L TWE's	C3L Current	C3L TWE's
NET AGRICULTURAL RETURNS	40.1	41.5	42.1	37.2	37.2	38.5	38.5	38.3	38.3	40.2	41.7	42.8	37.2	37.2	38.5	38.5	38.4	38.4	39.2	40.7	41.6	37.2	37.2	38.5	38.5	38.4	38.4
Extra on farm stock water costs due to reduction in irrigation service										0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
NET AGRICULTURAL BENEFIT	40.1	41.5	42.1	37.2	37.2	38.5	38.5	38.3	38.3	40.1	41.6	42.6	37.1	37.1	38.4	38.4	38.3	38.3	38.8	40.3	41.2	36.9	36.9	38.1	38.1	38.0	38.0
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	11.5	12.9	13.5	8.7	8.7	9.9	9.9	9.8	9.8	11.5	13	14.1	8.5	8.5	9.8	9.8	9.7	9.7	10.2	11.8	12.6	8.3	8.3	9.6	9.6	9.5	9.5
WATER COSTS																											
Headworks	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2
Operating costs	0.4	0.4	0.6	0.4	0.2	0.4	0.2	0.6	0.2	0.4	0.4	0.5	0.4	0.2	0.4	0.2	0.5	0.2	0.3	0.3	0.4	0.3	0.2	0.3	0.2	0.4	0.2
Capital costs	0.7	0.7	0.9	0.7	0.4	0.7	0.4	0.9	0.4	0.7	0.7	0.9	0.7	0.4	0.7	0.4	0.9	0.4	0.6	0.6	0.7	0.6	0.4	0.6	0.4	0.7	0.4
Distribution																											
Operating costs	13.7	13.7	11.0	12.1	12.3	12.1	12.3	9.5	9.6	12.9	12.9	10.3	11.4	11.6	11.4	11.6	8.9	9.0	11.5	11.5	9.6	10.4	10.6	10.4	10.6	8.5	8.6
Capital costs	4.8	4.8	30.0	4.4	4.4	4.4	4.4	29.9	20.0	4.6	4.6	22.9	4.2	4.3	4.2	4.3	22.8	15.9	4.2	4.2	16.6	4.0	4.0	4.0	4.0	16.5	12.5
Total distribution costs	18.5	18.5	41.0	16.5	16.6	16.5	16.6	39.4	29.6	17.5	17.5	33.1	15.6	15.8	15.6	15.8	31.6	24.9	15.7	15.7	26.2	14.4	14.6	14.4	14.6	25	21.1
Close down costs										0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
TOTAL WATER COSTS	19.2	19.2	41.9	17.2	17.0	17.2	17.0	40.3	30.0	18.3	18.3	34.1	16.4	16.3	16.4	16.3	32.6	25.4	16.5	16.5	27.1	15.2	15.1	15.2	15.1	25.9	21.7
AG. BENEFITS LESS WATER COSTS	20.9	22.3	0.2	20.0	20.2	21.3	21.5	-2.0	8.3	21.9	23.3	8.6	20.8	20.9	22.1	22.2	5.8	13.0	22.3	23.9	14.1	21.7	21.8	23	23.1	12.2	16.4
OPPORTUNITY COST (Includes $0.29m spillway cost)																											
Contribution of metro consumers to headworks	-0.29	-0.29	-0.29	-0.29	-0.18	-0.29	-0.18	-0.29	0.02	-0.29	-0.29	-0.25	-0.29	-0.18	-0.29	-0.18	-0.25	0.02	-0.29	-0.29	-0.16	-0.29	-0.18	-0.29	-0.18	-0.16	0.02
Cost to metro consumers																											
TOTAL OPPORTUNITY COST	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	0.0	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	0.0	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	-0.2	-0.2	0.0
NET BENEFIT TO THE STATE	21.2	22.5	0.5	20.3	20.4	21.6	21.7	-1.7	8.3	22.2	23.6	8.8	21.1	21.0	22.3	22.3	6.0	12.9	22.6	24.1	14.3	22.0	22.0	23.3	23.2	12.3	16.3
NET BENEFIT RELATIVE TO CLOSE DOWN	0.8	2.2	-19.9	-0.1	0.0	1.2	1.3	-22.1	-12.1	1.8	3.2	-11.6	0.7	0.7	1.9	1.9	-14.4	-7.5	2.2	3.8	-6.1	1.6	1.6	2.9	2.8	-6.1	-4.1

SCENARIO / Water Charging Policy	D1 H Current	D2H Current	D3H Current	D1L Current	D1L TWE's	D2L Current	D2L TWE's	D3L Current	D3L TWE's	E1 H Current	E2H Current	E1L Current	E1L TWE's	E2L Current	E2L TWE's	H TWE's	P Current	Close down Current
AGRICULTURAL BENEFITS																		
NET AGRICULTURAL RETURNS	39.2	40.7	41.6	38.1	38.1	39.4	39.4	38.7	38.7	39.2	40.7	38.1	38.1	39.4	39.4	29.9	29.9	29.9
Extra on farm stock water costs due to reduction in irrigation service	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	1.3	1.3	1.3
NET AGRICULTURAL BENEFIT	38.8	40.4	41.2	37.7	37.7	39.0	39.0	38.4	38.4	38.8	40.4	37.7	37.7	39.0	39.0	28.6	28.6	28.6
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	10.2	11.8	12.6	9.1	9.1	10.4	10.4	9.8	9.8	10.2	11.8	9.1	9.1	10.4	10.4			
WATER COSTS																		
Headworks																		
Operating costs	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.1	0.3	0.1	0.2	0.2	0.2
Capital costs	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.3	0.3	0.3	0.3			
Total headworks	0.6	0.6	0.7	0.6	0.4	0.6	0.4	0.7	0.4	0.6	0.6	0.6	0.4	0.6	0.4	0.2	0.2	0.2
Distribution																		
Operating costs	11.5	11.5	9.6	10.7	10.9	10.7	10.9	8.5	8.6	11.5	11.5	10.7	10.9	10.7	10.9	6.5	6.5	6.5
Capital costs	4.2	4.2	16.5	4.1	4.0	4.1	4.0	16.5	12.5	4.2	4.2	4.1	4.0	4.1	4.0	1.0	1.0	1.0
Total distribution costs	15.7	15.7	26.2	14.8	14.9	14.8	14.9	25	21.1	15.7	15.7	14.8	14.9	14.8	14.9	7.5	7.5	7.5
Close down costs	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.59	0.59	0.59
TOTAL WATER COSTS	16.5	16.5	27.1	15.6	15.5	15.6	15.5	25.9	21.7	16.5	16.5	15.6	15.5	15.6	15.5	8.2	8.2	8.2
AG. BENEFITS LESS WATER COSTS	22.3	23.9	14.1	22.1	22.2	23.4	23.5	12.5	16.7	22.3	23.9	22.1	22.2	23.4	23.5	20.4	20.4	20.4
OPPORTUNITY COST (Includes $0.29m spillway cost)																		
Contribution of metro consumers to headworks	-0.29	-0.29	-0.16	-0.29	-0.2	-0.29	-0.2	-0.16	0.02	-0.29	-0.29	-0.29	-0.2	-0.29	-0.2			
Cost to metro consumers																		
TOTAL OPPORTUNITY COST	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	-0.2	-0.2	0.0	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2			
NET BENEFIT TO THE STATE	22.6	24.2	14.3	22.4	22.4	23.7	23.7	12.6	16.7	22.6	24.2	22.4	22.4	23.7	23.7	20.4	20.4	20.4
NET BENEFIT RELATIVE TO CLOSE DOWN	2.2	3.8	-6.1	2.0	2.0	3.3	3.3	-7.8	-3.7	2.2	3.8	2.0	2.0	3.3	3.3			

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

HARVEY COST BENEFIT

ECONOMIC ANALYSIS

(All units $million unless specified) SCENARIO / Water Charging Policy	A1 H Current	A2H Current	A3H Current	A1L Current	A1L TWE's	A2L Current	A2L TWE's	A3L Current	A3L TWE's	B1H Current	B2H Current	B3H Current	B1L Current	B1L TWE's	B2L Current	B2L TWE's	B3L Current	B3L TWE's	C1 H Current	C2H Current	C3H Current	C1L Current	C1L TWE's	C2L Current	C2L TWE's	C3L Current	C3L TWE's
NET AGRICULTURAL RETURNS	45.3	46.7	46.9	42.7	42.7	44.0	44.0	43.2	43.2	45.1	46.7	47.4	42.7	42.7	44.0	44.0	43.3	43.3	44.4	46.1	46.7	42.7	42.7	44	44	43.3	43.3
Extra on farm stock water costs due to reduction in irrigation service										0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
NET AGRICULTURAL BENEFIT	45.3	46.7	46.9	42.7	42.7	44.0	44.0	43.2	43.2	44.9	46.5	47.2	42.5	42.5	43.8	43.8	43.1	43.1	44.1	45.7	46.4	42.4	42.4	43.7	43.7	43	43
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	15.4	16.8	17.0	12.8	12.8	14.1	14.1	13.3	13.3	15.0	16.6	17.3	12.6	12.6	13.9	13.9	13.2	13.2	14.2	15.8	16.5	12.5	12.5	13.8	13.8	13.1	13.1
WATER COSTS																											
Headworks	0.3	0.3	0.3		0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2
Operating costs	4.9	4.9	4.9	4.9	2.6	4.9	2.6	4.9	2.1	4.1	4.1	4.1	4.1	2.6	4.1	2.6	4.1	2.1	3.7	3.7	3.7	3.7	2.6	3.7	2.6	3.7	2.1
Capital costs	5.2	5.2	5.2	4.9	2.8	5.2	2.8	5.2	2.3	4.4	4.4	4.4	4.4	2.8	4.4	2.8	4.4	2.3	4	4	4	4	2.8	4	2.8	4	2.3
Distribution																											
Operating costs	18.7	18.7	13.9	16.7	16.9	16.7	16.9	12.2	12.3	17.3	17.3	14.7	15.8	16	15.8	16	13.1	13.2	16	16	12.6	14.7	14.9	14.7	14.9	11.3	11.4
Capital costs	7.5	7.5	35.2	7.1	6.7	7.1	6.7	35.2	23.1	7.0	7.0	23.3	6.7	6.5	6.7	6.5	23.3	16.4	6.6	6.6	19.5	6.4	6.2	6.4	6.2	19.5	14.3
Total distribution costs	26.1	26.1	49.0	23.7	23.5	23.7	23.5	47.3	35.4	24.3	24.3	38.0	22.5	22.4	22.5	22.4	36.4	29.6	22.6	22.6	32.1	21.1	21	21.1	21	30.8	25.7
Close down costs										0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.35	0.35
TOTAL WATER COSTS	31.3	31.3	54.2	28.6	26.3	28.9	26.3	52.5	37.7	29.0	29.0	42.7	27.2	25.5	27.2	25.5	41.1	32.2	26.9	26.9	36.4	25.4	24.1	25.4	24.1	35.2	28.4
AG. BENEFITS LESS WATER COSTS	14.0	15.4	-7.3	14.1	16.4	15.1	17.7	-9.3	5.5	15.9	17.5	4.5	15.3	17.0	16.6	18.3	1.9	10.8	17.2	18.8	10	16.9	18.2	18.3	19.6	7.8	14.6
OPPORTUNITY COST (Includes $5.33m spillway cost)																											
Contribution of metro consumers to headworks	-5.3	-5.3	-5.3	-5.3	-2.9	-5.3	-2.9	-5.3	-2.3	-4.5	-4.5	-4.5	-4.5	-2.9	-4.5	-2.9	-4.5	-2.3	-4.1	-4.1	-4.1	-4.1	-2.9	-4.1	-2.9	-4.1	-2.3
Cost to metro consumers	26.5	20.1	14.8	26.5	6.4	20.1	5.2	14.8	1.0	17.1	14.4	10.6	17.1	6.4	14.4	5.2	10.6	1.0	14	11.7	8.7	14	6.4	11.7	5.2	8.7	1
TOTAL OPPORTUNITY COST	21.2	14.8	9.5	21.2	3.5	14.8	2.3	9.5	-1.3	12.6	9.9	6.1	12.6	3.5	9.9	2.3	6.1	-1.3	9.9	7.6	4.6	9.9	3.5	7.6	2.3	4.6	-1.3
NET BENEFIT TO THE STATE	-7.1	0.6	-16.7	-7.1	12.9	0.4	15.4	-18.7	6.9	3.3	7.6	-1.6	2.7	13.5	6.7	16.0	-4.1	12.2	7.3	11.2	5.4	7.1	14.7	10.7	17.3	3.2	15.9
NET BENEFIT RELATIVE TO CLOSE DOWN	-27	-19.2	-36.6	-26.9	-7.0	-19.5	-4.5	-38.6	-13	-16.6	-12.3	-21.5	-17.2	-6.4	-13.1	-3.9	-24.0	-7.7	-12.6	-8.7	-14.5	-12.8	-5.2	-9.2	-2.6	-16.7	-4

SCENARIO / Water Charging Policy	D1 H Current	D2H Current	D3H Current	D1L Current	D1L TWE's	D2L Current	D2L TWE's	D3L Current	D3L TWE's	E1 H Current	E2H Current	E1L Current	E1L TWE's	E2L Current	E2L TWE's	H TWE's	P Current	Close down Current
AGRICULTURAL BENEFITS																		
NET AGRICULTURAL RETURNS	43.7	45.3	46.0	42.7	42.7	44.0	44.0	43.3	43.3	40.5	41.7	40.9	40.9	42.2	42.2	46.4	46.4	31.1
Extra on farm stock water costs due to reduction in irrigation service	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.79	0.79	0.79	0.79	0.79	0.79	0.6	0.9	1.18
NET AGRICULTURAL BENEFIT	43.3	44.9	45.6	42.3	42.3	43.6	43.6	42.9	42.9	39.7	40.9	40.1	40.1	41.4	41.4	47.6	45.5	29.9
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	13.4	15.0	15.7	12.4	12.4	13.7	13.7	13.0	13.0	9.8	11.0	10.2	10.2	11.5	11.5	17.9	15.6	
WATER COSTS																		
Headworks																		
Operating costs	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2
Capital costs	3.4	3.4	3.4	3.4	2.6	3.4	2.6	3.4	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.6	1.6	
Total headworks	3.7	3.7	3.7	3.7	2.8	3.7	2.8	3.7	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.7	1.8	0.2
Distribution																		
Operating costs	14.7	14.7	11.9	13.8	14.0	13.8	14.0	10.8	11.0	13.0	13.0	12.4	12.5	12.4	12.5	10.0	9.6	8.9
Capital costs	7.5	7.5	16.0	7.4	7.3	7.4	7.3	16.4	13.0	5.4	5.4	5.3	5.4	5.3	5.4	4.2	0.6	0.4
Total distribution costs	22.2	22.2	27.9	21.2	21.2	21.2	21.2	27.2	23.9	18.4	18.4	17.7	17.8	17.7	17.8	14.2	10.2	9.3
Close down costs	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.49	0.49	0.49	0.49	0.49	0.49	0.43	0.53	0.61
TOTAL WATER COSTS	26.3	26.3	32	25.3	24.4	25.3	24.4	31.3	26.6	21.1	21.1	20.4	20.5	20.4	20.5	17.3	12.5	10.0
AG. BENEFITS LESS WATER COSTS	17.0	18.6	13.6	17.0	17.9	18.4	19.3	11.6	16.3	18.6	19.8	19.8	19.7	21	20.9	30.5	33	19.9
OPPORTUNITY COST (Includes $5.33m spillway cost)																		
Contribution of metro consumers to headworks	-3.7	-3.7	-3.7	-3.7	-2.9	-3.7	-2.9	-3.7	-2.3	-2.2	-2.2	-2.2	-2.2	-2.2	-2.2	-2.9	-1.8	
Cost to metro consumers	11.4	9.6	7.0	11.4	6.4	9.6	5.2	7.0	1.0	2.7	2.0	2.7	2.6	2.0	1.9	3.7	0.7	
TOTAL OPPORTUNITY COST	7.7	5.9	3.3	7.7	3.5	5.9	2.3	3.3	-1.3	0.5	-0.2	0.5	0.4	-0.2	-0.3	0.9	-1.1	
NET BENEFIT TO THE STATE	9.4	12.8	10.4	9.3	14.4	12.5	17.0	8.3	17.6	18.1	20.1	19.3	19.3	21.3	21.3	29.7	34.1	19.9
NET BENEFIT RELATIVE TO CLOSE DOWN	-10.5	-7.1	-9.5	-10.6	-5.5	-7.4	-2.9	-11.6	-2.3	-1.8	0.2	-0.6	-0.6	1.4	1.4	9.8	14.2	

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

WAROONA COST BENEFIT

ECONOMIC ANALYSIS

(All units $million unless specified) SCENARIO / Water Charging Policy	A1 H Current	A2H Current	A3H Current	A1L Current	A1L TWE's	A2L Current	A2L TWE's	A3L Current	A3L TWE's	B1H Current	B2H Current	B3H Current	B1L Current	B1L TWE's	B2L Current	B2L TWE's	B3L Current	B3L TWE's	C1 H Current	C2H Current	C3H Current	C1L Current	C1L TWE's	C2L Current	C2L TWE's	C3L Current	C3L TWE's
NET AGRICULTURAL RETURNS	18.0	18.2	18.2	17.6	17.6	17.9	17.9	17.4	17.4	17.9	18.2	18.4	17.6	17.6	17.9	17.9	17.4	17.4	17.7	17.9	18.2	17.6	17.6	17.9	17.9	17.4	17.4
Extra on farm stock water costs due to reduction in irrigation service										0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
NET AGRICULTURAL BENEFIT	18.0	18.2	18.2	17.6	17.6	17.9	17.9	17.4	17.4	17.9	18.1	18.3	17.6	17.6	17.8	17.8	17.4	17.4	17.6	17.9	18.1	17.5	17.5	17.8	17.8	17.3	17.3
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	9.0	9.2	9.2	8.6	8.6	8.8	8.8	8.4	8.4	8.8	9.1	9.3	8.6	8.6	8.8	8.8	8.3	8.3	8.6	8.9	9.1	8.5	8.5	8.8	8.8	8.3	8.3
WATER COSTS																											
Headworks	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.3	0.1	0.3	0.1	0.3	0.2
Operating costs	5.2	5.2	5.2	5.2	3.7	5.2	3.7	5.2	2.4	4.7	4.7	4.7	4.7	3.7	4.7	3.7	4.7	2.4	4.0	4.0	4.0	4.0	3.7	4.0	3.7	4.0	2.4
Capital costs	5.6	5.6	5.6	5.6	3.8	5.6	3.8	5.6	2.6	5.0	5.0	5.0	5.0	3.7	5.0	3.7	5.0	2.5	4.3	4.3	4.3	4.3	3.7	4.3	3.7	4.3	2.5
Distribution																											
Operating costs	3.8	3.8	5.9	3.2	3.4	3.2	3.4	3.8	3.9	3.6	3.6	4.4	3.1	3.3	3.1	3.3	3.2	3.3	3.4	3.4	3.5	3.0	3.2	3.0	3.2	2.9	3.0
Capital costs	3.2	3.2	12.2	3.1	2.8	3.1	2.8	12.2	8.2	3.0	3.0	9.6	3.0	2.8	3.0	2.8	9.6	6.7	2.8	2.8	8.2	2.8	2.8	2.8	2.8	8.2	6.1
Total distribution costs	6.9	6.9	18	6.2	6.2	6.2	6.2	15.9	12.1	6.5	6.5	13.9	6.0	6.1	6.0	6.1	12.7	10.0	6.2	6.2	11.7	5.8	6.0	5.8	6.0	11.1	9.1
Close down costs										0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
TOTAL WATER COSTS	12.5	12.5	23.6	11.8	9.9	11.8	9.9	21.5	14.7	11.5	11.5	18.9	11.0	9.8	11.0	9.8	17.7	12.5	10.5	10.5	16.0	10.1	9.7	10.1	9.7	15.4	11.6
AG. BENEFITS LESS WATER COSTS	5.5	5.7	-5.4	5.8	7.7	6.1	8.0	-4.1	2.7	6.3	6.6	-0.6	6.5	7.7	6.8	8.0	-0.4	4.8	7.1	7.3	2.1	7.4	7.8	7.7	8.1	1.9	5.7
OPPORTUNITY COST (Includes $5.93m spillway cost)																											
Contribution of metro consumers to headworks	-5.9	-5.9	-5.9	-5.9	-4.2	-5.9	-4.2	-5.9	-2.7	-5.3	-5.3	-5.3	-5.3	-4.2	-5.3	-4.2	-5.3	-2.7	-4.5	-4.5	-4.6	-4.5	-4.2	-4.5	-4.2	-4.6	-2.7
Cost to metro consumers	18.7	15.0	12.4	18.7	6.8	15.0	6.1	12.4	2.7	13.2	10.9	9.9	13.2	6.8	11.2	6.1	9.9	2.7	10.1	8.6	7.7	10.1	6.8	8.6	6.1	7.7	2.7
TOTAL OPPORTUNITY COST	12.8	9.1	6.5	12.8	2.6	9.1	1.9	6.5		7.9	5.6	4.6	7.9	2.6	5.9	1.9	4.6	0.1	5.6	4.1	3.1	5.6	2.6	4.1	1.9	3.1	0.1
NET BENEFIT TO THE STATE	-7.3	-3.4	-11.9	-7.0	5.1	-3.0	6.0	-10.6	2.7	-1.5	1.0	-5.2	-1.3	5.1	0.9	6.1	-5.0	4.8	1.5	3.3	-1.1	1.8	5.2	3.6	6.1	-1.3	5.6
NET BENEFIT RELATIVE TO CLOSE DOWN	-13.7	-9.8	-18.3	-13.4	-1.4	-9.5	-0.4	-17	-3.7	-8.0	-5.4	-11.6	-7.8	-1.3	-5.5	-0.4	-11.4	-1.7	-5.0	-3.2	-7.5	-4.6	-1.3	-2.9	-0.3	-7.7	-0.8

SCENARIO / Water Charging Policy	D1 H Current	D2H Current	D3H Current	D1L Current	D1L TWE's	D2L Current	D2L TWE's	D3L Current	D3L TWE's	E1 H Current	E2H Current	E1L Current	E1L TWE's	E2L Current	E2L TWE's	H TWE's	P Current	Close down Current
AGRICULTURAL BENEFITS																		
NET AGRICULTURAL RETURNS	16.4	16.6	16.9	16.6	16.6	16.9	16.9	17.1	17.1	16.4	16.6	16.6	16.6	16.9	16.9	24.3	9.2	9.2
Extra on farm stock water costs due to reduction in irrigation service	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.21	0.21
NET AGRICULTURAL BENEFIT	16.2	16.5	16.8	16.5	16.5	16.7	16.7	17.0	17.0	16.2	16.5	16.5	16.5	16.8	16.8	24.1	9.0	9.0
NET AG. BENEFIT RELATIVE TO CLOSE DOWN	7.2	7.5	7.8	7.4	7.4	7.7	7.7	8.0	8.0	7.2	7.5	7.5	7.5	7.7	7.7	15.1		
WATER COSTS																		
Headworks																		
Operating costs	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2
Capital costs	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8	4.1		
Total headworks	2.0	2.0	2.0	2.0	1.9	2.0	1.9	2.0	2.0	2.0	2.0	2.0	1.9	2.0	1.9	4.2	0.2	0.2
Distribution																		
Operating costs	2.7	2.7	2.6	2.4	2.5	2.4	2.4	2.4	2.5	2.7	2.7	2.4	2.5	2.4	2.4	2.5	1.8	1.8
Capital costs	2.2	2.2	3.3	2.2	2.2	2.2	2.2	3.2	3.2	2.2	2.2	2.2	2.2	2.2	2.2	3.7	0.5	0.5
Total distribution costs	4.9	4.9	5.9	4.6	4.7	4.6	4.6	5.6	5.6	4.9	4.9	4.6	4.7	4.6	4.6	6.2	2.3	2.3
Close down costs	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.17	0.17
TOTAL WATER COSTS	7.0	7.0	8.0	6.7	6.7	6.7	6.6	7.7	7.7	7.0	7.0	6.7	6.7	6.7	6.6	10.5	2.6	2.6
AG. BENEFITS LESS WATER COSTS	9.2	9.5	8.8	9.7	9.7	10	10.1	9.3	9.3	9.2	9.5	9.8	9.8	10	10.1	13.6	6.4	6.4
OPPORTUNITY COST (Includes $5.93m spillway cost)																		
Contribution of metro consumers to headworks	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-4.6		
Cost to metro consumers	3.2	2.7	2.1	3.2	2.6	2.7	2.3	2.1	1.9	2.7	2.3	2.7	2.5	2.3	2.2	7.4		
TOTAL OPPORTUNITY COST	1.1	0.6	0.0	1.1	0.6	0.6	0.3	0.0	-0.2	0.6	0.2	0.6	0.5	0.2	0.2	2.8		
NET BENEFIT TO THE STATE	8.1	8.9	8.7	8.7	9.2	9.4	9.8	9.2	9.4	8.6	9.3	9.2	9.3	9.9	10.0	10.8	6.4	6.4
NET BENEFIT RELATIVE TO CLOSE DOWN	1.7	2.5	2.3	2.2	2.7	3.0	3.4	2.8	3.0	2.2	2.9	2.8	2.9	3.4	3.5	4.4		

NPV @ 6% over 60 years: Units $ million (1989/90): 15 June 1992

TOTAL COST BENEFIT

FINANCIAL ANALYSIS

(All units $million unless specified)	SCENARIO / Water Charging Policy	A1 H Current	A2H Current	A3H Current	A1L Current	A1L TWE's	A2L Current	A2L TWE's	A3L Current	A3L TWE's	B1H Current	B2H Current	B3H Current	B1L Current	B1L TWE's	B2L Current	B2L TWE's	B3L Current	B3L TWE's	C1 H Current	C2H Current	C3H Current	C1L Current	C1L TWE's	C2L Current	C2L TWE's	C3L Current	C3L TWE's
• EXPECTED REVENUE (at 1989/90 prices)		36.6	36.6	36.3	30.0	24.1	30.0	24.1	28.1	21.3	35.3	35.3	35.3	29.2	24.1	29.2	24.1	27.0	21.2	32.7	32.7	32.6	26.2	24.1	26.2	24.1	26.2	21.2
• REQUIRED REVENUE TO MEET WATER COSTS		61.1	61.1	117.8	56.1	52.1	56.1	52.1	112.4	81.6	56.8	56.8	93.7	52.7	50.1	52.7	50.1	69.5	68.9	52.0	52.0	77.5	48.9	47.3	48.9	47.3	74.4	60.2
(Operating costs + Distribution capital costs + 85% of head works capital costs)																												
"(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																												
• NET DEFICIT (NPV)		24.6	24.6	81.5	26.1	28.1	26.1	28.1	84.3	60.3	21.5	21.5	58.5	23.5	26.0	23.5	26.0	62.5	47.7	19.3	19.3	44.9	20.7	23.3	20.7	23.3	46.2	39.0
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	1488	1488	4938	1579	1700	1579	1700	5107	3651	1304	1304	3540	1421	1577	1421	1577	3783	2891	1171	1171	2718	1251	1409	1251	1409	2918	2365

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				11.8	7.1	11.8	7.1	15.6	7.1				10.3	7.1	10.3	7.1	13.3	6.8				9.1	7.1	9.1	7.1	11.7	6.7
Distribution	($ per megalitre)				52.5	52.6	55.5	55.6	163.7	123.1				49.4	49.8	52.4	52.7	123.4	98.9				46.0	46.5	46.8	49.2	100.2	83.7
TOTAL	($ per megalitre)				64.3	59.7	67.3	62.7	179.3	130.1				59.7	56.9	62.6	59.7	136.7	105.7				55.2	53.6	57.9	56.3	111.9	90.4
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	2.1		2.1		4.8		1.0	1.0	1.0	2.0		2.0		3.9		1.0	1.0	1.0	1.9		1.9		3.3	
• INCREASE OVER 1989/90 PRICE (Volume charge only)					2.6	2.5	2.8	2.6	7.4	5.4				2.5	2.4	2.6	2.4	5.6	4.4				2.3	2.2	2.4	2.3	4.6	3.7
NPV of FLOWS - Volume sold - megalitres																												

	SCENARIO / Water Charging Policy	D1 H Current	D2H Current	D3H Current	D1L Current	D1L TWE's	D2L Current	D2L TWE's	D3L Current	D3L TWE's	E1 H Current	E2H Current	E1L Current	E1L TWE's	E2L Current	E2L TWE's	H TWE's	P Current	Close down Current
• EXPECTED REVENUE (at 1989/90 prices)		30.5	30.5	30.5	27.7	24.1	27.7	24.1	25.4	21.1	27.3	27.3	25.8	22.9	25.8	22.9	21.9	19.0	16.9
• REQUIRED REVENUE TO MEET WATER COSTS		30.5	30.5	30.5	27.7	24.1	27.7	24.1	25.4	21.1	27.3	27.3	25.8	22.9	25.8	22.9	21.9	19.0	16.9
(Operating costs + Distribution capital costs +85% of head works capital costs)																			
"(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																			
• NET DEFICIT (NPV)		1849	1849	1850	1680	1459	1680	1459	1539	1278	1654	1654	1565	1387	1565	1387	1326	1153	1022
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000																		

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				6.4	5.2	6.4	5.2	8.1	6.0			5.2	4.8	5.2	4.8	8.4	3.1	
Distribution	($ per megalitre)				45.0	45.2	47.7	47.8	85.1	74.4			43.8	46.2	46.1	46.2	32.0	27.9	
TOTAL	($ per megalitre)				51.4	50.4	54.1	52.9	93.2	80.3			48.9	51.0	51.3	51.0	40.4	31.0	
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	1.8		1.8		2.9		1.0	1.0	1.8		1.8			1.2	1.0
• INCREASE OVER 1989/90 PRICE (Volume charge only)					2.1	2.1	2.2	2.2	3.8	3.3			2.0	2.0	2.1	2.1	1.7	1.3	
NPV of FLOWS - Volume sold - megalitres																			

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

COLLIE COST BENEFIT

FINANCIAL ANALYSIS

(All units $million unless specified)	SCENARIO	A1 H	A2H	A3H	A1L	A1L	A2L	A2L	A3L	A3L	B1H	B2H	B3H	B1L	B1L	B2L	B2L	B3L	B3L	C1 H	C2H	C3H	C1L	C1L	C2L	C2L	C3L	C3L
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's
• EXPECTED REVENUE (at 1989/90 prices)		15.2	15.2	15.2	12.1	9.4	12.1	9.4	11.5	8.6	14.9	14.9	14.9	11.9	9.4	11.9	9.4	11.2	8.6	13.5	13.5	13.5	11.3	9.4	11.3	9.4	10.7	8.6
• REQUIRED REVENUE TO MEET WATER COSTS		19.2	19.2	41.8	17.1	16.9	17.1	16.9	40.1	30.0	18.1	18.1	34	16.3	16.2	16.3	16.2	32.4	25.2	16.3	16.3	26.8	15.0	14.9	15.0	14.9	25.6	21.5
(Operating costs + Distribution capital costs + 85% of head works capital costs) "(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																												
• NET DEFICIT (NPV)		4.0	4.0	26.6	5.0	7.5	5.0	7.5	28.6	21.4	3.2	3.2	19.0	4.4	6.7	4.4	6.7	21.2	16.6	2.8	2.8	13.3	3.7	5.5	3.7	5.5	14.9	12.9
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	241	241	1614	302	454	302	454	1732	1293	192	192	1151	267	408	267	408	1286	1008	168	168	807	224	331	224	331	904	778

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				1.9	1.0	1.9	1.0	3.0	1.4				1.8	0.9	1.8	0.9	2.6	1.3				1.5	0.9	1.5	0.9	2.2	1.3
Distribution	($ per megalitre)				42.0	44.7	44.1	44.7	145.6	109.6				39.6	40.1	41.6	42.0	111.8	88.4				36.4	36.8	38.2	38.6	86.0	72.5
TOTAL	($ per megalitre)				43.9	45.7	46.0	45.7	148.5	111.0				41.4	41.0	43.4	42.9	114.5	89.6				37.9	37.8	39.6	39.6	88.2	73.7
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	1.5		1.5		4.1		1.0	1.0	1.0	1.4		1.4		3.3		1.0	1.0	1.0	1.4		1.4		2.7	
• INCREASE OVER 1989/90 PRICE (Volume charge only)					1.8	1.8	1.9	1.9	6.1	4.6				1.7	1.7	1.8	1.8	4.7	3.7				1.6	1.6	1.6	1.6	3.6	3.0
NPV of FLOWS - Volume sold - megalitres		637.0	637.0	600.6	434.0	414.0	434.0	414.0	374.9	375.0	637.9	637.9	601.4	434.0	414.0	434.0	414.0	375.5	376.0	580.3	580.3	548.8	434.0	414.0	434.0	414.0	375.5	376.0

	SCENARIO	D1 H	D2H	D3H	D1L	D1L	D2L	D2L	D3L	D3L	E1 H	E2H	E1L	E1L	E2L	E2L	H	P	Close down
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	TWE's	Current	TWE's	TWE's	Current	Current
• EXPECTED REVENUE (at 1989/90 prices)		13.5	13.5	13.5	12.1	10.4	12.1	10.4	10.7	8.6	13.5	13.5	12.1	10.4	12.1	10.4	6.9	6.9	6.9
• REQUIRED REVENUE TO MEET WATER COSTS		16.3	16.3	26.8	15.3	15.3	15.3	15.3	25.6	21.5	16.3	16.3	15.3	15.3	15.3	15.3	7.6	7.6	7.6
(Operating costs + Distribution capital costs +85% of head works capital costs) "(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																			
• NET DEFICIT (NPV)		2.8	2.8	13.3	3.2	4.9	3.2	4.9	14.9	12.9	2.8	2.8	3.2	4.9	3.2	4.9	0.7	0.7	0.7
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	169	169	807	193	294	193	294	904	778	169	169	193	294	193	294	44	44	44

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				1.4	0.8	1.4	0.8	2.2	1.3			1.4	0.8	1.4	0.8			
Distribution	($ per megalitre)				33.5	33.8	35.4	35.5	86.0	72.5			33.6	33.8	35.4	35.5			
TOTAL	($ per megalitre)				34.9	34.6	36.7	36.4	88.2	73.7			34.9	34.6	36.7	36.4			
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	1.3		1.3		2.7		1.0	1.0	1.3		1.3		1.0	1.0	1.0
• INCREASE OVER 1989/90 PRICE (Volume charge only)					1.4	1.4	1.5	1.5	3.6	3.0			1.4	1.4	1.5	1.5			
NPV of FLOWS - Volume sold - megalitres		580.2	580.2	548.8	483.5	460.0	483.5	460.0	375.5	376.0	580.2	580.2	483.5	460.0	483.5	460.0	270.1	270.1	270.1

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

HARVEY COST BENEFIT

FINANCIAL ANALYSIS

(All units $million unless specified)	SCENARIO	A1 H	A2H	A3H	A1L	A1L	A2L	A2L	A3L	A3L	B1H	B2H	B3H	B1L	B1L	B2L	B2L	B3L	B3L	C1 H	C2H	C3H	C1L	C1L	C2L	C2L	C3L	C3L
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's
• EXPECTED REVENUE (at 1989/90 prices)		16.8	16.8	16.5	14.0	11.3	14.0	11.3	13.1	10.0	16.0	16.0	16.0	13.5	11.3	13.5	11.3	12.5	10.0	15.2	15.2	15.2	13.2	11.3	13.2	11.3	12.3	10.0
• REQUIRED REVENUE TO MEET WATER COSTS		30.4	30.4	53.3	28.1	25.9	28.1	25.9	51.7	37.3	27.9	27.9	41.7	26.2	24.7	26.2	24.7	40.1	31.5	25.9	25.9	35.4	24.5	23.4	24.5	23.4	34.1	27.7
(Operating costs + Distribution capital costs + 85% of head works capital costs)																												
"(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																												
• NET DEFICIT (NPV)		13.7	13.7	36.8	14.1	14.6	14.1	14.6	38.6	27.3	12.0	12.0	25.7	12.7	13.4	12.7	13.4	27.6	21.5	10.7	10.7	20.2	11.3	12.1	11.3	12.1	21.8	17.7
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	828	828	2228	854	883	854	883	2336	1656	724	724	1558	768	813	768	813	1669	1304	649	649	1226	683	732	683	732	1322	1069
WATER COSTS																												
• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11 (Assuming 100% volumetric charge)																												
Headworks	($ per megalitre)				12.3	6.7	12.6	6.7	15.3	6.8				10.6	6.7	10.6	6.7	12.6	6.6				9.6	6.7	9.6	6.7	11.5	6.5
Distribution	($ per megalitre)				60.0	59.9	63.4	63.4	166.6	124.3				56.2	56.2	59.5	59.5	122.9	100.0				52.3	52.5	55.5	55.6	101.5	84.8
TOTAL	($ per megalitre)				72.3	66.7	76.0	70.1	181.9	131.2				66.8	62.9	70.1	66.1	135.6	106.6				61.8	59.1	65.1	62.3	113.0	91.3
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	2.3		2.3		4.7		1.0	1.0	1.0	2.2		2.2		3.7		1.0	1.0	1.0	2.1		2.1		3.2	
• INCREASE OVER 1989/90 PRICE (Volume charge only)					3.0	2.8	3.1	2.9	7.5	5.4				2.7	2.6	2.9	2.7	5.6	4.4				2.5	2.4	2.7	2.6	4.6	3.8
NPV of FLOWS - Volume sold - megalitres		670.6	670.6	616.4	488.3	465.0	488.3	465.0	405.9	406.0	654.2	654.2	616.4	488.2	465.0	488.2	465.0	405.9	406.0	617.9	617.9	582.7	488.3	465.0	488.3	465.0	405.9	406.0

	SCENARIO	D1 H	D2H	D3H	D1L	D1L	D2L	D2L	D3L	D3L	E1 H	E2H	E1L	E1L	E2L	E2L	H	P	Close down
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	TWE's	Current	TWE's	TWE's	Current	Current
• EXPECTED REVENUE (at 1989/90 prices)		14.3	14.3	14.3	13.0	11.3	13.0	11.3	12.0	10.0	11.1	11.1	11.1	10.1	11.1	10.1	11.3	10.0	7.8
• REQUIRED REVENUE TO MEET WATER COSTS		25.3	25.3	31.0	24.3	23.5	24.3	23.5	30.3	25.8	20.3	20.3	19.6	19.6	19.6	19.6	16.4	11.7	9.3
(Operating costs + Distribution capital costs +85% of head works capital costs)																			
"(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																			
• NET DEFICIT (NPV)		11.0	11.0	16.7	11.3	12.2	11.3	12.2	18.3	15.8	9.2	9.2	8.5	9.5	8.5	9.5	5.1	1.7	1.5
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	666	666	1012	684	741	684	741	1111	956	556	556	515	578	515	578	310	102	92
WATER COSTS																			
• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11 (Assuming 100% volumetric charge)																			
Headworks	($ per megalitre)				8.9	6.6	8.9	6.6	10.3	6.4			6.1	5.9	6.1	5.9	6.3	5.1	
Distribution	($ per megalitre)				53.4	53.5	56.5	56.7	87.9	77.2			51.4	51.5	54.0	54.0	34.5	29.2	
TOTAL	($ per megalitre)				62.3	60.1	65.4	63.3	98.2	83.6			57.5	57.4	60.1	60	40.8	34.3	
• INCREASE OVER 1989/90 PRICE (Current mixol rates & volume charges)		1.0	1.0	1.0	2.1		2.1		2.9		1.0	1.0	2.0		2.0			1.2	1.0
• INCREASE OVER 1989/90 PRICE (Volume charge only)					2.6	2.5	2.7	2.6	4.0	3.4			2.4	2.4	2.5	2.5	1.7	1.4	
NPV of FLOWS - Volume sold - megalitres		578.5	578.5	547.4	488.3	465	488.3	465.0	405.9	406.0	429.6	429.6	429.6	411.0	429.6	411.0	463.0	375.9	2773

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

WAROONA COST BENEFIT

FINANCIAL ANALYSIS

(All units $million unless specified)	SCENARIO	A1 H	A2H	A3H	A1L	A1L	A2L	A2L	A3L	A3L	B1H	B2H	B3H	B1L	B1L	B2L	B2L	B3L	B3L	C1 H	C2H	C3H	C1L	C1L	C2L	C2L	C3L	C3L
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's
• EXPECTED REVENUE (at 1989/90 prices)		4.6	4.6	4.6	3.9	3.3	3.9	3.3	3.5	2.7	4.4	4.4	4.4	3.8	3.3	3.8	3.3	3.3	2.6	4.0	4.0	4.0	3.7	3.3	3.7	3.3	3.2	2.6
• REQUIRED REVENUE TO MEET WATER COSTS		11.5	11.6	22.7	10.9	9.3	10.9	9.3	20.7	14.3	10.8	10.8	18.1	10.2	9.2	10.2	9.2	17.0	12.2	9.8	9.8	15.3	9.4	9.0	9.4	9.0	14.6	11.1
(Operating costs + Distribution capital costs + 85% of head works capital costs) "(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																												
• NET DEFICIT (NPV)		6.9	6.9	18.1	7.0	6.0	7.0	6.0	17.2	11.6	6.4	6.4	13.7	6.4	5.9	6.4	5.9	13.7	9.6	5.8	5.8	11.3	5.7	5.7	5.7	5.7	11.4	8.5
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	419	419	1096	422	363	422	363	1039	701	388	388	831	386	357	385	357	827	578	353	353	684	344	346	344	346	693	517

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				44.6	30.2	44.6	30.2	59.7	27.7				39.6	30.0	39.6	30.0	52.2	26.4				34.5	30.0	34.5	30.0	45.3	26.1
Distribution	($ per megalitre)				51.9	52.6	57.3	57.1	212.7	160.8				50.3	51.5	55.2	56.0	164.8	128.3				48.7	50.0	53.2	54.3	141.5	114.2
TOTAL	($ per megalitre)				96.5	82.7	101.9	87.3	272.4	188.5				90.0	81.5	94.8	86.0	217.0	154.7				83.1	80.0	87.7	84.3	186.8	140.2
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	3.2		3.2		7.3		1.0	1.0	1.0	3.1		3.1		6.2		1.0	1.0	1.0	2.9		2.9		5.5	
• INCREASE OVER 1989/90 PRICE (Volume charge only)					4.0	3.4	4.2	3.6	11.2	7.8				3.7	3.4	3.9	3.5	8.9	6.4				3.4	3.3	3.6	3.5	7.7	5.8
NPV of FLOWS - Volume sold - megalitres		199.1	199.1	187.4	153.1	145.0	153.1	145.0	115.7	116.0	187.7	187.7	177.1	153.1	145.0	153.1	145.0	114.4	114.0	170.8	170.8	161.7	153.1	145.0	153.1	145.0	114.4	114.0

	SCENARIO	D1 H	D2H	D3H	D1L	D1L	D2L	D2L	D3L	D3L	E1 H	E2H	E1L	E1L	E2L	E2L	H	P	Close down
	Water Charging Policy	Current	Current	Current	Current	TWE's	Current	TWE's	Current	TWE's	Current	Current	Current	TWE's	Current	TWE's	TWE's	Current	Current
• EXPECTED REVENUE (at 1989/90 prices)		2.7	2.7	2.7	2.6	2.4	2.6	2.4	2.7	2.5	2.7	2.7	2.6	2.4	2.6	2.4	3.7	2.2	2.2
• REQUIRED REVENUE TO MEET WATER COSTS		6.6	6.6	7.6	6.3	6.2	6.3	6.2	7.3	7.3	6.6	6.6	6.3	6.2	6.3	6.2	9.7	2.4	2.4
(Operating costs + Distribution capital costs +85% of head works capital costs) "(Allowance for capital costs based on "renewals" accounting principle with existing capital values written off)"																			
• NET DEFICIT (NPV)		3.8	3.8	4.8	3.6	3.9	3.6	3.9	4.6	4.8	3.8	3.8	3.6	3.9	3.6	3.9	6.0	0.3	0.3
• NET DEFICIT (ANNUAL EQUIVALENT)	$'000	233	233	294	220	233	220	233	279	288	233	233	220	233	220	233	360	17	16

WATER COSTS

• REQUIRED WATER CHARGE TO MEET ACTUAL COSTS BY YEAR 11
(Assuming 100% volumetric charge)

Headworks	($ per megalitre)				22.8	21.9	22.8	21.9	21.5	21.4			22.8	21.9	22.8	21.9	30.7		
Distribution	($ per megalitre)				55.8	56.7	59.1	59.8	71.9	71.2			55.8	56.7	59.1	59.8	52.3		
TOTAL	($ per megalitre)				78.6	78.6	82.0	81.6	93.4	92.6			78.6	78.6	82.0	81.6	83.0		
• INCREASE OVER 1989/90 PRICE (Current mix of rates & volume charges)		1.0	1.0	1.0	3.3		2.8		3.2		1.0	1.0	3.3		2.8			1.0	1.0
• INCREASE OVER 1989/90 PRICE (Volume charge only)					3.2	2.8	3.4	3.4	3.8	3.8			3.2	2.8	3.4	3.4	3.4		
NPV of FLOWS - Volume sold - megalitres		112.7	112.7	108.6	107.3	103.0	107.3	103.0	108.6	109.0	112.7	112.7	107.3	103.0	107.3	103.0	159.0	89.8	89.8

NPV @ 6% over 80 years: Units $ million (1989/90): 15 June 1992

THE OPTIONS EVALUATED

The opposite page shows a summary of the terms used to describe each option evaluated in Phase 2.

Each option is described by 4 factors.

- Area to be serviced;
- On-farm irrigation practices and engineering strategies for water delivery and salinity mitigation;
- Water demand scenario; and
- Water charging policy.

e.g. **A2L TWE**

A designates the Area to be irrigated (A, B, C, D, E, F, G, H, P or CD).

2 designates the On-farm Irrigation Practice and Engineering Scheme Strategy for salinity mitigation (Strategies 1, 2 or 3).

L designates the water demand scenario, in this case the low demand scenario (High or Low).

TWE designates the applicable water charging policy adopted. In this case the introduction of TWEs and a volumetric charge per megalitre of water used (Current or TWEs).

The primary factor for describing each of the 45 options is the area likely to be serviced in the future.

A survey conducted by the Department of Agriculture in 1986 provided a delineation of three broad land productivity classifications. These were used as a base to identify Area's A, B and C.

Area A: Existing area of service

B: Cease servicing the low productivity region (generally on the Western edge of the existing area of service)

C: Cease servicing the low and medium productivity regions (Western and Central areas)

Area Options D & E were developed to minimise nutrient export from irrigated areas to the Peel-Harvey Estuary. Environmentalists and EPA staff considered that any long term strategy for irrigation should specifically investigate ways of redressing nutrient discharge into the estuary.

Area Option D involved an extension of the Mangosteen Drain approximately 10 kilometres to the north and east to redirect the headwaters of the Harvey Main Drain to the Harvey Diversion Drain. The only area that would remain irrigated in the catchment of the Peel-Harvey Estuary would be the Dardanup loams in the core of the Waroona District.

Area Option E provided a similar environmental impact without constructing the Mangosteen Drain extension. Under Area Option E no irrigation would take place north of Harvey Main Drain except on the Dardanup loams in the core of the Waroona Irrigation District.

Area Option H models a scenario in which there was a total commitment of the Irrigation Service to horticultural production on the most productive Dardanup loam soils of the Harvey and Waroona Districts. This "horticulture only" scenario would require the development of large export markets.

Area Option P models the retention of the existing Harvey piped scheme and the closing down of all the remaining irrigation area.

Area option CD, the close down option, shows the impact of gradually closing down the Scheme altogether (over a 15 year period).

THE OPTIONS EVALUATED

AREAS — In each of the Waroona, Harvey and Collie Districts plus for the total South-West Irrigation Area

	A	B	C	D	E	H	P	CD
Total district served after 15 years	Existing area	Drop Western fringe (salt affected)	Drop marginal & salt affected land	Contract to Dardanup loams on Peel–Harvey Catchment Redirect 5,100ha of drainage from the Peel–Harvey Catchment	Contract to Dardanup loams on Peel–Harvey Catchment No change in Catchment drainage	Intensive horticulture (100%) on Dardanup loams	Close down irrigation except fully piped Harvey No 1 area Area all used for horticulture	Close down all irrigation between years 5 and 15
Irrigable Area	15,000 ha	12,900 ha	10,600 ha	9,100 ha	7,000 ha	3,800 ha	1,259 ha	
Water Allocated (megalitres)	110,000	94,700	79,100	68,500	52,200	72,400	11,500	

For each A, B, C, D & E area evaluate three different engineering and salinity mitigation options:

ON FARM IRRIGATION PRACTICES & ENGINEERING STRATEGIES FOR WATER DELIVERY & SALINITY MITIGATION

	STRATEGY 1	STRATEGY 2	STRATEGY 3	STRATEGY	STRATEGY
Distribution System — Wellington Catchment — Reforestation	**On-farm** • Current practices (including laser levelling) **Scheme** Minimum maintenance Yes	**On-farm** • Redesign for improved water & pasture management • 10% of land area planted to trees **Scheme** Minimum maintenance Yes	**On-farm** • As for Strategy 2 plus • Groundwater reduction by sub-surface drainage & regional pumping via bores **Scheme** Fully piped Yes	**On-farm** • 40ha properties • Farmers to supply head to distribute water on farm • Watering by sprinkler, trickle or spray **Scheme** Minimum maintenance Yes	**On-farm** • 40ha properties • Farmers to supply head to distribute water on farm • Watering by sprinkler, trickle or spray **Scheme** Minimum maintenance Yes

WATER DEMAND SCENARIOS

All options to then be evaluated for two water demand scenarios:

	SCENARIO H	SCENARIO L
Market outlook for agricultural enterprises	Favourable	Conservative
Improvement in enterprise productivity	Low	High
Estimated increase in real water prices	Increase at same rate as inflation rate	Full cost recovery

WATER CHARGING POLICY

All options to then be evaluated for water charging policies:

CURRENT	TWEs
Current pricing policy ie a mix of rates and volume charges	Transferable Water Entitlements No rates, 100% volume charge