CRC FOR CATCHMENT HYDROLOGY
CSIRO LAND AND WATER
MURRAY-DARLING BASIN COMMISSION

ON-FARM AND COMMUNITY-SCALE SALT DISPOSAL BASINS ON THE RIVERINE PLAIN

COST COMPARISONS OF ON-FARM AND COMMUNITY BASINS - CASE STUDIES OF THE MIA AND WAKOOL

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FOREWORD

To limit salinity increases in the River Murray, there are pressures to minimise salt leaving irrigated catchments of the Murray-Darling Basin. Part of this strategy is to manage drainage water in the irrigation areas using disposal basins. Unfortunately, there are no existing guidelines for siting, design and management of such disposal basins. The CRC for Catchment Hydrology and CSIRO Land and Water, with support from the Murray-Darling Basin Commission, have embarked on a project with the overall objective of producing such guidelines for the Riverine Plain of the Murray Basin.

This report is one of several being produced in this project to support the guidelines. It deals with the costs of designing and managing basins, ranging from on-farm, for use by that single property, to community basins used by several properties. While costs for constructing community basins are lower than for on-farm basins, there are costs incurred in transporting drainage water to the basin. The result is that the cheaper option will depend on a number of site aspects, including whether land needs to be purchased for the community basin. Cost is not the driving issue in the Land and Water Management Planning process for choosing widespread adoption of one option over the other.

Glen Walker
Leader, Salinity Program

Summary

In the Riverine Plain, constructed disposal basins are used to hold saline subsurface drainage water. These basins can be small on-farm basins, taking drainage water from individual farms, or larger community basins taking drainage water from a group of farms.

There is a perception that larger community basins are more economical than smaller on-farm basins due to economies of scale in construction. However, with community basins there is usually a large cost associated with the transport of the saline drainage water from the farms to the basin. The siting of the basin, drainage volume and hence pipe size and operational costs will affect the attractiveness of community basins.

This report has two sections; the first analyses and compares the cost and hence the financial viability of a group of grapevine enterprises with several on-farm basins against the option of a single community basin. The second section uses the Wakool basin as an example of a community basin that is then compared with an equivalent area of multiple smaller basins.

The aggregate cost estimates showed that the construction cost of a community basin was 21-36% lower than the equivalent on-farm basins. However, the drainage water transportation cost added 24-34% to the total cost. Thus overall, the community basin cost ranged between 12% less and 11% more than for on-farm basins depending upon the scenario.

Community basins were found to cost less under conditions of *land trading* between farms, and where a smaller basin overall could be used. However, community basins were found to cost more where additional land had to be purchased for their construction, where the drainage water transportation cost was high due to the location of the basin and where a larger basin than the equivalent on-farm basins was used.

Although these results are based on only two case studies (MIA and Wakool) it does appear that the overall cost differences between on-farm or community basins are not great. Thus, there is not a great financial imperative to choose either on-farm or community basins. This finding allows decisions between on-farm or community basins to be mainly based upon environmental and social considerations.

It was found that the cost of a community basin to individual farmers varied considerably. It was assumed that the individual farms had to pay their share of the basin construction cost based upon their drained area, and had to meet their own cost of drainage water transportation to the community basin. In some circumstances, it was found that for a community basin an individual farm had higher costs than for an on-farm basin, despite the overall cost of

the community basin being lower. Thus a community basin may in overall terms be advantageous to a group of farms, whilst actually costing some individuals more than an on-farm basin. These cost variations to individual farms can be attributed to factors such as: basin size, distance between farm and community basin and cost of purchasing additional land for a community basin.

A method has been developed using *critical pipe length*, to assess at what distance from a community basin a particular farm may be financially better off with an on-farm basin. This method was developed in recognition of the drainage transportation cost being a major factor in determining the financial attractiveness of a community basin over an on-farm basin.

This overall trade off between drainage transportation and basin costs means that a community basin needs to be large enough to achieve a balance between the increasing drainage transportation cost, and decline in basin construction cost, to provide an overall benefit.

Table of Contents

List of Tables

List of Figures

Acknowledgments

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1. Introduction

Downstream impacts of saline drainage water from irrigation areas have led to increasing pressure to manage drainage water within irrigation areas. An option for doing this, which has gained some acceptance, is the use of disposal basins where the drainage water is disposed and evaporated. These disposal basins may be at a farm scale, such as those used with tile drainage in perennial horticulture in the Murrumbidgee Irrigation Area (MIA). These basins tend to be less than 10ha and take water from single farms that have a tile drainage system.

An alternative option has been to develop community scale disposal basins, to take water from groups of farms. At present this type of basin is usually associated with groundwater pumping schemes, such as at Girgarre in the Shepparton Irrigation Region which is a 30ha basin and larger regional scale disposal basins, and the Wakool Disposal Basin which is 2000ha. These basins cover a number of farms and are much larger than on farm basins. With these schemes the drainage system, being groundwater pumps, usually covers more than one farm, with little possibility of linking the drainage volume and costs to a particular enterprise or water management.

For any particular drainage scheme there is, at the design stage, the opportunity to explore at what scale the disposal basin or basins should be. In the case of Wakool, one very large basin was chosen; however it would have been technically feasible to have a number of smaller basins at key locations, or even one disposal basin per groundwater pump. These issues from a financial viewpoint have not been explored. Intuitively, larger basins should be more economical to construct than smaller basins due to economies of scale. However, with larger basins a network of pipes is required to deliver the water from the farms/pumps to the basin. It is only if the cost savings in construction are greater than the drainage transportation costs that a larger basin will be more attractive than several smaller basins.

Thus, this report seeks to explore this balance between size of basin and transportation costs. Whether a small basin is on-farm, or a larger basin is shared by two or several farms and hence deemed a community basin, is more to do with ownership and cost sharing than any physical attribute. This analysis compares the financial viability of farms that use either on-farm (self owned) basins or combine together with other farms to share a basin. The costs and viability of basins will vary according to siting, design, land trade/purchase, size and pipe length required to transport saline drainage water from the farm to the community basin.

2. Objectives

The objectives of this study were to:

1. Document the cost of a community basin under various scenarios pertaining to land trade, land ownership, cost distribution, siting, design and size of basin
2. Compare the cost differences between on-farm and community basins under different scenarios
3. Compare the financial profitability of grapevines with on-farm or community disposal basins
4. Analyse the trade off between increased drainage transportation cost and construction cost savings with a community basin.

3. Methodology

3.1 Locale of the Study

The analysis was carried out on a subcatchment in the Ballingal area of the MIA, Figure 1. In the subcatchment were four viticulture farms (Farms 2, 3, 7 and 5); each had an existing on-farm disposal basin of 3.2-4.9ha, representing 5-11% of the farm area. The total area of the four farms was 276ha, served by approximately 17ha of on-farm basins, representing an average 6% of the drained area. All the farms had tile drainage.

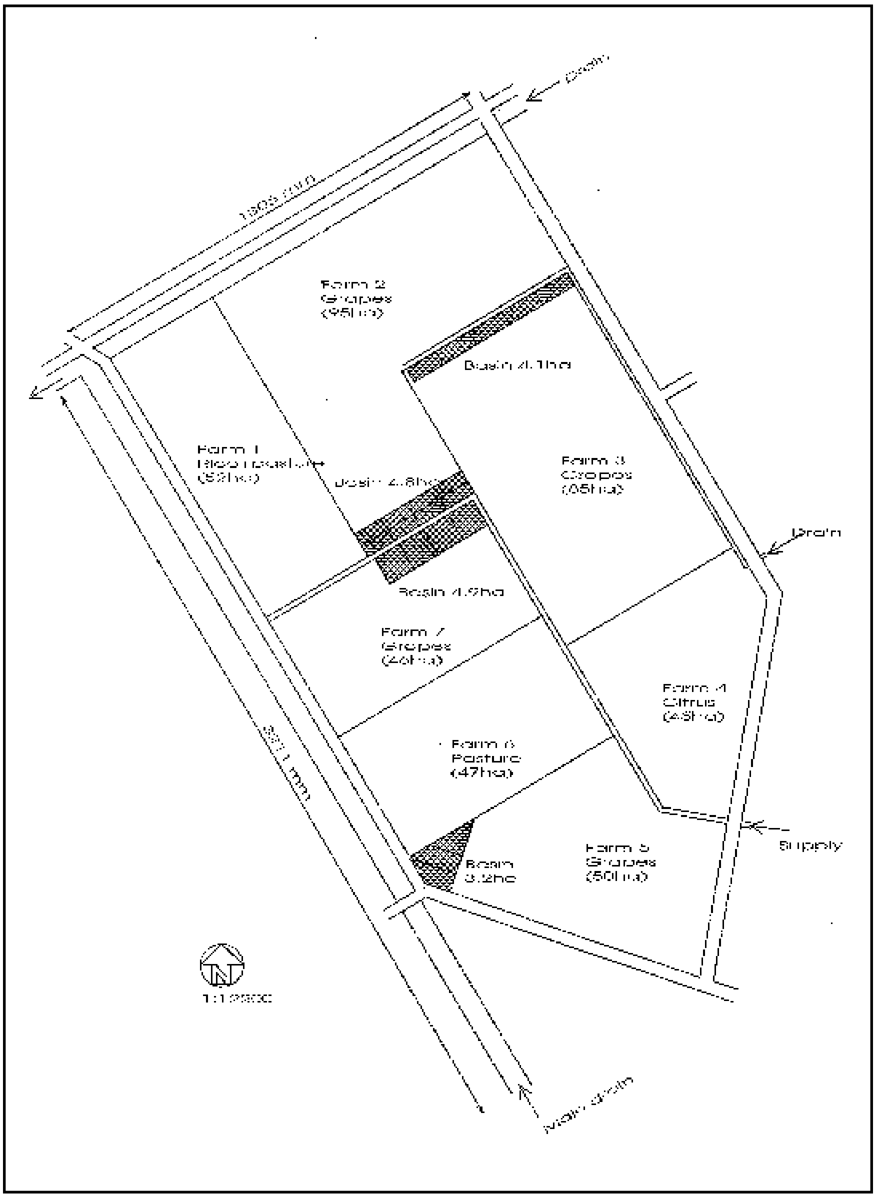

Figure 1.Case study area in MIA,existing multiple on-farm basins

3.2 Development of Scenarios

For comparison with the existing *status quo* of the individual on-farm basins, a number of scenarios were developed to determine the impact of variations in physical and financial parameters on the cost and financial attractiveness of a community basin. These scenarios assume that the existing landholders could have co-operated, or a development plan for the area could have been developed, before the current evaporation basins were built.

The parameters investigated were:

a) The trade of land between farms with existing on-farm basins to build a community basin. This requires that the farm or farms where the community basin is located are compensated with extra land from the farms that are to use that community basin. This helps to equalise the cost burden of lost production on the farm or farms where the community basin is located.

b) The purchase of land outside the existing farms for the community basin. This is where extra land is purchased outside the boundaries of the farms that had existing on-farm basins. This provides the farms overall with extra land as they do not have on-farm basins and they do not have to trade land to compensate the farm owners where the community basin is located. However, this scenario incurs extra cost in the land purchase.

c) The size of the community basin. The agglomeration of a group of smaller basins may result in a single basin that is either larger or smaller than the sum of the area of the individual basins. It may be larger in that the disposal capacity is reduced, as the evaporation from open water reduces with the size of the water body, or it may be smaller due to timing and amount of drainage across farms together with possible better management.

Extra land that becomes available due to amalgamation of on-farm basins or purchase of land outside the existing area is assumed to have been part of the vineyard development. Details of the various scenarios are shown in Table 1.

Table 1.Details of scenarios for comparison of community and on farm disposal basins

Scenarios	Basin site and land ownership	Basin size (ha)	% of drained area	Cost distribution*
1	Single land trade between original farms	17	6	Original basin area
2	Multiple land trade between original farms	17	6	Original basin area
3	Purchased land at A (Farm 6)	17	6	Original basin area
4	Purchased land at A (Farm 6)	17	6	Farm area
5	Purchased land at B (Farm 1)	17	6	Original basin area
6	Purchased land at A (Farm 6)	21	7.5	Farm area
7	Purchased land at A (Farm 6)	14	5	Farm area

*the cost distribution of a community basin to individual farms can be on the basis of the original on-farm basin area or on the basis of the farm area

From the scenarios described above, four groups were developed (Table 2) to form the basis of cost and financial comparisons between on-farm and community basins.

Table 2. Scenario comparison

Variables	Scenario groups
Single and multiple land trade	Scenario 1 and 2
Purchased land and land trade	Scenario 3 and 2
Varying community basin area	Scenario 4, 6 and 7
Purchased land at site A and site B	Scenario 3 and 5

Scenarios 1 and 2 amalgamate the existing multiple on-farm basins to a single site in the form of a community basin (see Figure 2). Scenario 1 used a single *land trade* where Farm 5 purchased land for the community basin from Farm 7. In Scenario 2, there was a multiple *land trade* where Farms 2, 3 and 7 each sold a fraction of land, proportionate to farm area, to Farm 5 for the community basin.

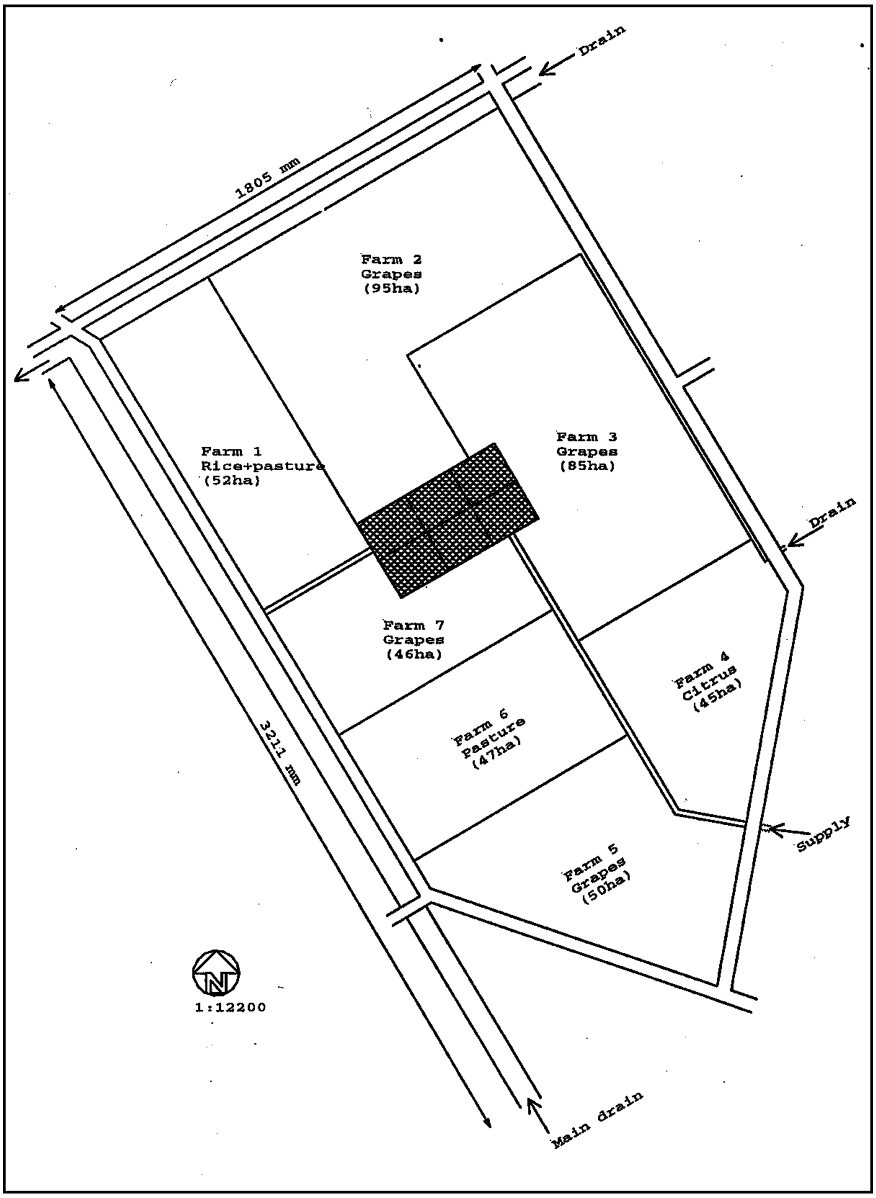

Figure 2. Community basin under Scenarios 1 and 2

Scenarios 2 and 3 permit a comparison between a community basin, accommodated via a land trade in the existing farms, versus a basin sited on land purchased outside the existing area (Figure 3).

Scenarios 4, 6 and 7 are used to compare community basin cost and financial viability when varying basin area (Figure 3). Community basins may be somewhat larger than the equivalent area of on-farm basins due to reduced leakage; thus a 7.5% community basin area was included. However, it may be argued that due to better management a smaller community basin would result, thus a 5% basin area was also included.

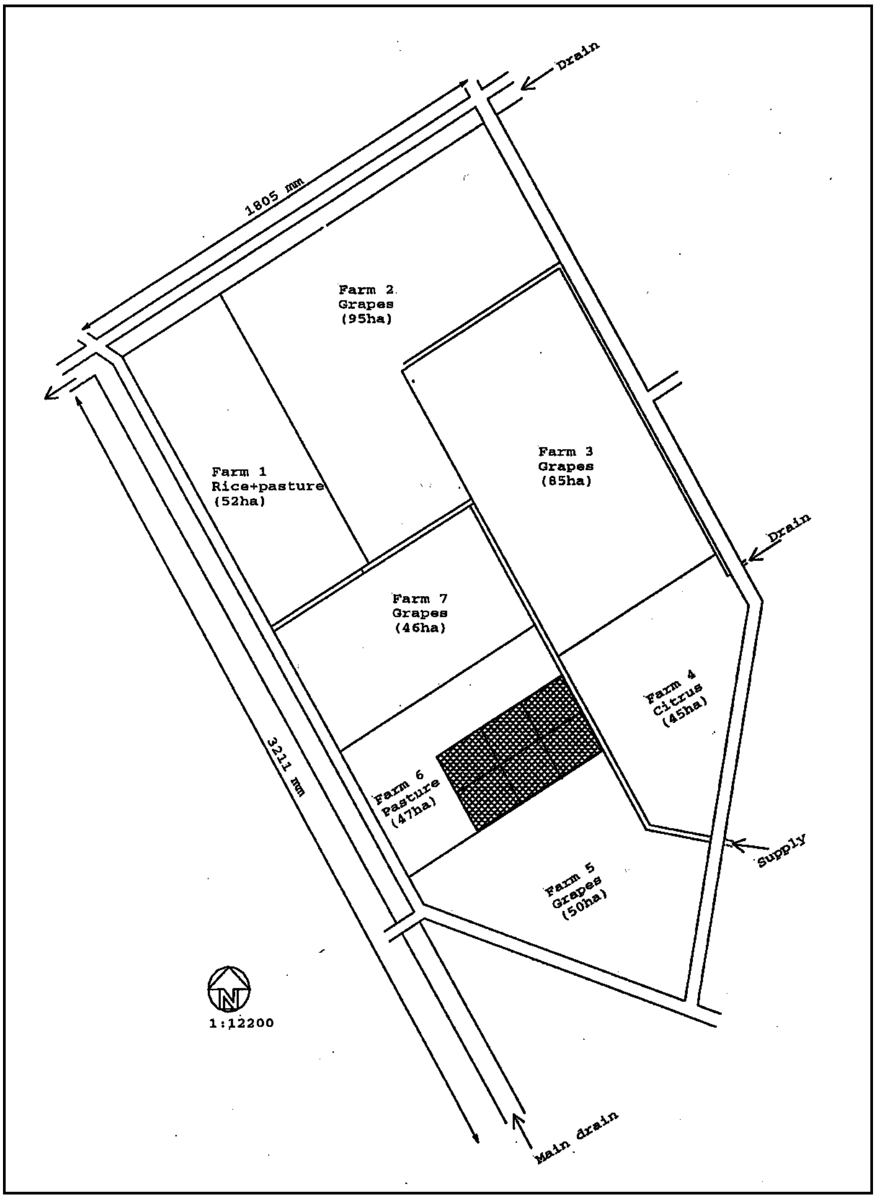

Figure 3.Community basin under Scenarios 3,4,6 and 7

Scenarios 3 and 5 are used to compare the effect of drainage transportation costs with a community basin at different sites, Figure 4.

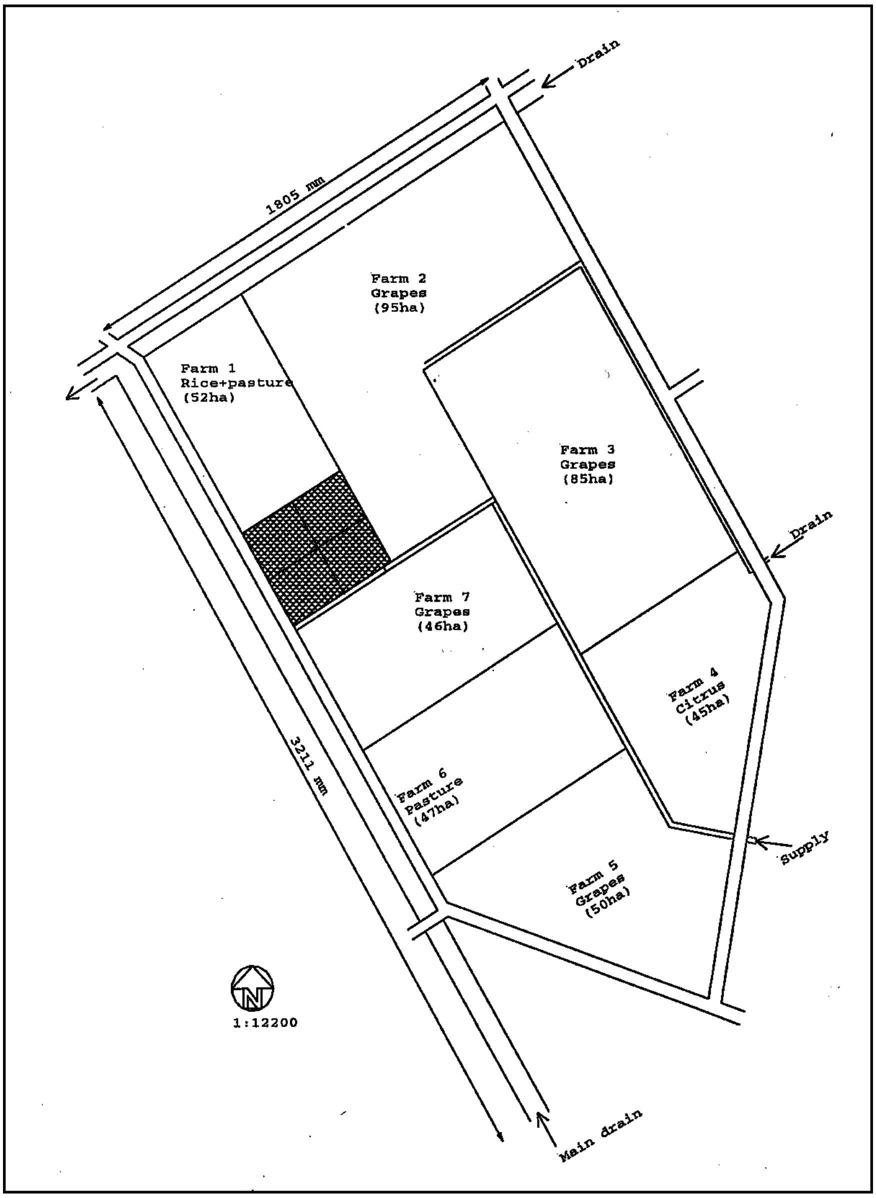

Figure 4.Community basin under Scenario 5

Drainage transportation is a major component of the total cost of a community disposal basin, the drainage water being conveyed by a network of pipes. The size of pipe and corresponding pump capacity is a function of drainage discharge rate, gradient, pressure head and pipe length. These factors affect the total cost of transporting drainage water from the farm to the disposal basin.

In these analyses, a number of assumptions with regard to location and size of disposal basin were made, to compare cost and financial viability of grapevines with a community basin to on-farm basin under different scenarios. Details of the variables for each scenario are given in Appendix 1. In calculating the cost under various scenarios it was assumed that the design drainage rate for the whole project area was 2.5mm/day.

3.3 Costs Analysis

Detailed estimates of costs were mainly obtained from Singh and Christen (1999). Costs were also determined by consulting various agencies such as surveyors, consultants, engineering suppliers and the electricity supply authority. The costs are based on 1999 dollar values.

3.4 Financial Evaluation

The financial evaluation of grapevines with multiple on-farm or a single community disposal basin was carried out using a Cash Flow Budget constructed for a 25 year period. Total yearly benefits (in terms of returns from grapevine yields obtained using different basin areas) and costs were discounted at a rate of 8%. Financial viability of grapevines was expressed as Net Present Value (NPV), Benefit Cost Ratio (BCR) and Break Even Time (BET). Details of analysis and methods used are presented in Singh and Christen (2000).

The trade off between drainage transportation cost and basin size was determined by working out the *critical pipe length* that equalises the cost of a community basin with the equivalent on-farm disposal basin. Annual costs of on-farm and community basins were worked out considering a 30 year basin design life.

3.5 Data Used

Average grape prices were taken from Wine Grape Marketing Board (1997). Costs of vineyard development, including the cost of machinery and equipment, land preparation, trellising, vine establishment and maintenance, irrigation system installation, operational cost, chemicals, harvesting and tile drainage were obtained from Moll and Christen (1996).

The cost of siting, design and construction of disposal basins were obtained from Singh and Christen (1999). A land value of $2000/ha was used as the purchase price.

In estimating the cost of a community basin, no consideration was given to additional land required for creating a buffer around the disposal basin.

This analysis did not include the costing of any environmental or social consequences in regard to the use of community or on-farm basins.

4. Results and Discussion

4.1 Total Costs of Disposal Basins

The construction cost of a community basin (6% of drained area) without transportation costs was lower than for the equivalent area of on-farm basins by 21-36%. When the community basin area was increased to 7.5% to accommodate a possible reduced disposal capacity, it still cost about 6% less than the on-farms basins, Table 3. A smaller community basin area (5%) cost 33% less than on-farm basins.

Table 3. Cost of on-farm and community basins

Scenario	Basin Cost ($)				% difference between community and on-farm basin
	On-farm basins total cost (6% of drained area)	Community basin			
		Construction	Transportation	Total	
1	229,736	147,161	55,407	202,568	-11.8
2	229,736	147,161	55,407	202,568	-11.8
3	229,736	181,960	71,171	253,131	+10.2
4	229,736	181,959	71,171	253,130	+10.2
5	229,736	181,960	77,892	259,852	+13.1
6	229,736	214,958	71,171	286,129	+24.5
7	229,736	152,571	71,171	223,742	-2.6

The transportation cost added 24-34% to the total cost. Thus, overall for the same basin area, the community basin cost either about 12% less or 13% more than the equivalent on-farm basins. The cost reduction resulted when the community basin was sited centrally as in Figure 2. The costs were greater when the community basin was sited on purchased land away from the existing farms (Figures 3 and 4).

4.2 Individual costs to Farms

There was considerable variation in cost to individual farms when using a community basin, Table 4. Some farms incurred higher costs when using a community basin compared to an on-farm basin, even when the total costs of a community basin were lower. For example, the community basin cost to Farm 5 was higher than the on-farm basin cost in Scenarios 1 and 2, whilst it was lower in Scenarios 3 and 4. Similarly, the community basin cost to Farms 2 and 3 was considerably higher than the on-farm basin cost in Scenario 7; however, the overall cost of the community basin was lower than for on-farm basins. These variations in community basin costs to individual farms were mainly due to variations in drainage transportation costs. For Farm 7, a community basin was cost effective in 6 out of 7 scenarios. This was due to a reduction in basin size in Scenarios 4, 6 and 7 and due to economies of scale in all other cases.

From these results, it is clear that there are several factors combining to increase or decrease the cost to individual farms. These individual factors, or factors in combination, are distance between farm and community basin, basin size and the trade off between increased production on additional land available when purchasing land for the community basin, and the cost of the land.

Table 4.Cost of on-farm and community basin to individual farms ($) (Cells shaded grey indicate where the costs of a community basin are less than the cost of an on-farm basin)

Basin type	Scenario	Farm 2	Farm 3	Farm 5	Farm 7
On-farm	Status quo	65,370	62,090	43,810	58,466
Community Basin	1	61,874	42,373	52,379	45,942
	2	60,888	41,534	52,114	48,032
	3	92,823	61,609	40,344	58,355
	4	104,268	73,891	38,870	36,101
	5	76,053	63,325	61,963	58,511
	6	115,602	84,109	44,715	41,703
	7	94,141	64,894	33,423	31,284

4.3 Scenario comparison

This section combines the cost differences between on-farm and community basins with the financial gains or losses in grape production using an on - farm or community basin.

4.3.1 Land trade

The total cost of a community basin to all farms was approximately 12% less than the on-farm basin cost under conditions of a *land trade* (Table 4). A land trade constrains the position of the basin to within the area of the existing farms; the chosen community basin position was the most central of all the scenarios. Thus, the effectiveness of a community basin in these circumstances is probably a combination of a central position and *land trade.* However, the effects on individual farms were quite variable (Table 5 and Figure 5). The total cost to Farm 3 was considerably lower (about 33%) whilst the total cost of a community basin to Farm 5 was 19% higher than the corresponding on-farm basin cost. Differences between construction costs of basins showed that the benefits due to economies of scale, ranged from 31-42%. The proportion of drainage transportation cost ranged from as low as 10% for Farm 3 and 7 to as high as 54% for Farm 5.

Table 5.Cost of community basin with land trade *within the original farm area as a % of on-farm basin cost*

Basin type	Scenario	Farm 2	Farm 3	Farm 7	Farm 5	Total
On-farm	Status quo	$65,370	$62,090	$58,466	$43,810	$229,736
Community basin	1 - Single land trade	95%	68%	79%	120%	88%
Community basin	2 - Collective land trade	93%	67%	82%	119%	88%

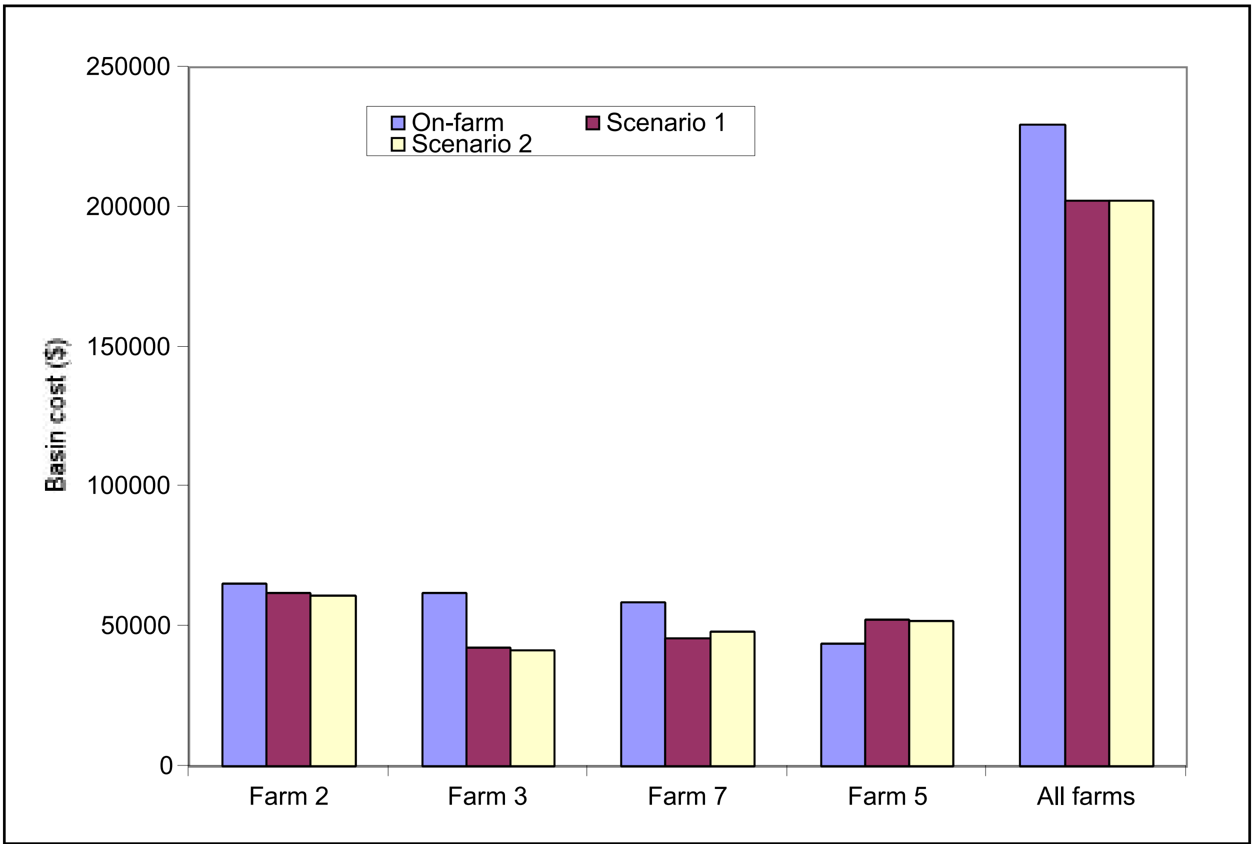

Figure 5.On-farm vs Communiy basin (land trade within farm areas)

The results of the financial analyses of grapevines under single and collective *land trade* (Table 6) indicated that there were only marginal (insignificant) changes in farm financial viability between using on-farm basins or a community basin.

Table 6. Financial profitability of grapevines under land trade scenarios

Items	On-farm	Community basin	
		Single land trade	Collective land trade
Benefit-Cost Ratio	1.63	1.63	1.64
Net Present Value ($'000s)	2,369	2,387	2,384
Net Cash Flow ($/ha)	5,998	6,015	6,024

4.3.2 Purchased land vs land trade

A cost comparison between Scenarios 2 and 3 is presented in Table 7 and Figure 6. The results show that land value has a significant impact on basin cost. In Scenario 3, the total cost of a community basin to different farms varied from 8% less to 42% more as a result of purchasing additional land and transportation costs.

Table 7.Cost of community basin with land trade *or land purchase as a % of on-farm basin cost*

Basin type	Scenario	Farm 2	Farm 3	Farm 7	Farm 5	Total
On-farm	Status quo	$65,370	$62,090	$58,466	$43,810	$229,736
Community basin	3 - Purchased land at Site A	142%	99%	100%	92%	110%
Community basin	2 - Collective land trade	93%	67%	82%	119%	88%

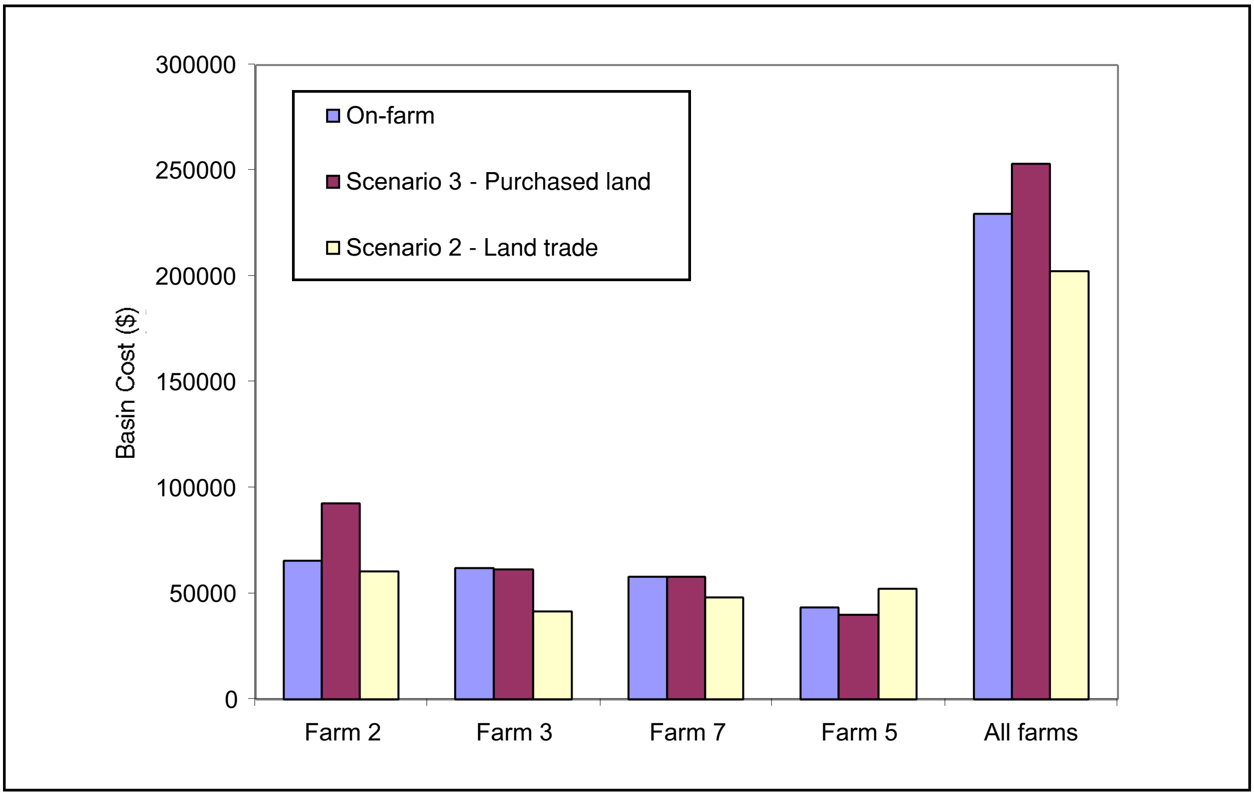

Figure 6.On-farm vs community basin (purchased land and land trade)

The drainage transportation cost to Farms 2 and 3 increased by 34 and 19%, respectively, when locating a community basin in Farm 6. Whilst the cost to Farm 5 decreased by 42 percent (mainly due to decrease in transportation cost), the cost to Farm 7 remained unaffected. The overall effect of purchasing additional land has increased the total cost (all farms) of a community basin by 22%, of which the drainage transportation cost constituted 7%.

The implications of these results are that there is a direct effect of purchasing additional land for a community basin on the cost incurred to each farm. However, there is additional benefit to the farms due to extra land available, equal to the land purchased for the community basin. The trade off between these depends on the cost of the new land purchased and its development cost.

Table 8 shows the effect of a community basin on the financial viability of grapevines with land purchase. The results show that there are again only minor effects on farm viability between on-farm or community basins.

Table 8. Financial viability of grapevines under purchased land and land trade scenarios

Items	On-farm	Community basin	
		Purchased land	Collective land trade
Benefit-Cost Ratio	1.63	1.66	1.64
Net Present Value ($'000s)	2,369	2,597	2,384
Net Cash Flow ($/ha)	5,998	6,107	6,024

4.3.3 Spatial comparisons

The extent of variability in community basin costs due to siting differences are given in Table 9. The cost of community basin was about 9% higher on average for Scenario 3 (site A), and about 14% higher on average for Scenario 5 (site B). This marginal cost difference was attributed to differences in drainage transportation cost.

Table 9.Comparison of on-farm basin cost with community basin sited at different locations

Basin type	Scenario	Farm 2	Farm 3	Farm 7	Farm 5	Total
On-farm	Status quo	$65,370	$62,090	$58,466	$43,810	$229,736
Community basin	3 - Purchased land at Site A	142%	99%	100%	92%	110%
Community basin	5 - Purchased land at Site B	116%	102%	100%	141%	113%

The financial profitability of grapes having a community basin again changed only marginally compared to on-farm basins, Table 10.

Table 10.Financial profitability of a community basin sited at different locations

Items	On-farm	Community basin	
		Purchased land Site A	Purchased land Site B
Benefit-Cost Ratio	1.63	1.66	1.66
Net Present Value ($'000s)	2,369	2,594	2,595
Net Cash Flow ($/ha)	5,998	6,107	6,103

4.3.4 Basin size

A comparison between the cost difference between the on-farm basins (6.2% area), and a community basin of 5, 6.2 and 7.5% area, showed that larger basins have economies of scale in construction (Table 11).

The community basin costs were an average 5% less than the on-farm basin cost, when the basin area was 5% of the farm area. However, when the same basin area was used (6%), then the community basin was an average 8% more expensive; when a 7.5% community basin was used, it was an average 22% more expensive than the on-farm basins.

Table 11.Comparison of on-farm basin cost with different size of community basins

Basin type	Scenario	Farm 2	Farm 3	Farm 7	Farm 5	Total
On-farm	Status quo	$65,370	$62,090	$58,466	$43,810	$229,736
Community basin	7 - 5% basin area	144%	105%	54%	76%	97%
Community basin	4 - 6% basin area	160%	119%	62%	89%	110%
Community basin	6 - 7.5% basin area	177%	135%	71%	102%	125%

These overall costs were higher, despite the community basin construction cost being about 21% less than the on-farm basin cost for equivalent areas, and a 7.5% community basin costing about 6% less to construct than the on-farm basin cost for a 6% area. Thus the cost increases associated with the community basin schemes were due to the drainage transportation and land purchase costs.

Results in Table 12 show that the overall financial profitability of the farms increase marginally when using a community basin. These results are sensitive to the land purchase price and drainage transportation cost. Thus, a central location for the community basin that minimises the drainage transportation cost is important.

Table 12. Financial profitability of grapevines with different size of community basins

Items	On-farm	Community basin		
		7.5% area	6% area	5% area
Benefit-Cost Ratio	1.63	1.68	1.68	1.66
Net Present Value ($'000s)	2,369	2,650	2,571	2,582
Net Cash Flow ($/ha)	5,998	6,204	6,019	6,026

4.4 Critical Pipe Length

Drainage transportation is a major component of the total cost of a community basin. The *critical pipe length* indicates how far away a community basin can be sited such that the community basin cost is equal to the on-farm basin cost for any farm. Beyond this point, any increase in pipe length increases the cost of a community basin above that of an on-farm basin. The *critical pipe length* provides a method of comparing the costs of on-farm and community basins with regard to basin siting.

Algebraically *critical pipe length* (CPL) can be expressed as:

$$CPL = (P_y - P_x) / P_p$$

Where, CPL is the critical pipe length in metres

P_y is the cost per ML of drainage per year of a community basin

P_x is the cost per ML of drainage per year of an on-farm basin

P_p is the cost per ML of drainage per meter of pipe

The *critical pipe length* is an inverse function of the difference between the community basin and on-farm basin construction cost. Table 13 shows critical pipe lengths for different scenarios.

Table 13. Trade off between drainage water transportation and basin cost

Scenario	Farm	On farm basin ($/ML/Year)	Community basin ($/ML/Year)	Transport cost ($/ML/Year)	Critical pipe length (m)
2 (Land trade)	2	46	32	0.02	700
	3	50	30	0.08	250
	7	91	72	0.11	173
	5	62	39	0.03	767
3 (Site A)	2	46	36	0.02	500
	3	50	34	0.03	533
	7	91	77	0.10	140
	5	62	59	0.09	33
5 (Site B)	2	46	36	0.02	500
	3	50	34	0.03	533
	7	91	77	0.09	156
	5	62	59	0.03	100

In Scenario 2, where the cost of a community basin is relatively lower than the other cases, the critical pipe length allowable for each farm is greater due to a larger cost difference between the community and on-farm basin.

Figure 9 gives the relationship between the price of pipe (dependent upon pipe diameter) and *critical pipe length*. Each curve represents the relationship between drainage transportation cost and pipe length, i.e. where the cost of a community basin is equal to the on-farm basin cost. The different curves represent the cost of on-farm basin disposal to the individual farm.

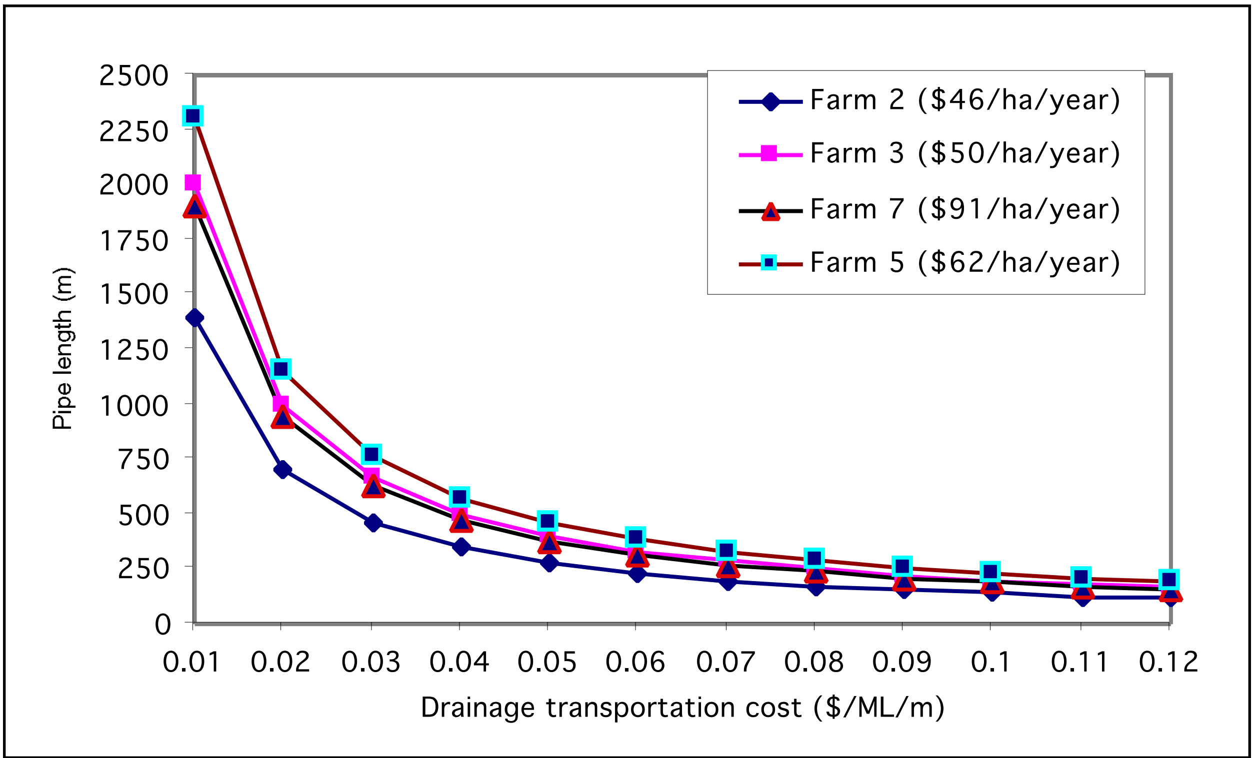

Figure 7.Relationship between drainage transportation cost and pipelengths for a community basin under collective land trade

5. Transportation Cost and Basin Size - Wakool Basin Case Study

In the previous analysis, the actual trade off between basin size and hence cost of construction and drainage transportation cost could not be examined, due to other factors such as land purchase or trading. Thus, the Wakool Disposal Basin was used to compare three scenarios, Table 14, where:

A - the *status quo* of one 2,000ha basin

B - replacing the 2000ha basin with 16 basins of 125ha each serving 3 farms

C - replacing the 2000ha basin with 48 basins of 42ha each.

Table 14.Scenarios for cost analysis of the Wakool disposal basin

Scenario	Total basin area (ha)	No of basins	Basin size (ha)	Pipe size (mm)	Total pipe length (km)	Pipe cost * ($/m)	Ground water pumps/basin
A	2000	1	2000	150	61.93	19.5	48
				200	16.61	30.0	
				225	10.45	32.0	
				300	16.17	46.0	
				375	29.92	73.0	
B	2000	16	125	150	56.25	19.5	3
C	2000	48	42	-	-	-	1

*Pipe cost also includes cost of installation

The Wakool Basin costings were taken from Nauton and Co. (1995), and the assumptions used were:

1. Drainage discharge rate was constant at 9mm/day/ha.
2. Protected area was 28,000 ha.
3. Each pump is of equal capacity and protects an area of 583 ha.
4. Average farm size was 583 ha.
5. Annual drainage volume disposed was 13,500 ML.

6. Geotechnical investigation cost of the 2,000 ha community basin is an extrapolated figure, based on the 20 and 200 ha basin costs in Singh and Christen (1999).
7. The square basin was divided into 100 cells of 20 ha.
8. Open drains were used to intercept lateral leakage.
9. Pump cost is a revised value from the initial 1975 estimates to 1997-98 dollars.
10. In Scenario B, the basins are located equidistant from each pump.
11. No drainage transportation cost is involved in Scenario C.
12. Annual operation and maintenance cost value was set at 2% of the total capital cost.
13. Analysis was based on 30 year basin design life with a 7% discount rate.

Table 15 shows the relationship between the number and size of basins and costs. The results show that the basin construction cost increases with increasing basin numbers, and hence decrease in basin size; the drainage water transportation cost increases with increase in basin size and hence reduced basin numbers.

Table 15. Total cost of a basin under all scenarios ($,000s)

Costs	Scenario A	Scenario B	Scenario C
Basin construction	13,122	15,922	18,539
Drainage water transportation	4968	1097	0
Ground water pumping	1791	1791	1791
Total cost	**19,881**	**18,810**	**20,330**
Net Present Cost	23,143	21,896	23,666
Net Present Cost/ha	11,572	10,948	11,832

This analysis also indicates the importance of achieving a balance between size and location of basins (Table 16). A comparison between Scenarios A and B shows that the increase in construction cost was lower than the decline in transportation cost as the number of basins increased from 1 to 16, which makes Scenario B more attractive than Scenario A in terms of cost saving. However, as the number of basins increased from 16 to 48 in Scenario C, the increase in construction cost was larger than the decline in transportation cost, which makes Scenario C more expensive.

Table 16.Basin construction cost and drainage transportation cost

Costs	Scenario A ($/ML)	Scenario B ($/ML)	Scenario C ($/ML)
Construction	975	1,179	1,373
Drainage water transportation	368	81	0
Pump	133	133	133
Total cost	**1,476**	**1,393**	**1,506**

The trade off between construction and drainage transportation costs (Table 17) show that the 2000ha basin cost about 5% more than the option of 16 community basins of 125ha, which in turn (scenario B) cost about 8% less than the possible 48 on-farm basins of 42ha each. Interestingly, the cost difference between a 2000ha community basin and 48 on-farm basins was only 2%.

Table 17.Comparison of scenario costs

Scenario comparison	Total cost % change
Scenario A to B	-5
Scenario B to C	+8
Scenario A to C	+2

This analysis shows that a community basin that is central to properties requiring disposal is a little cheaper than having a large number of on-farm basins. This assumes that sufficient suitable land is available and there is no adverse environmental impact.

The overall assessment from this analysis is that although there are minor cost changes with having more or less basins, the differences between transportation and basin construction costs balance each other out.

6. Conclusions

These analyses were conducted for a case study area in the MIA with on-farm basins and tile drainage, and for the Wakool scheme with groundwater pumping. Thus, these conclusions should be regarded as those from a very limited set of studies.

Community basins have lower construction costs than those of an equivalent area of on-farm basins; however a community basin may need to be larger than the sum of the on-farm basin areas due to decreased disposal capacity.

Drainage water needs to be transported to a community basin, usually through a pipe network. This drainage transportation cost is large and, depending upon the siting of the community basin, may outweigh the cost savings in basin construction, making the overall scheme more expensive than having on-farm basins.

Financial gains to farms from using a community basin on purchased land are likely to be from the reduction in basin construction cost (due to economies of scale) and increase in crop production due to the additional land available. However, this is provided cheap land is available nearby without significant developmental costs.

The cost of disposal to a community basin to individual farms in a drainage scheme can vary considerably. In some cases the cost to an individual farm of using a community basin is greater than the cost of an on-farm basin, even when the overall community basin scheme is cheaper. This may lead to inequity, and raises the need for careful consideration of cost sharing options.

Ideally a community basin should be designed, sited and managed such that all farms share the costs and benefits equally. This is unlikely to ever be the case. There are three main sets of costs associated with a community basin: basin construction, pipeline construction and operation/maintenance. Allocation of the basin construction cost is probably most fairly distributed on the basis of the area of each farm served by subsurface drainage. The pipeline construction cost to transport the saline drainage water to the community basin could be allocated on the actual cost to each farm, in which case farms further away from the basin will pay more than farms close to the basin. This has the advantage that it may somewhat compensate those closest to the basin for any real or perceived disadvantages to having a basin located close by. It may also help overcome objections from local landholders when trying to determine the site for a community basin. However, those further away may feel disadvantaged by this method of cost allocation, in which case the total cost for the pipeline construction cost could be distributed on the basis of the drained area on each farm. The operation and maintenance cost of a community basin should ideally be distributed on the basis of individual drainage volumes. This will encourage careful water management to minimise drainage volumes from each farm. Measuring the actual water volumes may be impractical in some cases, such as those where groundwater pumps serve more than one farm. In this case, it may be possible to allocate drainage volumes on the basis of water balance estimates for each individual farm. All the suggested charging methods above assume a similar level of service at each farm; this may not be the case. With groundwater pumping the level of service may vary markedly, in which case charges may be levied on the basis of the level of watertable drawdown on each farm.

The results of the financial analyses for individual farms under all the different scenarios indicated that there are only marginal differences in farm viability using community or on-farm basins. This result will probably vary regionally depending upon the drainage system and crops. However, it does indicate that financial considerations may not be the key consideration when choosing between on-farm or community basins. Social and environmental considerations may be much more important.

The critical pipe length provides a potential method for determining at what distance from a community basin a farm is better off using an on-farm basin.

The trade off between drainage transportation cost and basin size indicates that a community basin should be large enough to achieve a balance between increasing drainage transportation cost and reduced basin construction cost.

7. References

1. Moll, J. and Christen, E. (1996). Financial evaluation of options for managing tile drainage water to meet environmental constraints. CSIRO Division of Water Resources, Griffith (NSW). Technical Memorandum 96.20.

2. Nauton, D. and Co. (1995). Wakool land and water management plan economic survey. Terms of reference 3 and 4: Evaluation of Wakool Tullakool subsurface drainage scheme. Final Report.

3. Singh J. and Christen, E.W. (1999). Minimising the cost of basins: siting, design and construction factors. CSIRO Land and Water, Griffith (NSW). Technical Report 12/99 and CRC for Catchment Hydrology Report 00/5.

4. Singh J. and Christen, E.W. (2000). Effects of basins on the financial viability of subsurface drainage for grapevines and citrus in the MIA. CRC for Catchment Hydrology Report 00/4 and CSIRO Land and Water Technical Report 13/00.

5. Wine Grape Marketing Board (1997). Annual Report, Wine Grapes Marketing Board, Griffith.

Appendix 1

Table A1. Variables considered for financial analysis of community basin

Scenario	Farm no.	Area Drained (ha)	Share in community basin (ha)	(%)	Pipe size (mm)	Flow rate (l/s)	Head (m)	Pump capacity (l/s)	Pipe length (m)
On-farm	2	95	4.8	-	-	-	-	-	-
	3	85	4.1	-	-	-	-	-	-
	7	46	4.9	-	-	-	-	-	-
	5	50	3.2	-	-	-	-	-	-
1	2	95	4.8	29	150	25	10	35	609
	3	85	4.1	25	100	25	8	30	87
	7	42.8	4.6	27	80	11	7	20	87
	5	50	3.2	19	150	17	8	30	957
2	2	93.6	4.7	28	150	25	10	35	609
	3	83.8	4.0	24	100	25	8	30	87
	7	45.3	4.9	29	80	11	7	20	87
	5	50	3.2	19	150	17	8	30	957
3	2	95	4.8	28	200	28	8	35	1131
	3	85	4.1	24	150	25	9	35	522
	7	46	4.9	29	100	13	5	20	87
	5	50	3.2	19	100	14	5	20	87
4	2	95	5.9	34	200	28	8	35	1131
	3	85	5.3	31	150	25	9	35	522
	7	46	2.8	17	100	13	5	20	87
	5	50	3.1	18	100	14	5	20	87
5	2	95	4.8	28	150	25	10	35	880
	3	85	4.1	24	150	25	10	35	610
	7	46	4.9	29	100	12	5	20	100
	5	50	3.2	19	150	17	8	30	1140
6	2	95	7.1	34	200	28	8	35	1131
	3	85	6.4	31	150	25	9	35	522
	7	46	3.5	17	100	13	5	20	87
	5	50	3.8	18	100	14	5	20	87
7	2	95	4.8	34	200	28	8	35	1131
	3	85	4.3	31	150	25	9	35	522
	7	46	2.3	17	100	13	5	20	87
	5	50	2.5	18	100	14	5	20	87

Table A2. Variables included in different scenarios (Scenarios are grouped as dicussed in the report).

Variables	Community Basin Scenario 1				Community Basin Scenario 2			
	2	3	7	5	2	3	7	5
Drained area (ha)	95	85	42.76	50	93.64	83.78	45.34	50
Basin area (ha)	4.8	4.1	4.58	3.24	4.73	4.04	4.86	3.24
Pipe Length (m)	609	87	87	957	609	87	87	957
Pipe size (mm)	150	100	80	150	150	100	80	150
Pipe cost* ($/m)	19.50	12	10	19.5	19.5	12	10	19.5
Pump discharge rate (l/s)	35	30	20	30	35	30	20	30
Pump cost** ($)	7316	4975	4590	4975	7316	4975	4590	4975
Total energy required(kWh)	2857	2100	845	1296	2857	2100	845	1296
Variables	**Community Basin Scenario 3**				**Community Basin Scenario 5**			
Drained area (ha)	95	85	46	50	95	85	46	50
Basin area (ha)	4.8	4.1	4.93	3.24	4.8	4.1	4.93	3.24
Pipe Length (m)	1131	522	87	87	880	610	100	1140
Pipe size (mm)	200	150	100	100	150	150	100	150
Pipe cost* ($/m)	30	19.5	12	12	19.5	19.5	12	19.5
Pump discharge rate (l/s)	35	35	20	20	35	35	20	30
Pump cost** ($)	7316	7316	4590	4590	7316	7316	4590	4975
Total energy required(kWh)	2488	2430	767	833	2857	2857	767	1296

Variables Cont...

Variables	Community Basin Scenario 4				Community Basin Scenario 6				Community Basin Scenario 7			
Drained area (ha)	95	85	46	50	95	85	46	50	95	85	46	50
Basin area (ha)	5.87	5.25	2.84	3.10	7.13	6.38	3.45	3.75	4.75	4.25	2.3	2.5
Pipe Length (m)	1131	522	87	87	1131	522	87	87	1131	522	87	87
Pipe size (mm)	200	150	100	100	200	150	100	100	200	150	100	100
Pipe cost* ($/m)	30	19.5	12	12	30	19.5	12	12	30	19.5	12	12
Pump cost** ($)	7316	7316	4590	4590	7316	7316	4590	4590	7316	7316	4590	4590

* includes the cost of pipe installation
** includes the cost pump and sump installation