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

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

# FINANCIAL ANALYSIS OF SUBSURFACE DRAINAGE WITH A BASIN FOR PASTURE PRODUCTION

Jai Singh, Heinz Kleindienst, Peter Dickinson, Bill Trewhella and Evan Christen

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# Foreword

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

This report deals with the financial viability of disposal basin and groundwater pumping for dairying enterprises on the Riverine Plains. This complements a previous report for basins and tile drainage for horticultural enterprises. The report explores cost-sharing issues between neighbouring farms and the importance of these for the viability of these schemes.

**Glen Walker**
***Leader, Salinity Program***

# Summary


This report examines the financial viability of groundwater pumping with disposal to an on-farm evaporation basin for watertable and salinity control. It is specific to dairy enterprises in parts of the Shepparton Irrigation Region, which have very saline groundwater. The DESM (Drainage Evaluation Spreadsheet Model) model of the Murray-Darling Basin Commission was used to analyse the costs and benefits of this strategy. The analysis does not make provision for the broader community benefits such as those associated with environmental protection or enhancement and support of regional economic development.

A number of scenarios were developed representing dairy farming in the area. These scenarios had varying property size, pumping rate, basin leakage rate, effectiveness of subsurface drainage in reducing salinity and area served by groundwater pumping. The results were analysed from both a *single landholder* investment and salinity plan (all costs and benefits) perspective. The benefits in the *single landholder* case being the salinity control benefits on the farmers own property, where the groundwater pump and evaporation basin are sited. This ignores the benefits of groundwater pumps to surrounding farms. In the *salinity plan* case the salinity benefits were considered from the total area of watertable control, irrespective of who incurred the cost and who derived benefits.

The cost of the evaporation basin constituted a significant proportion of the total cost of subsurface drainage ranging from 44-77%. The cost per ML of groundwater pumped decreased with increased drainage volume or basin area.

The BCR value was less than 1 and NPV value negative under all the scenarios for the *single landholder* case. For the scenarios tested, the use of a groundwater pump with an evaporation basin appears not to be a financially viable proposition for the *single landholder* unless a substantial *salinity plan* subsidy is provided or a cost-sharing arrangement is made with other landholders. Even during sensitivity analysis, when costs were reduced and benefits increased, the present value of costs for the subsurface drainage and evaporation basin outweighed the productivity benefits due to salinity control in almost all scenarios. The main reason for the low viability was that the drained area within one farm was not adequate to cover the cost of the scheme. Some of the scenario tested would have yielded a positive BCR if it had been assumed that all the benefits accrued to a single property, as may be the case for larger properties.

The results suggested the need to further expand the analysis in terms of considering other benefits of subsurface drainage and also developing a financial mechanism in the form of incentive or cost sharing among the beneficiaries. This may then make investment in a groundwater pump with evaporation basin financially viable for an individual farmer.

In the *salinity plan* case, the analysis suggests that the drainage plus basin was viable (discount rate 7%) for 5 out of 18 scenarios. The scenarios that were viable were where there was a large area drained with a large impact on perennial pasture protection.

However the sensitivity tests for the *salinity plan* case showed that at a 4% discount rate, higher gross margin and lower cost of disposal basin all the scenarios were viable. Other factors that make the scenarios viable were lower pumping costs, a cost subsidy in the form of salinity grant and lower pumping rates (which result in a smaller basin size). Other factors such as the salinity loss function and basin leakage rates had marginal effect.

The results suggest that groundwater pumping to disposal basins can be attractive from a *salinity plan* perspective in some circumstances. However a large area of salinity protection from the groundwater pumping coupled with a high proportion of area in perennial pasture is crucial for the financial viability of groundwater pumping disposing to an evaporation basin. All proposed sites should be subject to rigorous financial analysis.

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# Acknowledgments

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# 1. Introduction

This analysis examines a strategy for watertable and salinity control for areas with very saline groundwater, based on groundwater pumping with disposal to an evaporation basin. The financial viability of this has been assessed based on the returns to dairying enterprises, which are based on perennial pasture production, using data taken from the Shepparton Irrigation Region (SIR). The analysis does not make provision for the broader community benefits such as those associated with environmental protection or enhancement and support of regional economic development. The work in this report complements a separate analysis for the MIA, which involved subsurface drainage (tile drainage) and an evaporation basin for horticultural enterprises (Singh and Christen, 2000).

## 1.1 Disposal Basins in the SIR

Shallow saline watertables and the resulting soil salinisation is causing pasture production losses on dairy farms in the Shepparton Irrigation Region of northern Victoria. The Shepparton region covers a total area of approximately 500,000ha, of which 280,000ha are irrigated. The watertable in approximately one third of the region can be controlled by pumping groundwater from shallow aquifers (ISIA, 1993).

Groundwater pumping for salinity control is a key component of the Shepparton Irrigation Region Land and Water Salinity Management Plan (SIRLWSMP). Without the SIRLWSMP it was forecast that 274,000ha within the Region would be at risk to high watertables and salinity by 2020, but about 30,000ha was already served by existing groundwater pumps. About 170,000ha of the remaining area is considered to have shallow aquifers with medium to high extraction capacity, and groundwater pumping is the most economic method of watertable control for this area.

For most of the area (about 142,000ha) groundwater salinities are low (less than 5000 EC), and regional reuse of the groundwater is the preferred method of disposal. Most groundwater pumps are privately owned and the water is reused directly on-farm. Where safe reuse on-farm is not possible public (Goulburn-Murray Water) owned pumps are installed with discharge to the region's channel and drain system. Some of this water is reused, and the remainder is discharged to the River Murray under controlled conditions and in line with the Salt Disposal Entitlements (SDE's) purchased by the SIRLWSMP under the Murray-Darling Basin Salinity and Drainage Strategy.

About 18,000ha has moderate groundwater salinities (5,000-11,700 EC), and a further 10,000ha has high groundwater salinities (more than 11,700 EC). The SIRLWSMP generally provides for installation of public pumps to serve these areas, with the pumps in the moderate groundwater salinity areas discharging to the region's channels and drains for regional reuse and some disposal to the Murray River. The SIRLWSMP requires that the very saline water be discharged to evaporation basins, and has estimated that 50 public pumps discharging to evaporation basins will be required.

The SIRLWSMP guidelines for management of saline groundwater are flexible, and each installation is assessed on its merits, particularly in relation to the safe disposal of the pumped groundwater. Groundwater pumping with on-farm reuse of the low salinity water is clearly the most economic solution where feasible. However in many areas the final solution will be a mixture of private pumps with on-farm disposal and public pumps discharging to channels and drains or to evaporation basins. Even though the public pumps may be less economic when seen in isolation, and particularly when discharging to evaporation basins, it is important that they be seen in the total Plan context. The groundwater salinities are highly variable locally, and failure to pump the more saline groundwater would ultimately contribute to rising salinities in the lower salinity groundwaters as a result of migration of the more saline groundwater. In addition the continuing high watertables in these areas, if uncontrolled, would result in highly saline base flows to the surface drainage system and increased surface drainage salt loads to the Murray. Therefore under the SIRLWSMP consideration is given to both the individual economics of each public groundwater pump, and its likely interaction with other private or public pumps in the vicinity.

The SIRLWSMP is also subject to regular review and every effort is made to minimise saline discharges to the regional channels and drains and the Murray River. It is therefore likely that there will be increasing interest over time in disposal to evaporation basins, possibly in conjunction with other disposal schemes such as Serial Biological Concentration. It is also possible that private evaporation basins may be considered once clearly agreed guidelines and standards are in place.

# 2. Objectives

The objectives of this study were to:

1. Develop an analytical framework for the financial analysis of groundwater pumping with disposal to an evaporation basin with varying farm size, land and water use, groundwater pumping, basin leakage, effective salinity control, size and siting of evaporation basin.

2. Analyse the financial viability of perennial pasture production using groundwater pumping and disposal to an evaporation basin from a s*ingle landholder* and *salinity plan* perspective.

3. Determine the overall conditions for successful use of groundwater pumping in conjunction with an evaporation basin.

# 3. Methodology

## 3.1 Drainage Evaluation Spreadsheet Model (DESM)

The Drainage Evaluation Spreadsheet Model (DESM), which has been developed for the Murray Darling Basin Commission (MDBC), is a spreadsheet model for PC use based on Microsoft EXCEL. Its purpose is to provide an economic assessment of both surface and subsurface drainage projects. The model evaluates the economic performance of the projects over a 50-year period using a discounted cash flow methodology (MDBC, 1995).

### *3.1.1 Modules*

There are a number of modules in the DESM model, each of which represent a key feature of the project evaluation:

**Agricultural production - without project and with project**
These two modules are concerned with: existing agricultural conditions; forecasts for agriculture over the next 50 years, with and without the drainage project under consideration; and the achievable value of production over the next 50 years, with and without the project.

**Agricultural production losses due to salinity**
This spreadsheet requires two data sets. One is a time series relating the extent of the shallow watertable area in the catchment under consideration to index years. The second data set is termed the "MDBC Salinity Loss Function". It links average productivity losses in shallow watertable areas with the time since the onset of shallow watertables.

**Agricultural production losses due to waterlogging and flooding**
This requires the input of the area affected by waterlogging.

**Drainage and on-farm works - without project and with project**
These modules are concerned with the extent and rate of development of drainage and landforming in the catchment under consideration.

**Effectiveness of drainage and on-farm works**
This requires input assumptions regarding the proportional effectiveness of the various measures (surface drainage, subsurface drainage and on-farm works) in reducing both the salinity losses and waterlogging losses.

**Drainage capital and Operation and Maintenance (O&M) costs**
All costs are input to this module.

**Reuse benefits**
This is concerned with calculating the benefits derived from reuse of the drainage water generated by the project under consideration. It requires assumptions to be made regarding the proportion of applied water that, without surface drainage, would have gone to waste but which, with the project, discharges to the drainage system and is reused. In the case of subsurface drainage an assumption is required as to the proportion of the groundwater produced by the scheme that is reused. The value of the reused water must also be specified.

**Downstream impacts**
The downstream impacts module is concerned with the disbenefits due to the salt load discharged to the River Murray resulting from the drainage scheme under consideration, and any other costs associated with the disposal of drainage water.

**Road benefits**
This module is concerned with calculating the benefits of surface and/or subsurface drainage in terms of reduced road construction and maintenance costs.

In this analysis benefits due to salinity were considered while the agricultural production losses due to waterlogging and flooding and the reuse benefits, downstream impacts and road benefits of the DESM were not considered. The analysis was done using a discount rate of 7%.

In applying the DESM model for the present analysis, a number of parameters relating to the project were defined in order to quantify a range of inputs. A number of representative case scenarios were developed based on the existing biophysical conditions in the Shepparton Irrigation Region relating to crop enterprise, property size, land use, water allocation, groundwater pumping and area served, groundwater extraction. It was assumed that suitable evaporation basin sites were available in all cases.

## 3.2 Study Assumptions, Data and Parameters

Details of the various assumptions and input parameters are given below.

### *3.2.1 Property size*

The following assumptions (Table 1) for property sizes were used for the analysis based on Census information on property size distribution. These farm sizes adequately represented the range of dairy properties in the Shepparton Irrigation Region. For each property size range, the "typical" (median/average) proportion of the following land use categories; perennial pasture, annual pasture, dryland pasture, and area under non agricultural use were estimated, as was the average water use (ML/ha). The relative productivity of these land uses was taken as perennial pasture: annual pasture: dryland pasture = 10:2:1, and the resulting area represented as "Perennial Pasture Equivalents" (PPE).

*Table 1. Parameter values adopted for dairy properties in the Shepparton Irrigation Region*

| Representative Range (ha) | 30-60 | 60-110 | 110-140 | 140-200 | 200-280 | >280 |
|---|---|---|---|---|---|---|
| Nominal farm size (median) (ha) | 40 | 80 | 120 | 160 | 240 | 320 |
| Perennial pasture % | 73.8 | 61.4 | 48.7 | 45.8 | 39.8 | 32.8 |
| Annual pasture % | 18.5 | 22.8 | 27.6 | 26.6 | 24.4 | 20.4 |
| Dryland pasture % | 7.8 | 12 | 16.3 | 17.1 | 19.6 | 17.4 |
| Area under non agricultural use % | 0 | 3.9 | 7.4 | 10.4 | 16.2 | 29.4 |
| Average water use (ML/ha) | 4.9 | 4.1 | 3.3 | 3.3 | 2.8 | 2.6 |
| Perennial Pasture Equivalent (ha) | 33.5 | 59.2 | 76.9 | 97.3 | 129.6 | 143.2 |

### *3.2.2 Groundwater extraction and area served by groundwater pumping*

A pumping rate of 0.7ML/yr/ha of area served was adopted based on experience in the Girgarre project. This incorporated an allowance for recycling 1 to 1.5mm/day seepage from the disposal basin at Girgarre. Based on a pumping rate of 0.7ML/ha/year the following assumptions were made regarding groundwater pumping:

1. The groundwater pump and evaporation basin would be located entirely on one property (Figure 1);
2. The groundwater pump will service both the 'pumping property' and an area on the neighbouring property (Figure 1);
3. The cost of the groundwater pump and evaporation basin would be borne by the landholder on which they were sited apart from any Salinity Plan contribution; and
4. Property size, land use and water allocations on both properties are the same.

The figure shows the disposal basin outside the area served by the pump. However the analysis, in terms of leakage, has assumed that the basin is inside

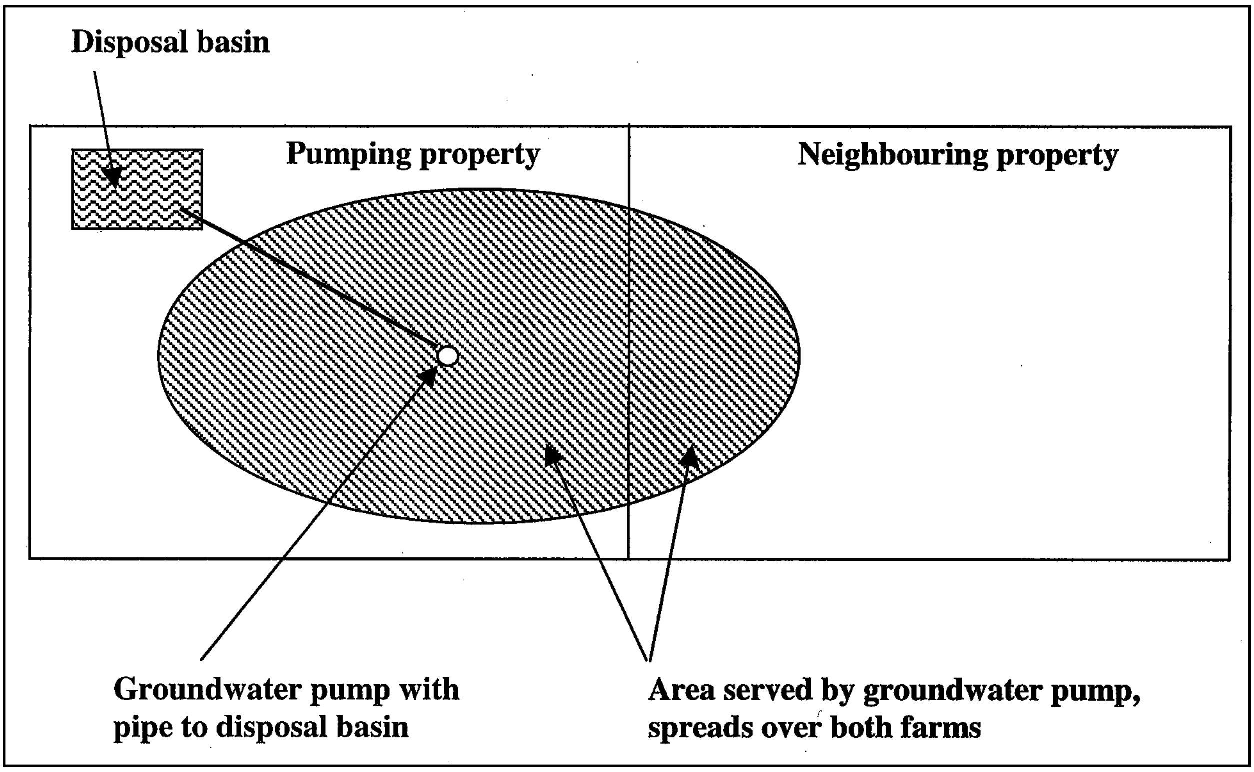


*Figure 1.Schematic representation of configuration for groundwater pumping scenarios.*

the area served. In practice either situation may occur, but this should not greatly affect the overall results of the analysis. Additional seepage interception works may be required if the basin is outside the area served, but the cost of this is likely to be offset because the cost of pumping within the area served should be reduced in that case. Any error associated with this issue should be covered within the range of sensitivity tests carried out.

Based on these assumptions the financial analysis of the viability of groundwater pumping with an evaporation basin was carried out for a number of scenarios, Table 2.

*Table 2. Scenarios of groundwater extraction and area served by the groundwater pump for different property sizes.*

| Scenario No | Property size (ha) | Area served by groundwater pump (ha) | | Groundwater extraction* (ML/year) |
|---|---|---|---|---|
| | | Pumping property | Neighbouring property | |
| 1 | 40 | 30 | 30 | 42 |
| 2 | 40 | 30 | 10 | 28 |
| 3 | 80 | 30 | 30 | 42 |
| 4 | 80 | 50 | 10 | 42 |
| 5 | 80 | 50 | 50 | 70 |
| 6 | 120 | 40 | 40 | 56 |
| 7 | 120 | 65 | 15 | 56 |
| 8 | 120 | 75 | 55 | 91 |
| 9 | 160 | 50 | 50 | 70 |
| 10 | 160 | 80 | 20 | 70 |
| 11 | 160 | 100 | 60 | 112 |
| 12 | 240 | 50 | 50 | 70 |
| 13 | 240 | 80 | 20 | 70 |
| 14 | 240 | 110 | 90 | 140 |
| 15 | 320 | 50 | 50 | 70 |
| 16 | 320 | 80 | 20 | 70 |
| 17 | 320 | 120 | 120 | 168 |
| 18 | 320 | 200 | 40 | 168 |

*at 0.7 ML/ha/year

The details of all the inputs for each scenerio used in the DESM are given in Appendix 1.

### *3.2.3 Achievable gross margin*

A value of $1512/ha of Perennial Pasture Equivalent was used as the achievable gross margin (North-East Gross Margins, 1997-1998).

### *3.2.4 Losses due to salinity*

The MDBC salinity loss function method 1 (MDBC, 1995) for high salinity groundwater for various irrigation intensities was used. The salinity loss functions assume a progressive increase in salt accumulation over a 50 year period following the onset of shallow watertables. Current productivity losses on the properties were assumed to be in the 15th year after the onset of shallow watertables. This corresponded to an initial productivity loss of 17, 19 and 22 per cent at water use intensities of 3ML/ha, 4ML/ha and 5ML/ha, respectively. The purpose of the works was to reclaim salinity losses already incurred to that time, and to prevent increasing salinity losses as a result of continuing salt accumulation in the longer-term.

### *3.2.5 Subsurface drainage salinity control*

The effectiveness of subsurface drainage alone in reducing salinity losses was assumed to be 82%. This figure was adopted from Sinclair Knight Merz (1999).

It was assumed that the full benefits of salinity control from subsurface drainage (groundwater pumping) would be achieved in the third year after pump installation, with 33% benefits achieved in the first year and 67% in the second year.

### *3.2.6 Evaporation basin size and costs*

The size of evaporation basins corresponding to different pumped volumes were derived using a spreadsheet model of the Girgarre basin as described in Leaney and Christen (2000), using the same input water quality (about 18,000 EC) and applying Girgarre weather data from 1957-1997 with 1mm/day leakage. The basin area required to dispose of the groundwater in the above scenarios is given in Table 3.

*Table 3. Evaporation basin area required.*

| Pumped volume (ML/ year) | Basin area* (ha) | Basin cost per unit area ($000's/ha) |
|---|---|---|
| 28 | 2.2 | 12.1 |
| 42 | 3.3 | 10.8 |
| 56 | 4.5 | 10.0 |
| 70 | 5.7 | 9.5 |
| 91 | 7.4 | 9.0 |
| 112 | 9.1 | 8.6 |
| 140 | 11.5 | 8.3 |
| 168 | 13.9 | 8.0 |

* 1mm/day leakage

The costs of evaporation basins were taken from Singh and Christen (1999). The evaporation basins were sited on dryland portions of the farms, which have the lowest land value. In each scenario there was sufficient area of dryland available for the basin and as a result there was no water saving accrued from land used for the evaporation basin and the land had a very low opportunity cost.

### *3.2.7 Capital, operation and maintenance costs*

The capital costs covered pumpsite cost (pump, motor and pump pit), cost of pipelines, three-phase power, earthworks contracting time, exploratory drilling and cost of evaporation basin construction. A uniform average capital cost of the groundwater pumping installation (excluding evaporation basin) of $34,275 (Table 4) was adopted for all cases. The total capital cost was assumed to incur in the first year. The capital cost adopted is likely to be high for all except the higher capacity sites serving the larger properties. However the sensitivity testing should adequately address this issue for the smaller sites.

Operation and maintenance costs included the cost of water pumped at $20 per ML and a range of costs associated with evaporation basins, as taken from Singh and Christen (1999).

*Table 4.Pump cost.*

| Cost component | Cost ($) |
|---|---|
| Pumpsite (pump, motor and pump pit) | 3,425 |
| Well points | 5,000 |
| Headerline | 5,400 |
| Delivery | 6,000 |
| Power supply (three phase) | 8,000 |
| Contractor | 3,400 |
| Exploratory drilling | 3,050 |
| Total capital cost | 34,275 |

Note that in these analyses it is assumed that the capital costs are the same over the whole pumping range (28-168 ML/year). This may not always be the case. An average asset life of 50 years with a discount rate of 7% was used.

## 3.3 Financial Analysis and Output

The financial analysis with respect to the various scenarios given in Table 2 was carried out from two perspectives:

1. *Single landholder*, where the costs accrue to a single landholder installing a groundwater pump and basin. The benefits are taken as only those accruing in the single farm, ignoring benefits to the neighbouring farms.
2. *Salinity Plan,* where the total costs of groundwater pumping and basin are compared to the total productivity benefits over the whole area served by the pump. Thus benefits to both farms are accounted for. This is a public investment type of analysis. The details of all the inputs for the *Salinity Plan* perspective are given in Appendix 2.

The output of these analyses are presented as Net Present Value (NPV), Benefit Cost Ratio (BCR) and average annual Net Cash Flow (NCF).

## 3.4 Sensitivity Analysis

A sensitivity analysis was carried out to determine the impact of varying a number of financial and physical factors on the financial viability. The factors considered in the sensitivity analysis are presented in Table 5.

The salinity grant for pump cost used in the sensitivity testing is an average value based on the current salinity grant available for groundwater pumping under the Shepparton Land and Water Salinity Management Plan.

The basin size and costs for the different leakage rates and different pumping rates are detailed in Appendix 3.

*Table 5. Factors considered for sensitivity analysis.*

| Factors | Standard scenario value | Sensitivity analysis values |
|---|---|---|
| Discount Rate (%) | 7 | 4<br>10 |
| Current production losses due to salinity (years of onset of shallow watertables) | 15 | 10<br>20 |
| Private pump cost ($) | $34,275 | $21,125<br>$47,925 |
| Salinity grant for pump cost (%) | 0 | 43.3 |
| Basin leakage (mm /day) | 1 | 0.5<br>1.5 |
| Groundwater pumping rate (ML/ha/year) | 0.7 | 0.5<br>1.0 |
| Gross margin ($/ha) | 1,512 | 1,210<br>1,814 |
| Disposal basin cost (%) | | +20<br>-20 |

# 4. Results and Discussion

## 4.1 Cost of Subsurface Drainage Scheme

The total cost of subsurface drainage (groundwater pump and basin) varied from $65,000 to $145,000 depending upon the volume of groundwater extracted and basin area (Table 6). The cost of evaporation basin constituted a significant proportion of the total cost ranging from about 44-77%. However, the cost per ML of groundwater pumped decreased with increase in drainage volume.

*Table 6. Capital cost of subsurface drainage to dairy farmer under different scenarios.*

| Pumped volume (ML/ year) | Basin cost ($) | Total cost ($) | Cost per unit pumping ($/ML) | Cost per unit area drained ($/ha) |
|---|---|---|---|---|
| 28 | 26,700 | 60,500 | 2,200 | 1,500 |
| 42 | 35,700 | 69,500 | 1,650 | 1,160 |
| 56 | 45,000 | 78,800 | 1,400 | 990 |
| 70 | 54,000 | 87,800 | 1,250 | 880 |
| 91 | 66,500 | 100,300 | 1,100 | 770 |
| 112 | 78,600 | 112,400 | 1,000 | 700 |
| 140 | 95,200 | 129,000 | 920 | 650 |
| 168 | 112,000 | 145,800 | 8,00 | 610 |

## 4.2 Financial Viability

### *4.2.1 Single Landholder Perspective*

For all scenarios the BCR was less than 1 and NPV negative, Table 7. This shows that for the given scenarios the use of a groundwater pump with a disposal basin is not a justifiable investment proposition unless the landholder receives some financial subsidy or enters into a cost-sharing arrangement with their neighbour. In the scenarios chosen the area served by groundwater pumping in the pump property averaged only 47% of the property, whilst an average of 29% of the neighbouring property was also served. However, all the costs were borne by the single landholder, for service on the pump property and the neighbouring property, in that the size of basin and pumping per year were to provide for all the total served area which includes a portion of the neighbouring property. In reality the landholder may pump at a lower rate that most benefits his property, minimising the area outside his property which is influenced by the pump. This would reduce running costs and the area of basin required.

These analyses suggest the need to consider a financial mechanism in the form of incentive or cost sharing among the beneficiaries to more equitably distribute costs on the basis of benefits.

*Table 7.Financial viability of groundwater pumping with a disposal basin from a* single landholder *perspective.*

| Scenario* | Value ($000's) | | | Benefit Cost Ratio | Av. Net Cash Flow ($/year) |
|---|---|---|---|---|---|
| | Salinity control benefits | Total costs | Net Present Value | | |
| 1 | 112 | 156 | -43 | 0.7 | 6,200 |
| 2 | 112 | 133 | -21 | 0.8 | 6,800 |
| 3 | 85 | 156 | -70 | 0.5 | 3,900 |
| 4 | 140 | 156 | -15 | 0.9 | 8,500 |
| 5 | 140 | 200 | -60 | 0.7 | 7,300 |
| 6 | 83 | 178 | -95 | 0.5 | 3,000 |
| 7 | 135 | 178 | -43 | 0.8 | 7,300 |
| 8 | 157 | 231 | -75 | 0.7 | 7,700 |
| 9 | 102 | 200 | -99 | 0.5 | 4,000 |
| 10 | 160 | 200 | -40 | 0.8 | 8,900 |
| 11 | 198 | 262 | -63 | 0.8 | 10,400 |
| 12 | 88 | 200 | -112 | 0.4 | 2,900 |
| 13 | 177 | 200 | -24 | 0.9 | 10,200 |
| 14 | 198 | 303 | -105 | 0.7 | 9,200 |
| 15 | 75 | 200 | -126 | 0.4 | 1,800 |
| 16 | 121 | 200 | -80 | 0.6 | 5,600 |
| 17 | 177 | 344 | -166 | 0.5 | 6,400 |
| 18 | 292 | 344 | -52 | 0.8 | 15,900 |
| Average | 142 | 213 | -72 | 0.7 | 7,000 |
| SD | 54.1 | 61.7 | 40.0 | 0.2 | 3,400 |

* Scenarios are described in Table 2

The analysis suggests that the best scenarios for a single landholder are those where a large proportion of the farm is served by the pump and only a small proportion of the served area is in the neighbouring farm, e.g. in scenarios 4 and 13, the BCR values are close to one. These scenarios represent a situation where the proportion of pumping property served by groundwater pump was higher (this is calculated by dividing the area of pumping property served by groundwater pump by total area of pumping property, as given in column A of Table 8) and the proportion of pumping property to total area served by groundwater pump (this is calculated by dividing the area of pumping property served by total area of both properties served by the groundwater pump, as given in column B of Table 8).

This is supported by the results of a multiple regression analysis which showed that these factors with BCR accounted for 84% of the variability, significant at $p = 0.05$. Both factors are significant, the slope coefficient for proportion of farm area drained being 0.48 and the slope coefficient for the proportion of area served within the pumping farm being 0.69.

*Table 8.Relationship between BCR,proportion of property served and proportion of total area served within the pump farm.*

| Scenario | BCR | Column A<br>Proportion of pumping property served by groundwater pump | Column B<br>Proportion of total area served within the pumping property |
|---|---|---|---|
| 1 | 0.7 | 0.75 | 0.50 |
| 2 | 0.8 | 0.75 | 0.75 |
| 3 | 0.5 | 0.38 | 0.50 |
| 4 | 0.9 | 0.63 | 0.83 |
| 5 | 0.7 | 0.63 | 0.50 |
| 6 | 0.5 | 0.33 | 0.50 |
| 7 | 0.8 | 0.54 | 0.81 |
| 8 | 0.7 | 0.63 | 0.58 |
| 9 | 0.5 | 0.31 | 0.50 |
| 10 | 0.8 | 0.50 | 0.80 |
| 11 | 0.8 | 0.63 | 0.63 |
| 12 | 0.4 | 0.21 | 0.50 |
| 13 | 0.9 | 0.33 | 0.80 |
| 14 | 0.7 | 0.46 | 0.55 |
| 15 | 0.4 | 0.16 | 0.50 |
| 16 | 0.6 | 0.25 | 0.80 |
| 17 | 0.5 | 0.38 | 0.50 |
| 18 | 0.8 | 0.63 | 0.83 |

### *4.2.2 Salinity Plan Perspective*

The *salinity plan* analysis is based on a whole area served approach. The total costs and benefits of the pumping accruing to the total area served by the pump are analysed. Table 9 shows that in most situations except scenario 1, 5, 8, 11 and 14 (where the BCR ranged from 1.2 - 1.4) groundwater pumping with disposal basin was not financially viable, although the average BCR across all the case studies was 1.1.

*Table 9.Financial viability of groundwater pumping with a disposal basin from a salinity plan perspective.*

| Scenario* | Present Value ($000's) | | | Benefit Cost Ratio | Av. Net Cash Flow ($/year 000's) |
|---|---|---|---|---|---|
| | Salinity control benefits | Total costs | Net Present Value | | |
| 1 | 225 | 156 | 69 | 1.4 | 15.7 |
| 2 | 149 | 133 | 16 | 1.1 | 9.3 |
| 3 | 171 | 156 | 16 | 1.1 | 11.1 |
| 4 | 171 | 156 | 16 | 1.1 | 11.1 |
| 5 | 281 | 200 | 81 | 1.4 | 19.1 |
| 6 | 167 | 178 | -12 | 0.9 | 10.0 |
| 7 | 167 | 178 | -12 | 0.9 | 10.0 |
| 8 | 271 | 231 | 40 | 1.2 | 17.2 |
| 9 | 203 | 200 | 3 | 1.0 | 12.4 |
| 10 | 203 | 200 | 3 | 1.0 | 12.4 |
| 11 | 321 | 262 | 59 | 1.2 | 20.5 |
| 12 | 177 | 200 | -23 | 0.9 | 10.2 |
| 13 | 177 | 200 | -23 | 0.9 | 10.2 |
| 14 | 354 | 303 | 51 | 1.2 | 22.1 |
| 15 | 150 | 200 | -51 | 0.7 | 8.0 |
| 16 | 150 | 200 | -51 | 0.7 | 8.0 |
| 17 | 356 | 344 | 13 | 1.0 | 21.3 |
| 18 | 356 | 344 | 13 | 1.0 | 21.3 |
| Average | 225 | 213 | 11 | 1.1 | 13.9 |
| SD | 77 | 62 | 38 | 0.2 | 5.0 |

* Scenarios are described in table 2

The analysis suggests that the most viable situations are where a large proportion of the total farm area is served. This is related to the return upon investment and the reduced cost per ML as the served area increases. This was confirmed by a regression analysis between BCR and proportion of the total farm area served which explained 88% of the total variation in BCR. The proportion of Perennial Pasture Equivalent was also important, explaining 44% of the variation in BCR. These two factors were highly correlated as the perennial pasture area increased with increasing area serviced by the pump. It was assumed here that area served has average "mix" of land uses adopted to arrive at Perennial Pasture equivalent area for each property. The results however are expected to improve on bigger properties if area served is targeted to higher value parts of property rather than average "mix" of land uses.

## 4.3 Sensitivity Analysis

### *4.3.1 Single Landholder Perspective*

The sensitivity analysis was carried out to determine the effect of changing different financial and biophysical factors and the results are shown in Table 10. They show that only the discount rate had a significant overall effect. However, for individual scenarios factors such as lower discount rate could improve the BCR from 0.8 to 1.3 in some cases e.g. scenarios 2, 4 and 13. All other factors such as higher values for the salinity loss function, lower pumping cost, salinity grant for the groundwater pump installation, higher basin leakage and lower pumping rate, increase in gross margin, decrease in disposal basin cost did not provide any significant improvement in results.

The overall results indicated that changing costs had little impact in the single landholder case because so much of the benefit is to the neighbouring property. This meant that cost reduction did not help much. Retention of more of the benefits on the farm is much more important.

*Table 10.Sensitivity analysis from a single landholder perspective.*

| | Value | Average BCR | S.D. |
|---|---|---|---|
| Standard scenarios | | 0.7 | 0.2 |
| **Factors** | | | |
| Discount Rate (%) | 4<br>10 | 0.9*<br>0.5* | 0.2<br>0.1 |
| Salinity loss function | 10 year<br>20 year | 0.6<br>0.7 | 0.2<br>0.2 |
| Pumping cost | Low<br>High | 0.8<br>0.6 | 0.2<br>0.1 |
| Salinity Grant (%) | 43.3 | 0.8 | 0.2 |
| Basin leakage (mm/d) | 0.5<br>1.5 | 0.7<br>0.8 | 0.2<br>0.2 |
| Pumping rate (ML/yr) | 0.5<br>1 | 0.8*<br>0.5* | 0.2<br>0.1 |
| Gross margin ($/ha) | 1210<br>1814 | 0.5*<br>0.8* | 0.1<br>0.2 |
| Disposal basin cost (%) | +20<br>-20 | 0.6<br>0.7 | 0.1<br>0.2 |

(Individual scenario results are presented in Appendices 4-11)
* Denotes these values are significantly different from standard scenario value at p=0.05 using t test (test of significance between two means with unequal variance).
Values without star are non-significant.

### *4.3.2 Salinity Plan Perspective*

The sensitivity results from a *salinity plan* perspective, Table 11, showed that discount rate, gross margin and pumping rate were the important factors; at a 4% discount rate and when the gross margin was increased by 20%, all of the scenarios were financially viable. Pumping rate is important as it changes the area of basin needed. Other significant factors were pumping cost and introduction of a salinity grant. The remaining factors had only marginal effect.

*Table 11.Sensitivity analysis for the* salinity plan *perspective.*

| | Value | Average BCR | S.D. |
|---|---|---|---|
| Standard scenarios | | 1.1 | 0.2 |
| **Factors** | | | |
| Discount Rate (%) | 4<br>10 | 1.5*<br>0.8* | 0.3<br>0.2 |
| Salinity loss function | 10 year<br>20 year | 1.0<br>1.1 | 0.2<br>0.2 |
| Pumping cost | Low<br>High | 1.2*<br>0.9 | 0.2<br>0.2 |
| Salinity Grant (%) | 43.3 | 1.2* | 0.2 |
| Basin leakage (mm/d) | 0.5<br>1.5 | 1.0<br>1.1 | 0.2<br>0.2 |
| Pumping rate (ML/yr) | 0.5<br>1 | 1.2*<br>0.9* | 0.2<br>0.2 |
| Gross margin ($/ha) | 1210<br>1814 | 0.8*<br>1.3* | 0.2<br>0.2 |
| Disposal basin cost (%) | +20<br>-20 | 1.0<br>1.2 | 0.2<br>0.2 |

(Individual scenario results are presented in Appendices 12-19)
* Denotes these values are significantly different from standard scenario value at p=0.05 using t test (test of significance between two means with unequal variance). Values without star are non-significant.

# 5. Conclusions

The following conclusions can be derived from the analyses:

1. For the *single landholder* scenarios studied, investment in groundwater pumping with a disposal basin was not an attractive investment proposition.
2. There is a need to devise a mechanism to compensate the landholder who installs and operates a groundwater pump for salinity control benefits which accrue on neighbouring farms.
3. From a *Salinity Plan* perspective, the scenarios suggest that investment in groundwater pumping with disposal to a basin appears to be justified under a range of circumstances, but rigorous financial analysis would be required in all cases.
4. The most viable scenarios were those where farms had a high proportion of their total area served by the pump (>50%) and a high proportion of perennial pasture. These provide the lowest costs per unit area and highest returns per unit area.
5. Discount rate, gross margin and rate of pumping (which affects size of basin required and hence total cost of the scheme) were the important factors affecting financial viability of groundwater pumping with disposal basin scheme in pasture production.

# 6. References


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6. Singh J. and Christen E.W. (1999). Minimising the cost of basins: Siting, design and construction factors. Technical Report 12/99. CSIRO Land and Water, Griffith. CRC for Catchment Hydrology Report 00/5.
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# Appendix 1

**Appendix 1. Input data for financial analysis from private investment perspective**

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average farm area (ha) | 40 | 40 | 80 | 80 | 80 | 120 | 120 | 120 | 160 | 160 | 160 | 240 | 240 | 240 | 320 | 320 | 320 | 320 |
| Perennial pasture equivalent area farmer 1 (ha) | 33 | 33 | 69 | 59 | 69 | 77 | 77 | 78 | 97 | 97 | 96 | 129 | 129 | 129 | 143 | 143 | 142 | 142 |
| Achievable GM ($/ha) | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1612 | 1512 | 1612 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 |
| Area protected | 30 | 30 | 30 | 50 | 50 | 40 | 65 | 75 | 80 | 80 | 100 | 50 | 80 | 110 | 50 | 60 | 120 | 200 |
| Average water use (ML/ha) | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| GW Extraction rate (ML/ha/year) | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Total GW extracted (ML) | 42 | 28 | 42 | 42 | 70 | 56 | 58 | 91 | 70 | 70 | 112 | 70 | 70 | 140 | 70 | 70 | 168 | 168 |
| Water use for MDBC Salinity loss function (Method 1) | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Initial salinity loss at 15 year on salinity loss function (%) | 22 | 22 | 19 | 19 | 19 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Area of shallow watertable assumed 20 years ago | 11 | 11 | 24 | 24 | 24 | 33 | 33 | 33 | 42 | 42 | 42 | 66 | 56 | 56 | 62 | 62 | 62 | 62 |
| Area of shallow watertable assumed 10 years ago | 27 | 27 | 48 | 49 | 48 | 48 | 66 | 56 | 84 | 84 | 84 | 112 | 112 | 112 | 124 | 124 | 124 | 124 |
| Area of shallow watertable assumed today | 33 | 33 | 59 | 59 | 59 | 77 | 77 | 78 | 97 | 97 | 98 | 129 | 129 | 129 | 143 | 143 | 142 | 142 |
| Losses due to waterlogging and flooding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Drainage and Land forming | | | | | | | | | | | | | | | | | | |
| Assumed area provided with subsurface drainage 1st year | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| 2nd year | 66 | 66 | 65 | 66 | 66 | 68 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 65 | 66 | 66 | 66 | 66 |
| 3rd year | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Effective ness of subsurface drainage in reducing salinity losses | 62 | 52 | 31 | 51 | 61 | 27 | 44 | 61 | 28 | 41 | 51 | 17 | 27 | 38 | 13 | 21 | 31 | 51 |
| Capital operation and maintenance cost ($) | | | | | | | | | | | | | | | | | | |
| Pump site construction (pumps motor and pump pit) | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 |
| Pipelines | | | | | | | | | | | | | | | | | | |
| Well points | 6000 | 6000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 6000 | 5000 | 6000 | 6000 | 5000 | 5000 | 5000 | 5000 |
| header line | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 |
| Delivery | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |

# Appendix 1 cont...

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Power supply three Phase | 8000 | 6000 | 8000 | 8000 | 8000 | 6000 | 8000 | 8000 | 8000 | 6000 | 8000 | 8000 | 8000 | 8000 | 8000 | 6000 | 8000 | 8000 |
| Contractor | 3400 | 2400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 2400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 |
| Typical Grant (%) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Land holder cost (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Exploratory drilling | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3060 | 3050 | 3050 | 3050 | 3060 | 3050 | 3050 | 3050 | 3060 | 3060 | 3050 |
| Total Cost of Investigation design, pumpsite construction | 34275 | 34276 | 34276 | 34276 | 34275 | 34275 | 34275 | 34275 | 34276 | 34275 | 34276 | 34275 | 34275 | 34275 | 34275 | 34275 | 34276 | 34275 |
| Evaporation basin size | 3.3 | 2.2 | 3.3 | 3.3 | 5.7 | 4.6 | 4.6 | 7.4 | 5.7 | 5.7 | 8.1 | 5.7 | 5.7 | 11.6 | 5.7 | 5.7 | 13.8 | 13.8 |
| Basin Construction cost ($/ha) | 10821 | 12180 | 10821 | 10829 | 9482 | 10006 | 10006 | 8882 | 9482 | 9482 | 8639 | 9482 | 9482 | 8279 | 9482 | 9482 | 8031 | 8031 |
| Total Evaporation basin cost | 35709 | 26706 | 35709 | 35736 | 54047 | 46036 | 46036 | 69467 | 54047 | 54047 | 76580 | 54047 | 54047 | 96209 | 54047 | 54047 | 1E+05 | 1E+05 |
| Total cost of Drainage and Land forming | 69984 | 60981 | 69984 | 70011 | 68322 | 79311 | 79311 | 1E+05 | 68322 | 68322 | 1E+05 | 68322 | 68322 | 1E+05 | 68322 | 68322 | 1E+05 | 1E+05 |
| Total cost (O&M) of Pump | 840 | 560 | 840 | 840 | 1400 | 1120 | 1120 | 1820 | 1400 | 1400 | 2240 | 1400 | 1400 | 2800 | 1400 | 1400 | 3360 | 3360 |
| Annual O&M cost of evaporation basin ($/ha) | 329 | 431 | 329 | 329 | 237 | 272 | 272 | 207 | 237 | 237 | 187 | 237 | 237 | 168 | 237 | 237 | 165 | 155 |
| Total O&M cost | 1926 | 1506 | 1926 | 1926 | 2761 | 2344 | 2344 | 3052 | 2751 | 2751 | 3942 | 2751 | 2761 | 4732 | 2751 | 2751 | 5515 | 6615 |
| Reuse Benefit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Downstream Impacts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Road Benefits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Appendix 2

**Appendix 2. Input data for financial analysis from salinity plan perspective**

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average farm area (ha) | 40 | 40 | 80 | 80 | 80 | 120 | 120 | 120 | 160 | 160 | 160 | 240 | 240 | 240 | 320 | 320 | 320 | 320 |
| Total Farm area (ha) | 80 | 80 | 160 | 160 | 160 | 240 | 240 | 240 | 320 | 320 | 320 | 480 | 480 | 480 | 640 | 640 | 640 | 640 |
| Perennial pasture equivalent area farmer 1 (ha) | 33 | 33 | 59 | 59 | 59 | 77 | 77 | 76 | 97 | 97 | 96 | 129 | 129 | 129 | 143 | 143 | 142 | 142 |
| Perennial pasture equivalent area farmer 2 (ha) | 34 | 34 | 59 | 59 | 59 | 77 | 77 | 77 | 97 | 97 | 97 | 130 | 130 | 130 | 143 | 143 | 143 | 143 |
| Total Effective area (ha) | 67 | 67 | 118 | 118 | 118 | 153 | 153 | 153 | 194 | 194 | 194 | 259 | 259 | 258 | 286 | 286 | 285 | 285 |
| Achievable GM ($/ha) | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 | 1512 |
| Farmer 1 | 30 | 30 | 30 | 50 | 50 | 40 | 65 | 75 | 50 | 80 | 100 | 50 | 80 | 110 | 50 | 80 | 120 | 200 |
| Farmer 2 | 30 | 10 | 30 | 10 | 50 | 40 | 15 | 55 | 50 | 20 | 60 | 50 | 20 | 90 | 50 | 20 | 120 | 40 |
| Area protected | 60 | 40 | 60 | 60 | 100 | 80 | 80 | 130 | 100 | 100 | 160 | 100 | 100 | 200 | 100 | 100 | 240 | 240 |
| Average water use (ML/ha) | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| GW Extraction rate (ML/ha/year) | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Total GW extracted (ML) | 42 | 28 | 42 | 42 | 70 | 56 | 56 | 91 | 70 | 70 | 112 | 70 | 70 | 140 | 70 | 70 | 168 | 168 |
| Water use for MDBC Salinity loss function (Method 1) | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Initial salinity loss at 15 year on salinity loss function | 22 | 22 | 19 | 19 | 19 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Area of shallow water-table assumed 20 years ago | 22 | 22 | 48 | 48 | 48 | 66 | 66 | 66 | 84 | 84 | 84 | 112 | 112 | 112 | 124 | 124 | 124 | 124 |
| Area of shallow water-table assumed 10 years ago | 54 | 54 | 96 | 96 | 96 | 132 | 132 | 132 | 168 | 168 | 168 | 224 | 224 | 224 | 248 | 248 | 248 | 248 |
| Area of shallow water-table assumed today | 67 | 67 | 118 | 118 | 118 | 153 | 153 | 153 | 194 | 194 | 194 | 259 | 259 | 258 | 286 | 286 | 285 | 285 |
| Losses due to waterlogging and flooding | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Drainage and Land forming | | | | | | | | | | | | | | | | | | |
| Assumed % area provided with subsurface drainage 1st year | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| 2nd year | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 | 66 |
| 3rd year | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Effective ness of subsurface drainage in reducing salinity losses | 62 | 41 | 31 | 31 | 51 | 27 | 27 | 44 | 26 | 26 | 41 | 17 | 17 | 34 | 13 | 13 | 31 | 31 |
| Capital operation and maintenance cost ($) | | | | | | | | | | | | | | | | | | |
| Pump site construction (pumps motor and pump pit) | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 | 3425 |

# Appendix 2 cont...

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipelines | | | | | | | | | | | | | | | | | | |
| Well points | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| header line | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 | 5400 |
| Delivery | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| Power supply Three Phase | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 |
| Contractor | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 |
| Land holder cost (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Exploratory drilling | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 | 3050 |
| Total Cost of investigation design, pump site construction | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 | 34275 |
| Evaporation basin size | 3.3 | 2.2 | 3.3 | 3.3 | 5.7 | 4.5 | 4.5 | 7.4 | 5.7 | 5.7 | 9.1 | 5.7 | 5.7 | 11.5 | 5.7 | 5.7 | 13.9 | 13.9 |
| Basin Construction cost ($/ha) | 10821 | 12139 | 10821 | 10829 | 9482 | 10008 | 10008 | 8982 | 9482 | 9482 | 8633 | 9482 | 9482 | 8279 | 9482 | 9482 | 8031 | 8031 |
| Total Evaporation basin cost | 35709 | 26706 | 35709 | 35736 | 54047 | 45036 | 45036 | 66467 | 54047 | 54047 | 78560 | 54047 | 54047 | 95209 | 54047 | 54047 | 1E+05 | 1E+05 |
| Total cost of Drainage and Land forming | 69984 | 60981 | 69984 | 70011 | 88322 | 79311 | 79311 | 1E+05 | 88322 | 88322 | 1E+05 | 88322 | 88322 | 1E+05 | 88322 | 88322 | 1E+05 | 1E+05 |
| Total cost (O&M) of Pump | 840 | 560 | 840 | 840 | 1400 | 1120 | 1120 | 1820 | 1400 | 1400 | 2240 | 1400 | 1400 | 2800 | 1400 | 1400 | 3360 | 3360 |
| Annual O&M cost of evaporation basin ($/ha) | 329 | 431 | 329 | 329 | 237 | 272 | 272 | 207 | 237 | 237 | 187 | 237 | 237 | 168 | 237 | 237 | 155 | 155 |
| Total O&M cost | 1926 | 1508 | 1926 | 1926 | 2751 | 2344 | 2344 | 3352 | 2751 | 2751 | 3942 | 2751 | 2751 | 4732 | 2751 | 2751 | 5515 | 5515 |
| Reuse Benefit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Downstream Impacts | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Road Benefits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Appendix 3

**Appendix 3. Basin size and cost with different basin leakage rates**

| Groundwater pumped (ML/year) | Leakage rate 0.5mm/day | | Leakage rate 1.5mm/day | |
|---|---|---|---|---|
| | Basin area (ha) | Capital cost ($/ha) | Basin area (ha) | Capital cost ($/ha) |
| 28 | 2.5 | 11700 | 1.9 | 13400 |
| 42 | 3.9 | 10400 | 2.9 | 11200 |
| 56 | 5.2 | 9700 | 3.9 | 10400 |
| 70 | 6.5 | 9200 | 5 | 9800 |
| 91 | 8.6 | 8700 | 6.5 | 9200 |
| 112 | 10.6 | 8400 | 8.0 | 8800 |
| 140 | 13.3 | 8100 | 10.1 | 8500 |
| 168 | 16.2 | 7800 | 12.2 | 8200 |

**Basin area and capital cost with different pumping rates**

| Pumping rate @0.5ML/ha/year | | | Pumping rate @1ML/ha/year | | |
|---|---|---|---|---|---|
| Vol (ML) | Basin area (ha) | Cost ($/ha) | Vol (ML) | Basin area (ha) | Cost ($/ha) |
| 20 | 1.6 | 14100 | 40 | 3.2 | 10900 |
| 30 | 2.4 | 11800 | 60 | 4.8 | 9900 |
| 40 | 3.2 | 10900 | 80 | 6.5 | 9200 |
| 50 | 4 | 10300 | 100 | 8.1 | 8800 |
| 65 | 5.2 | 9700 | 130 | 10.6 | 8400 |
| 80 | 6.5 | 9200 | 160 | 13 | 8100 |
| 100 | 8.1 | 8800 | 200 | 16.7 | 7800 |
| 120 | 9.8 | 8500 | 240 | 20.3 | 7600 |

# Appendix 4

**Appendices 4-11: Sensitivity analysis of subsurface drainage with and evaporation basin from private investment perspective**

**Appendix 4. Discount rate**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *0.04* | | | | | | | | | | | | | | | | | | |
| Net Present Value ($000) | 12 | 39 | -32 | 59 | 7 | -64 | 22 | -4 | -58 | 38 | 30 | -80 | 66 | -20 | -103 | -27 | -101 | -116 |
| BCR | 1.1 | 1.3 | 0.8 | 1.3 | 1.0 | 0.7 | 1.1 | 1.0 | 0.7 | 1.2 | 1.1 | 0.6 | 1.3 | 0.9 | 0.5 | 0.9 | 0.7 | 0.6 |
| | | | | | | | | | | | | | | | | | | |
| *0.1* | | | | | | | | | | | | | | | | | | |
| Net Present Value ($000) | -69 | -48 | -87 | -49 | -90 | -109 | -73 | -107 | -116 | -76 | -105 | -125 | -65 | -143 | -134 | -103 | -194 | -194 |
| BCR | 0.5 | 0.6 | 0.4 | 0.7 | 0.5 | 0.3 | 0.6 | 0.5 | 0.4 | 0.6 | 0.6 | 0.3 | 0.7 | 0.5 | 0.3 | 0.4 | 0.4 | 0.4 |

# Appendix 5

**Appendix 5. Salinity Loss function**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *10th year of salinity loss function* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 109 | 109 | 82 | 135 | 135 | 79 | 129 | 149 | 97 | 153 | 190 | 85 | 169 | 189 | 72 | 116 | 170 | 279 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV,$000) | -47 | -25 | -74 | -21 | -66 | -99 | -49 | -82 | -103 | -47 | -72 | -116 | -31 | -114 | -129 | -85 | -174 | -64 |
| Benefit Cost Ratio (BCR) | 0.7 | 0.8 | 0.5 | 0.9 | 0.7 | 0.4 | 0.7 | 0.6 | 0.5 | 0.8 | 0.7 | 0.4 | 0.8 | 0.6 | 0.4 | 0.6 | 0.5 | 0.8 |
| Average Net Cash Flow ($000) | 6 | 7 | 4 | 8 | 7 | 3 | 7 | 8 | 4 | 9 | 10 | 3 | 10 | 9 | 2 | 6 | 6 | 16 |
| *20th year of salinity loss function* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 120 | 121 | 90 | 148 | 148 | 87 | 141 | 164 | 106 | 168 | 208 | 92 | 185 | 207 | 78 | 126 | 185 | 305 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV,$000) | -35 | -13 | -65 | -7 | -52 | -92 | -37 | -68 | -94 | -33 | -54 | -108 | -15 | -96 | -122 | -74 | -158 | -39 |
| Benefit Cost Ratio (BCR) | 0.8 | 0.9 | 0.6 | 1.0 | 0.7 | 0.5 | 0.8 | 0.7 | 0.5 | 0.8 | 0.8 | 0.5 | 0.9 | 0.7 | 0.4 | 0.6 | 0.5 | 0.9 |
| Average Net Cash Flow ($000) | 7 | 7 | 4 | 9 | 8 | 3 | 8 | 8 | 5 | 10 | 11 | 3 | 11 | 10 | 2 | 6 | 7 | 17 |

# Appendix 6

**Appendix 6. Pumping costs sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Low* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 107 | 90 | 107 | 107 | 141 | 124 | 124 | 164 | 141 | 141 | 187 | 141 | 141 | 218 | 141 | 141 | 249 | 249 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 132 | 110 | 132 | 132 | 177 | 155 | 155 | 208 | 177 | 177 | 238 | 177 | 177 | 279 | 177 | 177 | 320 | 320 |
| Net Present Value (NPV, $000) | -20 | 3 | -46 | 9 | -36 | -72 | -20 | -51 | -75 | -17 | -40 | -88 | 0 | -82 | -102 | -56 | -142 | -28 |
| Benefit Cost Ratio (BCR) | 0.9 | 1.0 | 0.6 | 1.1 | 0.8 | 0.5 | 0.9 | 0.8 | 0.6 | 0.9 | 0.8 | 0.5 | 1.0 | 0.7 | 0.4 | 0.7 | 0.6 | 0.9 |
| Average Net Cash Flow (NCF, $000) | 6 | 7 | 4 | 9 | 8 | 3 | 8 | 8 | 4 | 9 | 11 | 3 | 10 | 9 | 2 | 6 | 7 | 16 |
| *High* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 155 | 139 | 155 | 155 | 190 | 173 | 173 | 213 | 190 | 190 | 235 | 190 | 190 | 267 | 190 | 190 | 297 | 297 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 180 | 158 | 180 | 180 | 225 | 203 | 203 | 256 | 225 | 225 | 286 | 225 | 225 | 327 | 225 | 225 | 368 | 368 |
| Net Present Value (NPV,$000) | -68 | -46 | -95 | -40 | -85 | -120 | -68 | -99 | -124 | -65 | -88 | -137 | -48 | -130 | -150 | -104 | -191 | -76 |
| Benefit Cost Ratio (BCR) | 0.6 | 0.7 | 0.5 | 0.8 | 0.6 | 0.4 | 0.7 | 0.6 | 0.5 | 0.7 | 0.7 | 0.4 | 0.8 | 0.6 | 0.3 | 0.5 | 0.5 | 0.8 |
| Average Net Cash Flow (NCF, $000) | 6 | 7 | 4 | 8 | 7 | 3 | 7 | 7 | 4 | 9 | 10 | 3 | 10 | 9 | 2 | 5 | 6 | 16 |

# Appendix 7

**Appendix 7. Salinity Grant sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *43.3% salinity grant* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 102 | 86 | 102 | 103 | 137 | 120 | 120 | 160 | 137 | 137 | 183 | 137 | 137 | 214 | 137 | 137 | 244 | 244 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 127 | 105 | 127 | 127 | 172 | 150 | 150 | 203 | 172 | 172 | 233 | 172 | 172 | 275 | 172 | 172 | 315 | 315 |
| Net Present Value (NPV,$000) | -15 | 7 | -42 | 13 | -32 | -67 | -15 | -47 | -71 | -12 | -35 | -84 | 5 | -77 | -97 | -51 | -138 | -24 |
| Benefit Cost Ratio (BCR) | 0.9 | 1.1 | 0.7 | 1.1 | 0.8 | 0.6 | 0.9 | 0.8 | 0.6 | 0.9 | 0.8 | 0.5 | 1.0 | 0.7 | 0.4 | 0.7 | 0.6 | 0.9 |
| Average Net Cash Flow (NCF, $000) | 6 | 7 | 4 | 9 | 8 | 3 | 8 | 8 | 4 | 9 | 11 | 3 | 11 | 9 | 2 | 6 | 7 | 16 |

# Appendix 8

**Appendix 8. Basin Leakage rate sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *0.5mm/day* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 148 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 140 | 119 | 140 | 140 | 176 | 158 | 158 | 204 | 176 | 176 | 230 | 176 | 176 | 265 | 176 | 176 | 300 | 300 |
| O&M | 26 | 20 | 26 | 26 | 37 | 31 | 31 | 45 | 37 | 37 | 53 | 37 | 37 | 63 | 37 | 37 | 74 | 74 |
| Total | 165 | 139 | 165 | 165 | 213 | 189 | 189 | 249 | 212 | 212 | 283 | 213 | 213 | 328 | 212 | 212 | 374 | 374 |
| Net Present Value (NPV, $000) | -53 | -26 | -80 | -25 | -64 | -106 | -54 | -92 | -111 | -52 | -85 | -124 | -36 | -130 | -138 | -92 | -196 | -82 |
| Benefit Cost Ratio (BCR) | 0.7 | 0.8 | 0.5 | 0.8 | 0.7 | 0.4 | 0.7 | 0.6 | 0.5 | 0.8 | 0.7 | 0.4 | 0.8 | 0.6 | 0.4 | 0.6 | 0.5 | 0.8 |
| Average Net Cash Flow (NCF, $000) | 6 | 7 | 4 | 8 | 8 | 3 | 7 | 7 | 4 | 9 | 10 | 3 | 10 | 9 | 2 | 5 | 6 | 15 |
| *1.5mm/day* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 125 | 112 | 125 | 125 | 155 | 140 | 140 | 176 | 155 | 155 | 196 | 155 | 155 | 224 | 155 | 155 | 251 | 251 |
| O&M | 24 | 19 | 24 | 24 | 34 | 29 | 29 | 42 | 35 | 35 | 49 | 35 | 35 | 59 | 35 | 35 | 69 | 69 |
| Total | 149 | 131 | 149 | 149 | 190 | 169 | 169 | 218 | 190 | 190 | 246 | 190 | 190 | 283 | 190 | 190 | 320 | 320 |
| Net Present Value (NPV, $000) | -37 | -18 | -64 | -9 | -50 | -86 | -34 | -61 | -88 | -31 | -47 | -101 | -13 | -86 | -115 | -69 | -142 | -28 |
| Benefit Cost Ratio (BCR) | 0.8 | 0.9 | 0.6 | 0.9 | 0.7 | 0.5 | 0.8 | 0.7 | 0.5 | 0.8 | 0.8 | 0.5 | 0.9 | 0.7 | 0.4 | 0.6 | 0.6 | 0.9 |
| Average Net Cash Flow (NCF, $000) | 6 | 7 | 4 | 9 | 8 | 3 | 8 | 8 | 4 | 8 | 11 | 3 | 10 | 10 | 2 | 6 | 7 | 16 |

# Appendix 9

**Appendix 9. Pump extraction rate sensitivity**

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *0.5ML/ha* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 117 | 106 | 117 | 117 | 141 | 129 | 129 | 158 | 141 | 141 | 176 | 141 | 141 | 198 | 141 | 141 | 220 | 220 |
| O&M | 20 | 16 | 20 | 20 | 28 | 24 | 24 | 34 | 28 | 28 | 39 | 28 | 28 | 46 | 28 | 28 | 54 | 54 |
| Total | 137 | 123 | 137 | 137 | 169 | 153 | 153 | 191 | 169 | 169 | 215 | 169 | 169 | 244 | 169 | 169 | 274 | 274 |
| Net Present Value (NPV, $000) | -25 | -11 | -52 | 3 | -28 | -71 | -18 | -35 | -67 | -9 | -17 | -80 | 8 | -47 | -94 | -48 | -97 | 18 |
| Benefit Cost Ratio (BCR) | 0.8 | 0.9 | 0.6 | 1.0 | 0.8 | 0.5 | 0.9 | 0.8 | 0.6 | 0.9 | 0.9 | 0.5 | 1.1 | 0.8 | 0.4 | 0.7 | 0.7 | 1.1 |
| Average Net Cash Flow (NCF, $000) | 7 | 7 | 4 | 9 | 8 | 4 | 8 | 9 | 5 | 10 | 12 | 4 | 10 | 11 | 3 | 6 | 8 | 18 |
| *1ML/ha* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 152 | 129 | 152 | 152 | 196 | 176 | 176 | 230 | 196 | 196 | 261 | 196 | 196 | 306 | 196 | 196 | 351 | 351 |
| O&M | 32 | 24 | 32 | 32 | 46 | 39 | 39 | 57 | 46 | 46 | 68 | 46 | 46 | 83 | 46 | 46 | 97 | 97 |
| Total | 184 | 153 | 184 | 184 | 242 | 215 | 215 | 287 | 242 | 242 | 329 | 242 | 242 | 389 | 242 | 242 | 448 | 448 |
| Net Present Value (NPV, $000) | -72 | -41 | -99 | -44 | -102 | -132 | -80 | -131 | -140 | -82 | -131 | -154 | -65 | -191 | -167 | -121 | -269 | -156 |
| Benefit Cost Ratio (BCR) | 0.6 | 0.7 | 0.5 | 0.8 | 0.6 | 0.4 | 0.6 | 0.5 | 0.4 | 0.7 | 0.6 | 0.4 | 0.7 | 0.5 | 0.3 | 0.5 | 0.4 | 0.7 |
| Average Net Cash Flow (NCF, $000) | 5 | 6 | 3 | 8 | 6 | 2 | 6 | 6 | 3 | 8 | 9 | 2 | 6 | 7 | 1 | 4 | 4 | 13 |

# Appendix 10

**Appendix 10. Gross margin sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *-20% ($1210 /ha)* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 96 | 90 | 68 | 112 | 112 | 67 | 108 | 126 | 81 | 128 | 159 | 71 | 112 | 158 | 60 | 97 | 143 | 235 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV, $000) | -59 | -44 | -87 | -43 | -88 | -112 | -70 | -106 | -119 | -72 | -102 | -130 | -88 | -145 | -141 | -104 | -201 | -109 |
| Benefit Cost Ratio (BCR) | 0.6 | 0.7 | 0.4 | 0.7 | 0.6 | 0.4 | 0.6 | 0.5 | 0.4 | 0.6 | 0.6 | 0.4 | 0.6 | 0.5 | 0.3 | 0.5 | 0.4 | 0.7 |
| Average Net Cash Flow (NCF, $000) | 4.6 | 4.9 | 2.5 | 6.2 | 5.0 | 1.7 | 5.1 | 5.2 | 2.3 | 6.2 | 7.1 | 1.4 | 4.9 | 5.9 | 0.5 | 3.6 | 3.6 | 11.2 |
| *+20% ($1814 /ha)* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 144 | 134 | 102 | 168 | 168 | 100 | 163 | 188 | 122 | 192 | 239 | 106 | 168 | 237 | 90 | 145 | 214 | 351 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 272 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 343 |
| Net Present Value (NPV, $000) | -11 | 1 | -53 | 13 | -32 | -79 | -16 | -43 | -79 | -8 | -23 | -95 | -32 | -66 | -111 | -56 | -130 | 8 |
| Benefit Cost Ratio (BCR) | 0.9 | 1.0 | 0.7 | 1.1 | 0.8 | 0.6 | 0.9 | 0.8 | 0.6 | 1.0 | 0.9 | 0.5 | 0.8 | 0.8 | 0.4 | 0.7 | 0.6 | 1.0 |
| Average Net Cash Flow (NCF, $000) | 8.5 | 8.6 | 5.3 | 10.8 | 9.7 | 4.4 | 9.6 | 10.4 | 5.7 | 11.5 | 13.7 | 4.4 | 9.5 | 12.5 | 3.0 | 7.6 | 9.5 | 20.9 |

# Appendix 11

**Appendix 11. Disposal basin cost sensitivity**

| Scenarios | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| +20% | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 144 | 124 | 144 | 144 | 185 | 165 | 165 | 213 | 185 | 185 | 240 | 185 | 185 | 277 | 185 | 185 | 314 | 314 |
| | O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| | Total | 169 | 143 | 169 | 169 | 221 | 195 | 195 | 256 | 221 | 221 | 291 | 221 | 221 | 338 | 221 | 221 | 385 | 385 |
| Net Present Value (NPV, $000) | | -57 | -31 | -84 | -28 | -80 | -112 | -60 | -99 | -119 | -61 | -93 | -132 | -44 | -141 | -146 | -100 | -208 | -93 |
| Benefit Cost Ratio (BCR) | | 0.7 | 0.8 | 0.5 | 0.8 | 0.6 | 0.4 | 0.7 | 0.6 | 0.5 | 0.7 | 0.7 | 0.4 | 0.8 | 0.6 | 0.3 | 0.5 | 0.5 | 0.8 |
| Average Net Cash Flow (NCF, $000) | | 6.0 | 7.4 | 3.7 | 8.4 | 7.1 | 2.9 | 7.2 | 7.5 | 4.0 | 9.0 | 10.6 | 2.7 | 7.0 | 8.8 | 1.5 | 5.3 | 6.0 | 15.5 |
| -20% | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 112 | 112 | 85 | 140 | 140 | 83 | 135 | 157 | 102 | 160 | 198 | 88 | 177 | 198 | 75 | 121 | 177 | 292 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 117 | 104 | 117 | 117 | 145 | 131 | 131 | 163 | 145 | 145 | 181 | 145 | 145 | 206 | 145 | 145 | 231 | 231 |
| | O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| | Total | 142 | 123 | 142 | 142 | 180 | 162 | 162 | 207 | 180 | 180 | 232 | 180 | 180 | 267 | 180 | 180 | 302 | 302 |
| Net Present Value (NPV, $000) | | -30 | -11 | -57 | -2 | -40 | -78 | -26 | -50 | -78 | -20 | -34 | -92 | -3 | -70 | -106 | -60 | -124 | -10 |
| Benefit Cost Ratio (BCR) | | 0.8 | 0.9 | 0.6 | 1.0 | 0.8 | 0.5 | 0.8 | 0.8 | 0.6 | 0.9 | 0.9 | 0.5 | 1.0 | 0.7 | 0.4 | 0.7 | 0.6 | 1.0 |
| Average Net Cash Flow (NCF, $000) | | 6.3 | 7.5 | 4.0 | 8.6 | 7.5 | 3.2 | 7.6 | 8.0 | 5.5 | 9.4 | 11.2 | 3.1 | 8.4 | 9.6 | 2.0 | 5.8 | 6.9 | 16.4 |

# Appendix 12

**Appendices 12-19 Sensitivity analysis of subsurface drainage with and evaporation basin from salinity plan perspective**

**Appendix 12. Discount rate** s

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Discount Rate | | | | | | | | | | | | | | | | | | |
| *0.04* | | | | | | | | | | | | | | | | | | |
| Net Present Value ($000) | 200 | 73 | 110 | 110 | 240 | 75 | 75 | 185 | 110 | 110 | 232 | 66 | 66 | 238 | 21 | 21 | 194 | 194 |
| BCR | 2.1 | 1.4 | 1.6 | 1.6 | 2.1 | 1.4 | 1.4 | 1.7 | 1.5 | 1.5 | 1.8 | 1.3 | 1.3 | 1.7 | 1.1 | 1.1 | 1.5 | 1.5 |
| *0.1* | | | | | | | | | | | | | | | | | | |
| Net Present Value ($000) | 8 | -44 | -28 | -28 | 6 | -52 | -52 | -29 | -47 | -47 | -22 | -65 | -65 | -37 | -83 | -83 | -72 | 88 |
| BCR | 1.1 | 0.7 | 0.8 | 0.8 | 1.0 | 0.7 | 0.7 | 0.9 | 0.7 | 0.7 | 0.9 | 0.7 | 0.7 | 0.9 | 0.6 | 0.6 | 0.8 | 1.2 |

# Appendix 13

**Appendix 13. Salinity Loss function**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *10th year of salinity loss function* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 218 | 145 | 165 | 165 | 183 | 160 | 160 | 260 | 195 | 195 | 308 | 170 | 170 | 339 | 144 | 144 | 341 | 341 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV, $000) | 63 | 12 | 9 | 9 | -18 | -19 | -19 | 28 | -5 | -5 | 47 | -31 | -31 | 36 | -57 | -57 | -2 | -2 |
| Benefit Cost Ratio (BCR) | 1.4 | 1.1 | 1.1 | 1.1 | 0.9 | 0.9 | 0.9 | 1.1 | 1.0 | 1.0 | 1.2 | 0.8 | 0.8 | 1.1 | 0.7 | 0.7 | 1.0 | 1.0 |
| Average Net Cash Flow (NCF, $000) | 16 | 10 | 11 | 11 | 19 | 10 | 0 | 17 | 12 | 12 | 20 | 10 | 10 | 22 | 8 | 8 | 21 | 21 |
| *20th year of salinity loss function* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 240 | 160 | 181 | 181 | 204 | 174 | 174 | 284 | 212 | 212 | 335 | 185 | 185 | 370 | 157 | 157 | 373 | 373 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV, $000) | 85 | 27 | 26 | 26 | 4 | -4 | -4 | 53 | 12 | 12 | 73 | -15 | -15 | 67 | -44 | -44 | 29 | 29 |
| Benefit Cost Ratio (BCR) | 1.5 | 1.0 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.1 | 1.1 | 1.3 | 0.9 | 0.9 | 1.2 | 0.8 | 0.8 | 1.1 | 1.1 |
| Average Net Cash Flow ($000) | 17 | 11 | 11 | 11 | 20 | 11 | 11 | 18 | 13 | 13 | 21 | 11 | 11 | 23 | 9 | 9 | 22 | 22 |

# Appendix 14

**Appendix 14. Pumping cost**

| Scenarios | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Low* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 107 | 90 | 107 | 107 | 141 | 124 | 124 | 164 | 141 | 141 | 187 | 141 | 141 | 218 | 141 | 141 | 249 | 249 |
| | O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| | Total | 132 | 110 | 132 | 132 | 177 | 155 | 155 | 208 | 177 | 177 | 238 | 177 | 177 | 279 | 177 | 177 | 320 | 320 |
| Net Present Value (NPV, $000) | | 93 | 39 | 39 | 39 | 14 | 12 | 12 | 63 | 27 | 27 | 83 | 0 | 0 | 74 | -27 | -27 | 36 | 36 |
| Benefit Cost Ratio (BCR) | | 1.7 | 1.4 | 1.3 | 1.3 | 1.6 | 1.1 | 1.1 | 1.3 | 1.2 | 1.2 | 1.3 | 1.0 | 1.0 | 1.3 | 0.8 | 0.8 | 1.1 | 1.1 |
| Average Net Cash Flow (NCF, $000) | | 16 | 10 | 11 | 11 | 19 | 10 | 10 | 17 | 13 | 13 | 21 | 11 | 11 | 22 | 8 | 8 | 22 | 22 |
| *High* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 155 | 139 | 155 | 155 | 190 | 173 | 173 | 213 | 190 | 190 | 235 | 190 | 190 | 267 | 190 | 190 | 297 | 297 |
| | O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| | Total | 180 | 158 | 180 | 180 | 225 | 203 | 203 | 256 | 225 | 225 | 286 | 225 | 225 | 327 | 225 | 225 | 368 | 368 |
| Net Present Value (NPV, $000) | | 45 | -9 | -9 | -9 | -34 | -36 | -36 | 15 | -22 | -22 | 35 | -48 | -48 | 26 | -75 | -75 | -12 | -12 |
| Benefit Cost Ratio (BCR) | | 1.2 | 0.9 | 0.9 | 0.9 | 1.2 | 0.8 | 0.8 | 1.1 | 0.9 | 0.9 | 1.1 | 0.8 | 0.8 | 1.1 | 0.7 | 0.7 | 1.0 | 1.0 |
| Average Net Cash Flow (NCF, $000) | | 15 | 10 | 11 | 11 | 19 | 10 | 10 | 17 | 12 | 12 | 20 | 10 | 10 | 22 | 8 | 8 | 21 | 21 |

# Appendix 15

**Appendix 15. Salinity Grant**

| Scenarios | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *43.3% salinity grant* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 102 | 86 | 102 | 103 | 137 | 120 | 120 | 160 | 137 | 137 | 183 | 137 | 137 | 214 | 137 | 137 | 244 | 244 |
| | O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| | Total | 127 | 105 | 127 | 127 | 172 | 150 | 150 | 203 | 172 | 172 | 233 | 172 | 172 | 275 | 172 | 172 | 315 | 315 |
| Net Present Value (NPV, $000) | | 98 | 44 | 44 | 44 | 109 | 17 | 17 | 68 | 31 | 31 | 87 | 5 | 5 | 79 | -22 | -22 | 41 | 41 |
| Benefit Cost Ratio (BCR) | | 1.8 | 1.4 | 1.3 | 1.3 | 1.6 | 1.1 | 1.1 | 1.3 | 1.2 | 1.2 | 1.4 | 1.0 | 1.0 | 1.3 | 0.9 | 0.9 | 1.1 | 1.1 |
| Average Net Cash Flow (NCF, $000) | | 16 | 10 | 11 | 11 | 19 | 10 | 10 | 18 | 13 | 13 | 21 | 11 | 11 | 22 | 8 | 8 | 22 | 22 |

# Appendix 16

**Appendix 16. Basin Leakage rate**

| Scenarios | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *0.5mm/day* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 140 | 119 | 140 | 140 | 176 | 158 | 158 | 204 | 176 | 176 | 230 | 176 | 176 | 265 | 176 | 176 | 300 | 300 |
| | O&M | 26 | 20 | 26 | 26 | 37 | 31 | 31 | 45 | 37 | 37 | 53 | 37 | 37 | 63 | 37 | 37 | 74 | 74 |
| | Total | 165 | 139 | 165 | 165 | 213 | 189 | 189 | 249 | 212 | 212 | 283 | 213 | 213 | 328 | 212 | 212 | 374 | 374 |
| Net Present Value (NPV, $000) | | 60 | 10 | 6 | 6 | 68 | -22 | -22 | 22 | -9 | -9 | 38 | -35 | -35 | 26 | -63 | -63 | -18 | -18 |
| Benefit Cost Ratio (BCR) | | 1.4 | 1.1 | 1.0 | 1.0 | 1.3 | 0.9 | 0.9 | 1.1 | 1.0 | 1.0 | 1.1 | 0.8 | 0.8 | 1.1 | 0.7 | 0.7 | 1.0 | 1.0 |
| Average Net Cash Flow (NCF, $000) | | 15 | 10 | 11 | 11 | 19 | 10 | 10 | 17 | 12 | 12 | 21 | 10 | 10 | 22 | 8 | 8 | 21 | 21 |
| *1.5mm/day* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 125 | 112 | 125 | 125 | 155 | 140 | 140 | 176 | 155 | 155 | 196 | 155 | 155 | 224 | 155 | 155 | 251 | 251 |
| | O&M | 24 | 19 | 26 | 24 | 34 | 29 | 29 | 42 | 35 | 35 | 49 | 35 | 35 | 59 | 35 | 35 | 69 | 69 |
| | Total | 149 | 131 | 150 | 149 | 190 | 169 | 169 | 218 | 190 | 190 | 246 | 190 | 190 | 283 | 190 | 190 | 320 | 320 |
| Net Present Value (NPV, $000) | | 76 | 18 | 21 | 22 | 91 | -2 | -2 | 53 | 14 | 14 | 75 | -13 | -13 | 71 | -40 | -40 | 36 | 36 |
| Benefit Cost Ratio (BCR) | | 1.5 | 1.1 | 1.1 | 1.1 | 1.5 | 1.0 | 1.0 | 1.2 | 1.1 | 1.1 | 1.3 | 0.9 | 0.9 | 1.2 | 0.8 | 0.8 | 1.1 | 1.1 |
| Average Net Cash Flow (NCF, $000) | | 16 | 10 | 11 | 11 | 19 | 10 | 10 | 17 | 13 | 13 | 21 | 10 | 10 | 22 | 8 | 8 | 22 | 22 |

# Appendix 17

**Appendix 17. Pumping rate**

| Scenarios | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *0.5ML/ha* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 117 | 106 | 117 | 117 | 141 | 129 | 129 | 158 | 141 | 141 | 176 | 141 | 141 | 198 | 141 | 141 | 220 | 220 |
| | O&M | 20 | 16 | 20 | 20 | 28 | 24 | 24 | 34 | 28 | 28 | 39 | 28 | 28 | 46 | 28 | 28 | 54 | 54 |
| | Total | 137 | 123 | 137 | 137 | 169 | 153 | 153 | 191 | 169 | 169 | 215 | 169 | 169 | 244 | 169 | 169 | 273 | 273 |
| Net Present Value (NPV, $000) | | 88 | 26 | 34 | 34 | 112 | 13 | 13 | 80 | 35 | 35 | 106 | 8 | 8 | 110 | -19 | -19 | 83 | 83 |
| Benefit Cost Ratio (BCR) | | 1.6 | 1.2 | 1.2 | 1.2 | 1.7 | 1.1 | 1.1 | 1.4 | 1.2 | 1.2 | 1.5 | 1.0 | 1.0 | 1.5 | 0.9 | 0.9 | 1.3 | 1.3 |
| Average Net Cash Flow (NCF, $000) | | 16 | 10 | 12 | 12 | 20 | 11 | 11 | 18 | 13 | 13 | 22 | 11 | 11 | 24 | 9 | 9 | 23 | 23 |
| *1ML/ha* | | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | | |
| | Salinity | 225 | 149 | 171 | 171 | 281 | 167 | 167 | 271 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 356 | 356 |
| Present value of costs | | | | | | | | | | | | | | | | | | | |
| | Capital cost | 152 | 129 | 152 | 152 | 196 | 176 | 176 | 230 | 196 | 196 | 261 | 196 | 196 | 306 | 196 | 196 | 351 | 351 |
| | O&M | 32 | 24 | 32 | 32 | 46 | 39 | 39 | 57 | 46 | 46 | 68 | 46 | 46 | 83 | 46 | 46 | 97 | 97 |
| | Total | 184 | 153 | 184 | 184 | 242 | 215 | 215 | 287 | 242 | 242 | 329 | 242 | 242 | 389 | 242 | 242 | 448 | 448 |
| Net Present Value (NPV, $000) | | 41 | -4 | -13 | -13 | 39 | -48 | -48 | -16 | -39 | -39 | -8 | -65 | -65 | -35 | -92 | -92 | -91 | -91 |
| Benefit Cost Ratio (BCR) | | 1.2 | 1.0 | 0.9 | 0.9 | 1.2 | 0.8 | 0.8 | 0.9 | 0.8 | 0.8 | 1.0 | 0.7 | 0.7 | 0.9 | 0.6 | 0.6 | 0.8 | 0.8 |
| Average Net Cash Flow (NCF, $000) | | 15 | 9 | 10 | 10 | 18 | 9 | 9 | 16 | 11 | 11 | 19 | 9 | 9 | 20 | 7 | 7 | 18 | 18 |

# Appendix 18

**Appendix 18. Gross margin sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *-20% ($1210 /ha)* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 180 | 119 | 137 | 137 | 225 | 133 | 133 | 217 | 163 | 163 | 257 | 142 | 142 | 283 | 120 | 120 | 286 | 286 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 211 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 262 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV, $000) | 25 | -14 | -19 | -19 | 25 | -45 | -45 | -14 | -38 | -38 | -5 | -59 | -59 | -20 | -81 | -81 | -58 | -58 |
| Benefit Cost Ratio (BCR) | 1.2 | 0.9 | 0.9 | 0.9 | 1.1 | 0.7 | 0.7 | 0.9 | 0.8 | 0.8 | 1.0 | 0.7 | 0.7 | 0.9 | 0.6 | 0.6 | 0.8 | 0.8 |
| Average Net Cash Flow (NCF, $000) | 11.9 | 7.3 | 8.2 | 8.2 | 14.4 | 7.2 | 7.2 | 12.8 | 9.1 | 9.1 | 15.2 | 7.3 | 7.3 | 16.3 | 5.5 | 5.5 | 15.4 | 15.4 |
| *+20% ($1814 /ha)* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 270 | 179 | 205 | 205 | 338 | 200 | 200 | 326 | 244 | 244 | 385 | 212 | 212 | 425 | 180 | 180 | 429 | 429 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 131 | 114 | 131 | 131 | 165 | 148 | 148 | 188 | 165 | 165 | 210.8 | 165 | 165 | 242 | 165 | 165 | 273 | 273 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 156 | 133 | 156 | 156 | 200 | 178 | 178 | 231 | 200 | 200 | 261 | 200 | 200 | 303 | 200 | 200 | 344 | 344 |
| Net Present Value (NPV, $000) | 114 | 45 | 50 | 50 | 137 | 22 | 22 | 94 | 44 | 44 | 123 | 12 | 12 | 122 | -21 | -21 | 85 | 85 |
| Benefit Cost Ratio (BCR) | 1.7 | 1.3 | 1.3 | 1.3 | 1.7 | 1.1 | 1.1 | 1.4 | 1.2 | 1.2 | 1.5 | 1.1 | 1.1 | 1.4 | 0.9 | 0.9 | 1.2 | 1.2 |
| Average Net Cash Flow (NCF, $000) | 19.4 | 12.3 | 13.9 | 13.9 | 23.9 | 12.7 | 12.7 | 21.8 | 15.8 | 15.8 | 25.8 | 13.2 | 13.2 | 28.0 | 10.5 | 10.5 | 27.3 | 27.3 |

# Appendix 19

**Appendix 19.Disposal basin cost sensitivity**

| Scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *+20%* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 225 | 149 | 171 | 171 | 282 | 167 | 167 | 272 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 357 | 357 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 144 | 124 | 144 | 144 | 185 | 165 | 165 | 213 | 185 | 185 | 240 | 185 | 185 | 277 | 185 | 185 | 314 | 314 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 169 | 143 | 169 | 169 | 221 | 195 | 195 | 256 | 221 | 221 | 291 | 221 | 221 | 338 | 221 | 221 | 385 | 385 |
| Net Present Value (NPV, $000) | 56 | 5 | 2 | 2 | 61 | -28 | -28 | 15 | -17 | -17 | 30 | -44 | -44 | 16 | -71 | -71 | -29 | -29 |
| Benefit Cost Ratio (BCR) | 1.3 | 1.0 | 1.0 | 1.0 | 1.3 | 0.9 | 0.9 | 1.1 | 0.9 | 0.9 | 1.1 | 0.8 | 0.8 | 1.0 | 0.7 | 0.7 | 0.9 | 0.9 |
| Average Net Cash Flow (NCF, $000) | 15.5 | 9.7 | 10.9 | 10.9 | 18.9 | 9.8 | 9.8 | 17.0 | 12.2 | 12.2 | 20.2 | 10.0 | 10.0 | 21.8 | 7.8 | 7.8 | 20.9 | 20.9 |
| *-20%* | | | | | | | | | | | | | | | | | | |
| Present value of benefits | | | | | | | | | | | | | | | | | | |
| Salinity | 225 | 149 | 171 | 171 | 282 | 167 | 167 | 272 | 203 | 203 | 321 | 177 | 177 | 354 | 150 | 150 | 357 | 357 |
| Present value of costs | | | | | | | | | | | | | | | | | | |
| Capital cost | 117 | 104 | 117 | 117 | 145 | 131 | 131 | 163 | 145 | 145 | 181 | 145 | 145 | 206 | 145 | 145 | 231 | 231 |
| O&M | 25 | 19 | 25 | 25 | 35 | 30 | 30 | 43 | 35 | 35 | 51 | 35 | 35 | 61 | 35 | 35 | 71 | 71 |
| Total | 142 | 123 | 142 | 142 | 180 | 162 | 162 | 207 | 180 | 180 | 232 | 180 | 180 | 267 | 180 | 180 | 302 | 302 |
| Net Present Value (NPV, $000) | 83 | 25 | 29 | 29 | 101 | 5 | 5 | 65 | 23 | 23 | 89 | -3 | -3 | 87 | -31 | -31 | 55 | 55 |
| Benefit Cost Ratio (BCR) | 1.6 | 1.2 | 1.2 | 1.2 | 1.6 | 1.0 | 1.0 | 1.3 | 1.1 | 1.1 | 1.4 | 1.0 | 1.0 | 1.3 | 0.8 | 0.8 | 1.2 | 1.2 |
| Average Net Cash Flow (NCF, $000) | 15.8 | 9.9 | 11.2 | 11.2 | 19.4 | 10.2 | 10.2 | 17.5 | 12.7 | 12.7 | 20.8 | 10.5 | 10.5 | 22.6 | 8.2 | 8.2 | 21.7 | 21.7 |