The Wagga Wagga City

Natural Resource Management Plan

Urban Salinity Economic Study

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1. EXECUTIVE SUMMARY

The Wagga Wagga City Natural Resource Management Plan (NRMP) covers an area of 55,000 hectares in and around the city of Wagga Wagga in southwestern New South Wales. The city is located on the Murrumbidgee River and is the largest inland city in New South Wales with a population of about 58,000.

Salinity is considered a major problem for the urban areas as well as the surrounding agricultural areas. The NRMP was developed to help the local community manage its resources over the next 30 years. Within the NRMP is the Wagga Wagga City Urban Salinity Plan (WWCUSP) which includes a range of options designed to reduce the impact of salinity and waterlogging in the plan area.

This economic evaluation identified and quantified the costs and benefits of implementing the options with respect to salinity and waterlogging, and follows on from the scoping study on the impacts of urban salinity and waterlogging in Wagga Wagga under a 'no plan' scenario undertaken by the Department of Land and Water Conservation in 1998 (DLWC 1998).

The economic evaluation consisted of two parts. The first part, called the 'no plan' scenario, quantified the economic costs incurred if no further action was undertaken to minimise degrading water and land quality. The second part was the 'with plan' scenario, which consisted of quantifying the economic benefits and costs of implementing the WWCUSP.

The 'no plan' scenario indicated that with the current anticipated increases in areas of salinity and rates of damage to infrastructure, the present value of costs of no further action over the next 30 years was $183 million. Analysis of the 'with plan' scenario, ie incorporating the WWCUSP, indicated that present value of benefits of $29 million dollars would be achieved if the plan were undertaken and the present value of costs was $26 million. These benefits were calculated on the avoidance of the costs that would otherwise be incurred under the 'no plan' scenario, with the assumption that benefits would commence in year 10 of the plan. It is recognised that there will be ongoing benefits past the 30 year study period as well as ongoing costs. Benefits could also be realised in a different time frame and this was reported in the sensitivity analysis.

The purpose of the 'with plan' evaluation was to determine the economic viability of the options pertaining to salinity and waterlogging under the NRMP. The stream of benefits and costs from implementing the plan was discounted over thirty years to determine their values in today's dollars, called the present value. Economic viability is indicated if the overall benefit cost ratio is greater than one, meaning that the net benefits of the plan were positive.

The economic evaluation of the Wagga Wagga City Urban Salinity Plan within the NRMP considered the following activities;

- revegetation, including tree planting and pasture improvement
- rubble pit removal
- dewatering borefields
- maintenance of an existing evaporation basin
- replacement of water mains
- relining of sewer pipes
- implementation of building controls
- septic tank removal
- annual monitoring program and
- an education program.

The economic analysis results indicated that the plan was economically viable as it currently stands under the assumptions applied, with a net present value of $2.9 million and a benefit cost ratio of 1.11.

Table A Present value of benefits and costs of 'with plan' scenario

Present Value	$ at 7% over 30 years
Benefits	28,929,518
Costs	26,016,155
Net present value	2,913,363
Benefit Cost Ratio	1.11

Table B Total value of benefits and costs of 'with plan' scenario

Total Value	$ over 30 years
Benefits	116,074,386
Costs	59,038,689
Difference	57,035,697

The scope of this analysis focussed on the benefits and costs of the land management and engineering options in the Natural Resource Management Plan. However, such activities would also result in impacts on the environment and the social well being of both the local population and visitors to the area. Environmental benefits of a healthy and diversified landscape include improved flora and fauna habitats, aesthetic and biodiversity values. Social well-being benefits can be considered in terms of avoidance or reduction in costs incurred through stress, ill health, vandalism and crime due to the local enhancement of the environment. These public health issues were also not part of the scope of this paper but the presence of these unquantified benefits is acknowledged.

2. INTRODUCTION

One of the Wagga Wagga City's Natural Resource Management Plan (NRMP) aims is to reduce the impacts of rising watertables and dryland salinity over the next thirty years. The plan area is 55,000 hectares surrounding Wagga Wagga City with the Murrumbidgee River bisecting the area.

This document outlines the methodology applied in the economic evaluation. This study outlines the options within the Wagga Wagga City Urban Salinity Plan (WWCUSP), how the benefits and costs of implementing these proposed options were evaluated and the final results. A sensitivity analysis was also undertaken to assess the impact of changes in several variables on the outcomes of the evaluation.

Further details of the options evaluated can be found in the supporting documents referenced throughout this report.

3. ECONOMIC EVALUATION

Economic evaluation is a technique used to calculate benefits and costs over a predetermined period of time. These benefits and costs, which are incurred at different stages over time, are then discounted so that they can be compared in today's dollars and are called present value benefits and present value costs. To determine if the implementation of a proposed strategy is considered economically viable, the difference between present value benefits and costs, called the net present value, needs to be positive. A similar measure of economic viability is the benefit cost ratio of equal to or greater than one, which is the present value of benefits divided by the present value of costs.

The economic evaluation of the Wagga Wagga City Urban Salinity Plan considered the economic benefits and costs of implementing the program over a period of 30 years. The economic benefits of the plan were valued largely in terms of avoided damages as identified in the 'no plan' scenario (DLWC 1998). The damages consisted of; costs to agriculture in terms of lost production; costs of increased maintenance of roads, water, stormwater infrastructure and other infrastructure; increased maintenance and repairs to houses; and the cost of implementing new building codes in Wagga Wagga. The economic costs were those incurred in implementing the options in the WWCUSP.

Initially the costs of not undertaking a plan needed to be identified and quantified. Called the 'no plan' scenario, this indicates what actions are and will be undertaken by the community to combat declining water quality and increasing erosion. The benefits and costs of the plan are the marginal benefits and costs compared to the 'no plan' scenario.

Sensitivity analysis was undertaken on key variables in the study, including discount rate and lag times for benefits. If altering a key variable resulted in a significant change in results, this indicates that such movements in values of that input could influence the outcome of the study. The sensitivity analysis indicates the influence assumptions can have on results.

3.1 'No Plan' scenario

The 'no plan' scenario looked at the impacts of salinity, both current and expected over the next 30 years without the plan in place. In the Wagga Wagga City area, salinity is a major contributor to maintenance and repair costs being incurred by the local population and the council. Briefly (see DLWC 1998 for detail) damage costs were anticipated to increase over the next 30 years in the study area due to rising watertables and salinity. (Note that damages would be ongoing past the study period, but the evaluation was restricted to this time frame). In particular, damage to roads and water and stormwater infrastructure was expected to incur additional maintenance and repair costs. Other major costs were expected to be incurred through rehabilitation of sewer pipes, replacement of gas pipes, and protection/maintenance of parks and sportsgrounds.

A further area of damage would be the agricultural area within the study zone. The 'no plan' study (DLWC 1998) indicated that loss of agricultural yields would amount to a present value of $3.6 million over the study period. To summarise, the 'no plan' losses are outlined in Table 1.

Table 1 Present value of losses incurred in the 'no plan' scenario.

Losses	**$ Present Value (7%)**
Sewerage pipe rehabilitation	**8,308,844**
Septic Tank conversions	**714,087**
Damage to roads Increase in annual expenditure - 1% increase p.a.	**56,198,642**
Repairs to houses 60% of costs incurred in 1st 10 yrs, 40% in next 20 yrs	**19,589,500**
Water and stormwater infrastructure 60% of costs incurred in 1st 10 yrs, 40% in next 20 yrs	**87,883,000**
Gas Pipe replacement 34% affected, @ $40/m to replace over next 15 years	**5,782,141**
Damage to footpaths and bicycle tracks 1% increase in expenditure p.a.	**66,687**
Damage to parks and sportsgrounds increase in annual expenditure 1%	**850,340**
Agriculture -	**3,586,211**
Total	**182,979,452**

Source DLWC (1998)

Note; a reworking of water and stormwater infrastructure has altered the 'no plan' figure from DLWC (1998). Costs were $100,000, $200,000 and $500,000 per kilometre of water and stormwater infrastructure and stormwater augmentation respectively, based on ACTEW (1997).

If the 'no plan' scenario were to be specifically implemented, then the losses over the period of study would amount to a present value of $183 million. The majority of damages were assumed to occur in the first 10 years of study with the balance spread over 20 years. While details of the 'no plan' scenario can be found in the DLWC report (1998) *Natural Resource Management Plan - impact of urban salinity and waterlogging in Wagga Wagga – the no plan scenario _ A scoping study*' a more recent reworking of the calculations of storm and water infrastructure damage in the course of this evaluation resulted in an increase in present value of costs in that category to $88 million.

3.2 'With Plan' scenario

The Wagga Wagga City Urban Salinity Plan contained a number of options, or courses of action, to be implemented to reduce impacts of rising groundwater. The majority of these options were to be undertaken over a shorter time period than that of the plan, while benefits were calculated over the life of the plan, being thirty years. Table 2 outlines those options in detail, indicating their components. The options were evaluated to establish benefits and costs over the life of the plan. The main categories of options were education, revegetation, rubble pit removal, management of dewatering borefields, monitoring, evaporation basins, preventing and sealing leakage from watersupply and sewer pipes, implementing building controls and septic tank removal or modification.

Table 2 Detailed list of options for Wagga Wagga City Urban Salinity Plan

Option	Code*
Education	
staff, advertising, education material yrs 1-10	E01
staff, advertising, education material yrs 2-20	E02
Revegetation Class 7, 8 land	
tree planting	RI01
land purchase	RI02
coordinator	RI03
maintenance 1	RI04
maintenance 2	RI05
maintenance 3	RI06
planning controls for vegetation reserves	RI08
Revegetation Class 4,5,6 land	
pasture improvement	R201
tree cover	R202
education costs	R203
Revegetation Class 1,2,3 land	
tree cover	R301
education costs	R302
Rubble pit removal	
Area A	H01
Area B	H02
Area C	H03
Area D	H04
Area E	H05
Area F	H06
Area G	H07
maintenance	H08
Borefields	
Investigation	B01
pilot area program	B02
midslope investigation	B03
Leavenworth/Maher St	B04
Railway Reserve	B05
maintenance	B06
Monitoring	
annual monitoring program	M01
Evaporation Basin	
Evaporation basin maintenance	EB01
Leakage from Watersupply Pipes	
Riverina water mains replacement cost	WS1
Sewer pipes	
sewer pipes relining program	SP01
Building controls	
new houses	BC01
Septic Tanks	
septic tank removal	ST01

*the code was used for both easy identification of options and their components and for modelling purposes.

3.2.1 Options

Details of the options listed in Table 2 are outlined in this section. For model development these options were broken down into detailed components so costs could be calculated. The Wagga Wagga City Council staff involved in the development of the NRMP provided these options. They also provided most data, except where otherwise acknowledged. For discussion the options are grouped as follows

Education

The aim of the education program is to change behaviour in the local population, reduce the amount of water going into the watertable and generally increase efficiency in water use. This would occur through reducing overwatering by promoting water efficient gardening practices. The education program required 1 fulltime officer at $60,000 p.a, an advertising budget of $20,000 p.a. and education material of $20,000 p.a. These costs would be incurred for the first 10 years of the plan, and then would be reduced to annual costs of $50,000 p.a. for the next 20 years (Short, pers. comm. 1999). One feature of the Wagga Wagga population is its high turnover, therefore requiring an ongoing education program.

The education program would also have a positive impact on the uptake of other plan initiatives through community support of revegetation, de-watering bores and leakage reduction programs.

Revegetation

The plans for revegetation throughout the study area have several goals. One is to intercept rainfall before it enters the watertable, and the other is to intercept and extract water through planting in recharge and discharge areas.

There were slightly different plans for the different land classes. For more detailed definitions of the land classes see Wagga Wagga City Council (1998 page 37).

Revegetation in Class 7 and 8 land, totalling 685 hectares (WWCC 1998 page 111) consisted of

- tree planting over 22 hectares per annum for 30 years at a cost of $4,000 / hectare, including tree costs and fencing and preparation costs (Short 13/9/99)
- full time coordinator at $60,000 per annum for 30 years, including salary and oncosts.
- Maintenance costs of $10,000 per annum for the first ten years, then $20,000 per annum for the next ten years and $40,000 per annum for the last ten years of the plan.
- planning controls to provide vegetation reserves through future development areas, costing $60,000 over the next 2 years.

Rural land capability Class 7 land is best protected by timber and generally consists of steep slopes, shallow soils and/or rock outcrop. Class 8 land comprises cliffs, lakes or swamps and is unusable for agricultural or pastoral uses.

Note that while the plan also provided for the purchase of 15.4 hectares annually for planting at an average cost of $10,000 per hectare, this is considered a financial cost as it is a transfer of ownership and therefore not included in an economic study.

Revegetation in Class 4, 5 and 6 land, totalling 7,231) hectares (WWCC 1998 page 111) consisted of;

- pasture improvement consisting of 30% pastures to be sown to perennial pastures.
- tree cover of 35% for Class 6 and 12% for Classes 4 and 5
- education costs, help with funding applications, running small holder field days, help in improving seed bank.

For Class 4 and 5 land, the plan is proposing 12% cover under trees (source Wagga Wagga Draft Natural Resource Management Plan 1998) and 30% under perennial pastures. For Class 6, the goal is 35% under trees and 30% under perennial pastures.

Class 4 land is not suitable for cultivation on a regular basis but forms the better grazing land. Class 5 land is even less suitable for cultivation on a regular basis due to limitations of slope, soil erosion, shallowness or rockiness. Class 6 land comprises less productive grazing lands.

Revegetation Class 1,2,3 land, which totalled 41,958 hectares, consisted of;

- tree cover over 8 % of land over 30 years
- education costs, similar to those in Class 4-6 land

Class 1 land is suitable for a variety of purposes and needs no special soil conservation works or practices. Class 2 land is usually gently sloping land suitable for a wide variety of agricultural uses. Class 3 land is sloping land suitable for cropping on a rotational basis.

The objective of these revegetation goals is a 50% reduction in accessions to the watertable.

Benefits of planting trees and perennial pastures were based on the information included in the Kyeamba Land and Water Management Plan (DLWC 1999 page 25). The net benefits from planting perennial pastures were calculated as a marginal gross margin of $127 per hectare. This reflects the long-term increase in productivity from perennial pastures compared to the pastures that would otherwise have been grown. Note that this figure is similar to that applied in the Boorowa catchment (Hill, 1997 page 9). The figure also reflects the initial costs of establishment of pastures. Gross margins are the gross income less variable costs of production. They do not include overhead costs.

The benefits from tree planting were reflected in the anticipated avoided costs to infrastructure and agricultural production as the tree planting program impacted on the rise of the watertable and salinity to slow the increase projected the 'no plan' scenario. However there are also benefits from tree planting in terms of windbreaks to pastures. Based on previous studies (DLWC 1999, Hill 1996), the current study assumed that the areas being planted to trees provided an average of equivalent area increases in productivity in the plan area. The benefits were calculated on the basis of 20% of the average regional gross margin with a lag of 8 years before benefits were realised. There would be other benefits from tree planting such as increased and improved habitats and aesthetic values.

The benefits of avoided impacts of salinity losses were calculated on $30.70 pre hectare as derived and applied by the Kyeamba Valley economic evaluation (DLWC 1999).

Rubble pit removal

This consists of changing roof water drainage from entering rubble pits to being redirected to join the street drainage. The following costs of the project assumed goodwill for entry onto properties

and changes in the Local Government Act to allow maintenance in areas where easements were not created. Maintenance was an additional cost of $20,000 pa.

Table 3 Schedule of costs for Rubble Pit removal

Area	timeframe	$ cost p a
area A Pilot area	years 1-5	500,000
area B Dandaloo	year 6	500,000
area C Mt Austin	years 6-8	500,000
area D Ashmont	year 9-11	500,000
area E Kooringal	years 12-14	500,000
area F Lake Albert	years 15-16	500,000
area G Warrawong	year 17	500,000
area H Central Wagga	low priority and not included	

Borefields

The objective of the borefield is to intercept and remove 1,000 megalitres of water per annum that has entered the watertable. The investigation phases of these borefields would identify the availability of a pumpable quantity of water, the connectivity of these aquifers to shallower aquifers, the likely quality of this water and the possible sustainable water reuse options. At this stage it is considered that the water would be of a standard that could be used or shandied with potable water to irrigate parks and sports grounds that are currently irrigated with potable water (McGhie 1/3/00).

The current program in the pilot area will run from years 1-3 at a total cost of $800,000. The midslope borefield project, running in years 5-6, consists of an investigation in year 4 costing $100,000, then 12 bores and irrigation at Leavenworth and Maher streets costing a total of $300,000. The borefield at Railway Reserve was costed at $300,000 and annual maintenance was estimated at $40,000 per annum (Short 1999).

Monitoring

While monitoring was kept as a separate category, it could have been evenly distributed over several categories. The purpose is to monitor movements in the watertable and changes in salinity. While this plan was estimated over 30 years, the results of monitoring would be used to review the plan at 5 yearly intervals and revise it if necessary.

The cost of monitoring was estimated at $30,000 per annum.

Evaporation Basin

While the evaporation basin was completed and so is not included in the plan, the annual maintenance cost was incorporated at $2,000 per annum. The objective was to enable the continued operation of the main arena of the showground (Short 1999).

Leakage from Watersupply pipes

Currently a testing program is underway to determine the extent of leakage from the water supply mains. This was not included in the 'with plan' scenario. However, of the mains' replacement cost of $500,000, 20% was attributed to urban salinity and therefore included in the costs of this project (Short 1999).

Leakage from sewer pipes

The objective of the relining sewer pipe program was to reduce tree root invasion and thus leakage into and out of the sewer system. This is a 20-year program and, with 20% of capital cost attributable to urban salinity, an allowance of $50,000 pa was included (Short 1999).

Building Controls

The objective of the building controls is to minimise damage from a hostile saline environment. This will have a cost impact of $2,000 per new residence built in high and medium risk areas. However, the life expectancy of the houses should double from 40 to 80 years. The high and medium risk areas are currently fully developed with the rate of redevelopment being a function of house deterioration and economic activity. Currently about 15 houses per year are being replaced, but will increase over time as, given the current age structure of the houses. The modelling incorporates a sliding scale of new houses being built in the pilot area over time, starting with 15 in year 1 and finishing with 60 in year 30. The total number of new houses being built and incorporating these building controls totalled 1102 (Short 1999). Further costs would be incurred in the balance of the NRMP area, which were based on assumptions of an average of 0.7% increase in population in Wagga Wagga, and a constant percentage of rural residents at 10.5%. (McGhie 15/3/2000).

Under the 'no plan' scenario, 7404 houses will be refurbished over the 30-year period of study. The benefits of the 'with plan' scenario are the avoided damage to these houses through measures to reduce the impacts of salinity and high watertables.

Septic Tank Removal

The removal of septic tanks was planned for a number of reasons, and not solely related to salinity. Given that the proposal also incorporated public health and surface water quality issues, 50% of the costs incurred in their removal was attributed to this plan. Septic tanks removal would occur in small rural lots and consists of the cost of removing the septic tanks and the connecting to sewer. The total estimated cost was $15,000 per house lot with 400 lots being undertaken over 30 years at an average of almost 14 a year. Based on 50% attributed to other programs the cost to this plan was $7,500. The benefits of septic tank removal are linked to quality of lifestyle (Short, 27/4/2000).

Total costs and benefits

'With plan' scenario costs are outlined in Table 4 in two forms, present value (the discounted value of costs over 30 years) and total costs (the sum of costs over 30 years).

Table 4 Present value costs and total costs over 30 years

'With plan' options	**present value cost 7%**	**total costs**
	$	**$**
Education	971,631	2,000,000
Revegetation	11,465,566	29,996,316
Rubble pit removal	5,168,134	8,800,000
Borefields	1,720,573	2,700,000
Monitoring	372,271	900,000
Evaporation Basin maintenance	24,818	60,000
Water mains replacement	1,240,904	3,000,000
Sewer pipes relining	2,648,504	5,000,000
Building controls	1,162,849	3,582,373
Septic tank removal	1,240,904	3,000,000
Total	26,016,155	59,038,689

Benefits

The benefits of the 'with plan' scenario, of implementing the foregoing actions, are directly related to the impact of the 'with plan' scenario on the rate of rise of the watertable. If the projected rates of rising watertables and spreading salinity are arrested then the benefits of the plan can be calculated in terms of the avoided losses that would have been incurred under the 'no plan' scenario. In fact, the avoided losses become the benefits.

The 'no plan' scenario consisted of costs that would be incurred if damage due to waterlogging and salinity continued without the impact of the actions planned under the Wagga Wagga City Natural Resource Management Plan. These costs are outlined in Table 5. Also outlined are the avoided losses of the 'no plan' scenario, which form the benefits of the 'with plan' scenario. The middle column of figures completes the mathematics and shows the losses incurred under the ''no plan' 'scenario that are not avoided under the 'with plan' scenario and are estimate to still be incurred.

Table 5 Present value of the costs of salinity in 'no plan' scenario and present value of benefits in the 'with plan' scenario

Options	Present value losses (7%) 'no plan' scenario	Present value losses (7%) 'with plan' scenario	Present value benefits (7%) 'with plan' scenario
	$	$	$
Sewerage pipes	8,308,844	0	8,308,844
Septic Tanks	714,087	0	714,087
Roads Increase in annual expenditure - 1% increase p.a.	56,198,642	47,003,861	9,194,781
Cost to houses 60% of costs incurred in 1st 10 yrs, 40% in next 20 yrs	19,589,500	18,010,901	1,578,599
Water and stormwater infrastructure 60% of costs incurred in 1st 10 yrs, 40% in next 20 yrs	87,883,000	80,801,037	7,081,963
Gas Pipes 34% affected, @ $40/m to replace over next 15 years	5,782,141	5,543,571	238,570
Footpaths and bicycle tracks 1% increase in expenditure p.a.	66,687	55,776	10,911
Parks and sportsgrounds increase in annual expenditure 1%	850,340	800,373	49,967
Agriculture -	3,586,211	2,651,291	934,920
Tree cover	-		816,877
Total	182,979,452	154,049,934	28,929,518

Source DLWC (1998)

The benefits from the actions of education, revegetation, house block drainage, borefields, mains replacement, were considered and calculated in terms of avoided costs that would otherwise be incurred under the 'no plan' scenario. However, a number of assumptions underlie these figures. For maximum benefits to be achieved, the avoided losses would have to occur within the timeframe that they were calculated. It is unrealistic to anticipate that damages incurred now would be immediately alleviated, so for most of the benefits a lag was incorporated into benefit calculations.

After discussions with Wagga Wagga City Council and perusal of the literature, the avoided damages were calculated on the basis of a 10 year lag before any benefits were realised, then an increasing rate of benefits from year 10 to year 30 as follows in Table 6. However, some option benefits were assumed to be realised from the start and were not affected by the assumption of lags. These were sewerage pipes, septic tanks and the total benefits from tree cover (which already incorporated some conservative lags in its initial calculations).

Table 6 Scale of applied benefits with 10-year lag.

years of plan implementation	rate of benefits as a % of losses in the 'no plan' scenario
0-9	0
10-12	10
13-15	20
16-18	30
19-21	40
22-23	50
24-25	60
26-27	70
28	80
29	90
30	100

3.3 Results

The results of the economic evaluation are shown in Tables 7 and 8. The total benefits and costs were calculated over 30 years. In most cases the costs of implementing the options were incurred in the early years while benefits, calculated in terms of avoided losses, were accrued in the longer term. These were then discounted to compare options in today's dollars.

The results indicate that the benefits of implementing the Wagga Wagga City Urban Salinity Plan within the Natural Resource Management Plan are greater than the costs from such implementation based on the above assumptions and a lag time of 10 years. The present value of benefits was $28.9 million and the present value of costs was $26 million, giving a net present value of $2.9 million. The corresponding benefit cost ratio, which of course only reflects quantified benefits and costs, was 1.11. The results are presented in Table 7.

Table 7 Present value of benefits and costs for 'with plan' scenario

Present Value	$ at 7% over 30 years
Benefits	28,929,518
Costs	26,016,155
Net present value	2,913,363
Benefit Cost ratio	1.11

Table 8 shows the total undiscounted values of benefits and costs incurred over the 30-year time frame of the study. While the total value of benefits was $116 million and the total value of costs was $59 million, in cash flow terms there would be a positive difference of $57 million.

Table 8 Total value of benefits and costs

Total Value	$ over 30 years
Benefits	116,074,386
Costs	59,038,689
Difference	57,035,697

3.3.1 Sensitivity Analysis

Key variables were changed in the sensitivity analysis to assess the impacts of assumptions on the economic results. Discount rates and the rates of benefit accrual including the lag before realisation of benefits were evaluated. Initial testing indicated that other variables did not significantly affect the outcomes.

The study was sensitive to changes in the discount rate. An increase in the discount rate from 7% to 10% resulted in a benefit cost ratio change from 1.11 to 0.86, while a decrease in the discount rate from 7% to 4% increased the benefit cost ratio to 1.43. The discount rate changes reflect the impact of the flow of costs and benefits over time. NSW Treasury guidelines indicate the use of 7% but the changes in the discount rate indicate that the study is still robust, given that significant environmental benefits were not quantified.

The impacts of various discount rates are shown in Tables 9-11. Table 9 indicates the impact of changing discount rates on the present values of benefits, costs and the benefit cost ratio. Under a 4% discount rate the net present value is $15 million, compared to $2.9 million for the 7% rate and minus $2.7 million for a discount rate of 10%.

Table 9 Present values with 4%, 7% and 10% discount rate over 30 years

Present Value	4%	7%	10%
Benefits	50,602,001	28,929,518	17,418,035
Costs	35,387,486	26,016,155	20,143,969
Net present value	15,214,515	2,913,363	-2,725,934
Benefit Cost ratio	1.43	1.11	0.86

Tables 10 and 11 provide a detailed view of the impacts of changing discount rates by option for benefits (Table 10) and costs (Table 11).

Table 10 Present value of benefits by option with 4%, 7% and 10% discount rate over 30 years

Benefits	4%	7%	10%
	$	$	$
Sewer Mains	12,840,211	8,308,844	5,636,128
Septic tanks	1,095,886	714,087	473,799
Roads	17,136,158	9,194,781	5,147,754
Households	2,901,752	1,578,599	898,737
Sewer and water	13,017,934	7,081,963	4,031,942
Gas	343,857	238,570	167,565
Footpaths and bicycle tracks	20,334	10,911	6,108
parks	78,959	49,967	32,798
Agriculture	1,797,481	934,920	506,715
Tree cover	1,369,429	816,877	516,490
Total	**50,602,001**	**28,929,518**	**17,418,035**

Table 11 Present value of costs by option with 4%, 7% and 10% discount rate over 30 years

Costs	4%	7%	10%
	$	$	$
Education	1,270,146	971,631	778,574
Revegetation	16,491,283	11,465,566	8,480,009
Rubble Pit removal	6,378,842	5,168,134	4,281,181
Borefields	2,023,625	1,720,573	1,506,549
Monitoring	518,761	372,271	282,807
Evaporation Basin maintenance	34,584	24,818	18,854
Water mains replacement	1,729,203	1,240,904	942,691
Sewer pipes relining	3,397,582	2,648,504	2,128,391
Building controls	1,814,257	1,162,849	782,222
Septic tank removal	1,729,203	1,240,904	942,691
Total	**35,387,486**	**26,016,155**	**20,143,969**

Further analysis was undertaken on the assumed time lag and rate before benefits were realised. The economic evaluation was based on an estimated rate of benefits starting in year 10 and increasing to 100% in year 30. Sensitivity analysis was undertaken on scenarios evaluating benefits starting in year 5 and 15 with results below.

Table 12 Rate of benefits with 5-year lag

years of plan implementation	rate of benefits as a % of losses in the 'no plan' scenario
0-4	0
5-8	10
9-11	20
12-14	30
15-17	40
18-19	50
20-21	60
22	70
23	80
24	90
25-30	100

Table 13 shows that with the lag time reduced from 10 years to 5 years (on those benefits that were assumed to have a lag), the benefits increased by $14.7 million over 30 years, resulting in a net present value of $17.6 million and a benefit cost ratio of 1.68.

Table 13 Present value of benefits and costs with 5-year lag for benefits

Present Value	$ at 7% over 30 years
Benefits	43,624,563
Costs	26,016,155
Net present value	17,608,408
Benefit Cost ratio	1.68

The difference between benefits and costs (undiscounted) over 30 years increased from $57 million to $102 million with a reduction in the lag time of benefits.

Table 14 Total value of benefits and costs with 5-year lag for benefits

Total Value	$ over 30 years
Benefits	160,702,479
Costs	59,038,689
Difference	101,663,790

Increasing the time lag from 10 to 15 years at rates indicated in Table 15, reduced the benefits. Even though the time lags were altered, the assumption remained that 100% of benefits would be reached in the 30 years. Any reduction in this rate would naturally further reduce the benefits realised.

Table 15 Rate of benefits with 15-year lag

years of plan implementation	rate of benefits as a % of costs in the 'no plan' scenario
0-14	0
15-16	10
17-18	20
19-20	30
21-22	40
23-24	50
25-26	60
27	70
28	80
29	90
30	100

With delays in realising benefits under the 15-year lag scenario, the present value of benefits fell below the present value of costs by $2.9 million.

Table 16 Present value of benefits and costs with 15-year lag for benefits

Present Value	$ at 7% over 30 years
Benefits	23,062,016
Costs	26,016,155
Net present value	(2,954,139)
Benefit Cost ratio	0.89

However, the total undiscounted value of benefits still exceeded that of costs by $40 million. This clearly indicates the effects of discounting when costs are incurred early in the 30-year study and benefits realised later.

Table 17 Total value of benefits and costs with 15-year lag for benefits

Total Value	$ over 30 years
Benefits	99,422,367
Costs	59,038,689
Difference	40,383,678

The following table summarises the comparison in present value of benefits with the change in lag periods. Note that those options with an asterisk were not subject to the lag assumption.

Table 18 Comparison of present values of benefits with 5, 10 and 15 year lags at 7% discount

Benefits	5 year lag	10 year lag	15 year lag
	$	$	$
Sewer Mains*	8,308,844	8,308,844	8,308,844
Septic tanks*	714,087	714,087	714,087
Roads	14,962,252	9,194,781	6,561,097
Households	3,035,039	1,578,599	1,072,718
Sewer and water	13,615,890	7,081,963	4,812,465
Gas	642,213	238,570	23,010
Footpaths and bicycle tracks	17,755	10,911	7,786
Parks	93,350	49,967	20,579
Agriculture	1,418,257	934,920	724,555
Tree cover*	816,877	816,877	816,877
Total	43,624,563	**28,929,518**	23,062,016

* benefit not subject to lag assumption

Table 19 summarises the comparison by option in total value of benefits with the change in lag periods.

Table 19 Comparison of total values of benefits with 5, 10 and 15 year lags at 7% discount

Benefits	5 year lag	10 year lag	15 year lag
	$	$	$
Sewer Mains*	25,000,000	25,000,000	25,000,000
Septic tanks*	2,000,000	2,000,000	2,000,000
Roads	61,592,311	42,118,272	34,419,233
Households	11,106,780	7,034,294	5,627,435
Sewer and water	49,827,600	31,557,480	25,245,984
Gas	1,396,666	571,363	63,485
Footpaths and bicycle tracks	73,087	49,979	40,843
Parks	269,800	155,800	85,600
Agriculture	6,439,128	4,590,091	3,942,681
Tree cover*	2,997,107	2,997,107	2,997,107
Total	**160,702,479**	**116,074,386**	**99,422,367**

* benefit not subject to lag assumption

Clearly the sensitivity analysis indicated that the economic evaluation results were influenced by the assumptions relating to the time frame of benefits. Further reductions in benefits realised through slower rates or greater time lags would jeopardise the economic viability of the proposed course of action to reduce salinity and waterlogging in the study area.

4. CONCLUSION AND DISCUSSION

The economic evaluation indicated that implementing the Wagga Wagga City Urban Salinity Plan was economically viable with respect to avoided salinity and waterlogging costs over 30 years. The present value of benefits exceeded that of costs by $2.9 million. The benefit cost ratio was 1.11 under the assumptions of a 10-year lag before benefits eventuated. If the lag was longer then benefits would decline. However if the rate of avoidance of costs was higher then benefits would increase.

Given that only benefits and cost from the land management and engineering options were quantified, the significant environmental benefits of the Plan could be expected to improve the indicators of economic viability. Recognising this, the sensitivity analysis indicated that the plan would be fairly robust under different discount rates and changes in the assumptions of lag times before benefits would be realised.

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Appendix 1

Table C Cash flow of benefits and costs over 30 years

Year	1	2	3	4	5	29	30	**total**		**PV**
Total Costs	2,201,121	2,216,990	2,272,858	2,222,059	2,737,928	1,723,292	1,700,242	59,038,689		**$26,016,154**
Total Benefits	4,413	9,261	14,109	18,957	23,805	9,468,189	10,410,467	116,074,386		**$28,929,518**
Net	-2,196,709	-2,207,729	-2,258,749	-2,203,103	-2,714,123	7,744,897	8,710,225	57,035,697	**NPV**	**$2,913,363**