Farm management of saline groundwater for controlling salinity problems

Report on pilot site establishment at Blighty, Southern NSW

Margaret Crowe and Matthew Bethune[#]
Department of Natural Resources and Environment

Executive summary.

Groundwater pumping with farm reuse is a widespread practice in the southern Murray Darling Basin. This practice is the preferred option by Land and Water Management Plans in these areas for controlling irrigation salinity where irrigated pasture is the main crop. However, farm reuse of groundwater on pasture is limited in areas where groundwater salinity exceeds 5 dS/m. Options contained in Management Plans for controlling salinity in these areas are limited to groundwater pumping with farm export of salt or groundwater pumping with disposal to evaporation basins.

There is considerable scope for farm management of saline groundwater using agronomic disposal options as an alternative to evaporation basins. This report summarises the establishment of a pilot site developed to assess the impact of farm management of saline groundwater. The site will be monitored from 1999 to 2004 for farm impacts on rootzone salinity, soil sodicity and groundwater salinity. This data can then be used to provide an assessment of the farm impacts of managing saline groundwater to control salinity. The outcome from this assessment can be used to modify Land and Water Management Plans.

Establishment of the pilot site was funded by the landholders, the Berriquin Community Land and Water Management Plan, the Murray Darling Basin Commission and the Department of Natural Resources and Environment, Victoria.

corresponding author.
Department of Natural Resources and Environment, Private Bag 1, Ferguson Road, Tatura, 3616

Table of Contents.

Introduction

Rising watertables and increasing salinity levels are contributing to social and economic problems in irrigated regions. This realisation has lead to many important initiatives by local communities and governments to alleviate these problems. These initiatives have involved significant funding, research, changed attitudes and altered farming practices.

This report describes the development of a pilot site that is part of one of these initiatives. This initiative is focussed on areas with high groundwater salinity which currently have limited options for controlling salinity.

Salinity control at the site is provided by groundwater pumping. The groundwater is too saline for complete reuse on irrigated pasture within the property. Therefore, part of the pumped groundwater is diluted to 0.8 dS/m to irrigate pasture. Pasture yield should not be affected at this irrigation water salinity. The remaining groundwater is reused to irrigate a 2.2 hectare native tree/shrub plantation without dilution. All groundwater reuse is contained within the area of influence of the groundwater pump. This should ensure that salinity control is provided to areas receiving saline irrigation waters and that salt export is minimal over time. It is hoped that this management option will serve the dual objectives of minimising salt export off farm and providing salinity control to the irrigated pastures.

The location of the pilot site is near Blighty in southern NSW. The property, “Yargunyuh”, was found to have the physical conditions necessary to meet the objectives of the pilot site. These include: a cooperative landholder, high watertables, moderate to high salinity groundwater and soil salinity, high profile and easy public access. There was also the possibility of the involvement of a local landcare group.

The pilot study is part of a joint venture between the following participating parties: the Department of Natural Resources and Environment (DNRE), Tatura, Victoria, the Murray Darling Basin Commission (MDBC), the Berriquin Community Land and Water Management Plan (BLWMP) and the property managers Colin and Shelley Ogilvie.

Definition.
For the purposes of this report, water salinity will be expressed in μS/cm (EC unit).

Objectives of pilot site

The objectives of establishing and monitoring the pilot site are:

- to enable assessment of the impact of farm management of saline groundwater on rootzone salinity, soil sodicity and groundwater salinity.
- to monitor and provide hydrologic data necessary for evaluating the costs and benefits of pumping saline groundwater for controlling salinity.
- to demonstrate farm management of salinity problems in areas with high groundwater salinity.

Based upon the results of this study, recommendations will be made to the Berriquin Land and Water Management Plan Committee to upgrade and enhance the existing BLWMP.

Process for the Development of Trial Site

The following tasks were undertaken in the establishment of the pilot site. Site specific tasks and completion dates are detailed in the schedule of activities (appendix 5).

1. ***Site location and design***
   - Locating of a suitable site
   - Development of concept plan.
   - Review and approval of concept plan by BLWMP
   - Finalise concept plan through development of a 'Formal contract'

2. ***Site development***

   Groundwater pump upgrade
   - Upgrade groundwater pumping system
   - Piezometer installation
   - Pump test and approximation of area of influence of groundwater pump

   Tree plantation
   - Species selection and plantation layout
   - Ordering plants
   - Organising fencing material
   - Earthworks for site preparation
   - Pre planting weed control
   - Planting

3. ***Implementation of irrigation and groundwater management***

4. ***Monitoring***

   Establishing a record of past irrigation application
   Providing land manager with record sheet to record future irrigation application
   Establishing responsibility for collection, analysis and interpretation of soil and water data

Results and discussion

Site location and design

Locating of suitable site

Considerable time was initially invested into the location and establishment of a site that in the end proved unsuitable. The site was unsuitable as a result of two neighbouring properties having difficulties reaching agreement on cost sharing arrangements for site establishment and ongoing operation. Following a meeting (9/2/1999) with representatives from the MDBC, MIL, NSW Agriculture and DNRE it was decided to try and locate another pilot site. The time invested into the unsuccessful pilot site resulted in establishment of the successful pilot site being delayed.

The successful pilot site is located approximately 35 km east of Deniliquin near Blighty in southern NSW (Fig 1). The property, owned by JH Ogilvie Pty Ltd, is 110 Ha and operates a 100 herd dairy as well as mixed cropping. JH Ogilvie also owns the property “Pinelea” which adjoins “Yargunyah”.

The pilot study steering committee inspected the site on 3/5/1999. An outcome from this meeting was that the site be approved as a suitable study site.

Fig 1. Location of pilot site.

Development of concept plan

Assessment of site hydrogeology

A modest amount of information is known regarding site hydrogeology. There is no information relating to deep aquifers underlying the property, however more is known of shallow aquifer systems. Aerial photo interpretation and bore samples suggest that prior stream(s) run near or through the property. Locally, the area is subject to high watertables (<2m below surface).

The Ogilvies have been pumping groundwater since 1967 using an 18 spearpoint system connected to a 200m long headerline. The spearpoints intersect the aquifer approximately 6

metres below the surface. Pumped groundwater was diluted and used to irrigate pastures. Groundwater pump yield was not known, however the land manager suggested the aquifer was capable of yielding greater than 2ML/day.

In recent years, salinity levels have increased from an estimated 500 EC to approximately 5000 EC. As a result of these levels, the use of groundwater for irrigation has greatly decreased. Increased salinity and watertable levels, waterlogging and salt stress that have became evident on the farm and may be attributed to reduced pumping rate.

To enhance hydrogeological information for this study, a series of shallow piezometers were installed and a pump test was conducted.

The concept plan

Land use on the farm is given in Fig 2. Table 1 gives land areas associated with each land use. All values are approximate only. Details on calculation methods are included in the notes below Table 1. In the concept plan, groundwater reuse was restricted to areas within the estimated area of influence of the groundwater pump (Fig 2). The estimated area of influence is calculated assuming that pumping 1 ML protects 1 Ha of land, and that the area protected is circular shaped, and centred around the pump. Since the concept plan was developed a pump test was conducted.

It was estimated that a total of 60 ML of groundwater could be safely pumped and reused on the farm. 35 ML of the groundwater would be mixed to 800 EC with low salinity channel supply water, and reused for irrigating summer pasture and lucerne. A further 25 ML would be used to irrigate a 2.2 Ha tree woodlot. The tree plantation was established on an unproductive salt affected 2.2 Ha area adjoining the western boundary of the property (Fig 2). In summary, the system protects 60 Ha of land without the need for farm export of salt.

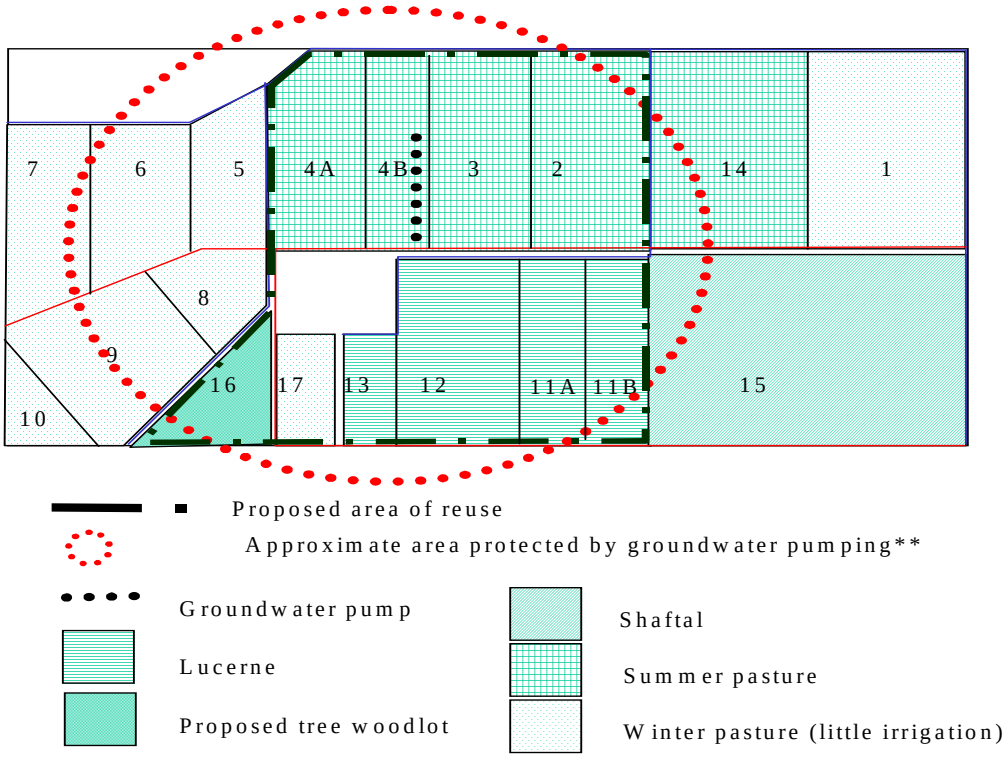
Approval by BLWMP

The concept plan above was discussed with stakeholders and agreement was reached between the parties involved. This included outlining tasks and cost sharing arrangements. Finally, the concept plan was endorsed with the formal approval from the BLWMP Committee in September 1999.

Formal agreement – Contract

A contract was drawn up detailing site specifics and the agreed responsibilities of the land manager regarding the pilot site. The final cost sharing arrangement is detailed in appendix 6 The contract has agreement from all stakeholders but is currently with lawyers representing DNRE and is yet to be signed.

Fig 2. Farm layout for proposed research site. (Not to scale)



Note *** Assumes that pumping 1 ML protects 1 Ha of land and that 60 ML of groundwater are pumped per season*

Table 1. Summary of farm layout.

Field	Area Ha	Land use	Irrigation intensity ML/Ha	Total Irrigation ML	Groundwater reuse (ML)
1	10.2	WP	0	0	0
2	7.8	SP	5.1	40	5.38
3	7.7	SP	5.1	40	5.4
4	8.6	SP	5.1	44	5.9
5	3.6	WP	0	0	0
6	4.1	WP	0	0	0
7	5	WP	0	0	0
8	2.9	WP	0	0	0
9	6.2	WP	0	0	0
10	1.2	WP	0	0	0
11	8.2	L	8.8	72	9.7
12	7.2	L	8.8	63	8.5
13	1.9	L	8.8	17	5.4
14	8.4	SP	5.1	42	0
15	20	Sh	0	102	0
16	2.5	Tree	0	0	25
17	1.5	swamp	0	0	0
Total	107			420	65.3

Note: WP = winter pasture, SP = summer pasture, L = lucerne, Sh = shaftal. Areas are approximated from whole farm plan. Irrigation intensity and volumes estimated from information provided by the landholder and were calculated from the number irrigations, duration of irrigation and the speed of the water wheel. Safe volume of reuse is calculated as the volume of groundwater (6000 µS/cm) that can be mixed with the good quality supply water (100 µS/cm) to a salinity of 800 µS/cm. Rainfall is not taken into consideration in the calculation.

Site development

Groundwater pump
Due to the antiquity and inappropriate size of the pump and motor, an upgrade of the groundwater pumping system was required. A 4 inch self priming pump, coupled to a 7.5 Hp 480 Volt electric motor replaced the existing diesel motor. This included a throttling valve to reduce the pumping rate to approximately 2ML/day. A 200 metre long 480 Volt underground supply was connected from the motor to the existing dairy switchboard. A 6 inch Davies Shepherd Flow meter with ceramic bearings and flanges was installed at the outlet of the 219 metre long delivery line.

Piezometers
Piezometers on and near the property are being monitored as part of the study. Available data such as existing Electromagnetic data (EM 34) survey results were used to assist in locating sites for potential piezometers. Piezometer sites were chosen to reflect areas influenced by the groundwater pump as well as areas likely to be out of the area of influence. Based on observations while previously pumping, the land manager was aware of the general area of influence. A total of 5 piezometer sites (4 nested) within the property were installed. These were installed at depths of 2 metres (observation well), 5 metres and 10 metres. The piezometers were slotted for 30cm at the lowest sections of the pipe length. The method of installing the piezometers consisted of drilling with a continuous flight spiral, blowing out with water, inserting the PVC pipe, gravel packing around the screen as well as half a metre above the screen, sealing with bentonite then backfilling with local material. The top 30cm of the pipe was also sealed with bentonite. To minimise risk of cattle damage, the piezometers were encased with a steel cylinder set in concrete at ground level. The entire soil profile of the drilled holes was logged every half metre interval.

Two existing piezometers (depth 5 metres) installed by the previous Department of Water Resources adjoin the northern boundary of the property. These are also being monitored as part of this study. (piezometers locations illustrated in report on pump test a2)

Pump test

A pump test was conducted to clearly identify the area of influence of the groundwater pump. All piezometers in the study area were monitored during the test (appendix 4a). In addition, a control bore located 3 km from the study site and not affected by groundwater pumping was also monitored. Groundwater levels were taken at resting level (7 days after pump cessation preceded by 3 weeks continuous pumping), during 19 days of pumping and 7 days following cessation of pumping. Sinclair Knight Merz (SKM) analysed the pump test data. The report prepared by SKM on the pump test is attached (appendix 5).

Plantation site preparation
Approximately 2.2 hectares was prepared for planting. In the latter part of the year 2000, a further 1.5 Ha adjoining the site will also be prepared, planted and irrigated as per the trial site. Soil monitoring in this additional area will not be conducted.

A channel and pad adjoining the northern boundary of the plantation site was remodelled so that pumped groundwater could be used to irrigate the plantation.

Given the layout and topography, it was decided that flood irrigated contour banks, would provide the most practicable irrigation layout. Two weeks prior to planting, large soil clods

were manually removed. A disc plough was then used to rotaire the site and break up the smaller remaining clods. Following this, a scarifier of 0.15 metre depth was twice applied to then used to further break up the soil. A uni banker was used to create mounds (approximately 2 metres apart) and banks which separated each bay. Four bays were created with a 0.15 metre fall between bays. Ten days prior to planting, the site was sprayed for weed control. This consisted of 5 Litres of “Simozine” and 8 litres of “Stomp”.

Lastly, on the day of planting the mounds were deep ripped to a depth of 0.75 metre. The timing of the deep ripping assisted in preserving soil moisture.

Species choice and planting layout

The trees and shrubs destined for the plantation were ordered months ahead to ensure sufficient growing time for the seedlings and also so that delivery could be coordinated with the other activities necessary for the establishment of the site. In consultation with the land manager and Greening Australia, the selection of plant species and ordering were completed in July 1999.

The trees and shrubs were grown in hyco trays and were chosen on the basis of tolerance to site conditions, in particular, waterlogged and sodic soils. A local contractor (Riverina Trees) were engaged to plant the trees. This was undertaken over a two day period (10 and 13 December 1999). Margaret Crowe and Colin Ogilvie also assisted. The trees were dunked in channel water prior to planting and were manually watered in with channel water from a tank within a matter of hours post planting. The salinity of the first irrigation, applied on the13th December, was approximately 3000 EC.

Generally, the plantings were spaced at 2 to 3 metre intervals with an alternating pattern of trees and shrubs. The intent is to have full canopy cover and ground cover once the plantation matures. It is anticipated that not all of the plants will survive, hence the close planting. The general pattern of planting along rows was as follows; river redgum, moonah, blackbox, paperbark, old man saltbush, black wattle, swamp yate, nitre goosefoot, casuarina glauca, lignum, plains redgum and native willow. (For a comprehensive list refer appendix 1)
It was decided that by planting in such an order, it will be easier to identify those which do not survive. Awareness of species locality may be useful in future analysis. An exception to this pattern of planting was the most northerly rows in the first bay adjoining the channel. There was some confusion amongst those planting as to the order of planting.

The lower two bays which are subject to greater water logging and soil salinity were planted out to more tolerant species in random order. This included river redgum, paperbark, swamp yate, black wattle and old man saltbush. It was anticipated that survival rate would be lower, in these bays due to salinity and waterlogging. Therefore, these bays were planted at intervals of less than 2 metres.

The lower 3 banks were planted with river red gum, swamp yate and saltbush. All other banks were mostly planted with *Casuarina cunninghamii* and paperbark at 3 metre intervals.

Fencing
To minimise stock damage, the site will be fenced off. The land manager has agreed to fence off the site with materials supplied by Greening Australia (fencing and pickets). The shortfall of materials (end assemblies and gates) will be supplied by the land manager.

Implementation of irrigation and groundwater management

The land manager currently irrigates a shandy of groundwater and channel water to his pastures. The farm irrigation set up is such that the drainage and irrigation channels are interlinked and that 70% of the farm, including the plantation site can be irrigated. Any runoff from the property gravitates through the channel and drainage system towards a depression adjoining the plantation which acts as a sump. With the aid of a lift pump, drainage water is recycled back into the irrigation system.

The original intent of the study was to irrigate the plantation in the first year with channel water only (approximately 100 EC). In subsequent years the salinity levels were then to be slowly increased by a shandy mix of channel and groundwater so that by the third year, the application would consist entirely of groundwater. However, due to the extremely low water right allocation of the 1999/2000 season (23%), it was agreed that the plantation would be irrigated with groundwater only.

Actual irrigation water for the plantation however, was slightly shandied with channel water. Groundwater is mixed with surface waters as it is pumped via a delivery line to the main channel on the eastern boundary. It is then fed into the drainage system via a shallow channel and lifted via the pump to another channel which directly flows into the plantation plot. It takes 24 hours for groundwater from the delivery line outlet to reach the plantation plot and a further 4 to 6 hours for the plot to be completely irrigated. The above mentioned shallow channel was to be upgraded, but has been postponed due to limited finances.

Irrigation of the plantation is achieved by manually removing stops from two 15cm diameter clay pipes to the first bay, followed by the successive removal of stops from each of the lower bays.

As there is variability in climatic conditions, it is not feasible to have a set watering regime. However, one of the expectations in the farm management during this study, is to maximise groundwater application to the plantation site and therefore protect a greater area of farming land. DNRE advised the land manager to apply up to 10ML/Ha/Year to the plantation.

Monitoring

A protocol for the ongoing monitoring of the pilot site was developed. This details monitoring that will occur between 1999 and 2004. Responsibility for the collection, analysis, interpretation and archiving of data was established between these two parties. It was agreed that MIL would contribute financially to collection and chemical analysis costs and DNRE would be responsible for analysing, interpreting and archiving results. The monitoring protocol is attached (appendix 2). Main components of the protocol are summarised below.

Irrigation volume record

The land manager has been requested to maintain a record of the volume and salinity of irrigation water applied to all individual paddocks comprising the property over the year. The annual volume of pumped groundwater is recorded from the flowmeter attached to the groundwater pump. The volume of channel supply water is measured through the dethridge wheel.

Soil and Water Monitoring

Soil and water monitoring data will be collected annually at the end of the irrigation season. Soils samples from 45 locations across the farm will be collected. Samples will be analysed

for 0-0.3 m, 0.3-0.6 m depths. Soil EC, pH and Cl will be monitored each year. Soil sodicity will be measured every second year. Groundwater quality will also be monitored annually from the pump and piezometers.

Public relations

The land manager has agreed to allow group visitation such as that from Landcare groups, Government bodies etc. A sign has been erected at the site outlining site objectives and participating organisations.

A field visit has been held at the site for members of the Berriquin Community Land and Water Management Plan. Positive feedback was received from this field day.

Conclusions

- A pilot site was established at Blighty in southern NSW. This site demonstrates the potential for controlling salinity problems with farm management of saline groundwater.

- A monitoring protocol was developed and initiated for the period between 1999 and 2004. This monitoring will provide hydrologic data necessary for evaluating the sustainability of farm salt management in areas with high groundwater salinity.

- The project will be subject to an annual review which is administered by DNRE. A report with any issues that arise will be distributed to project stakeholders.

Acknowledgments

Financial contributions to site establishment were made by the landholders, Berriquin Community Land and Water Management Plan, Murray Darling Basin Commission and the Department of Natural Resources and Environment.

Appendix 1. Species planted at Blighty Pilot site.

A total number of 1280 plants of 13 different species were planted at the site on 13th December 1999. These following species were planted:

Botanical name	Common name
Eucalyptus camaldulensis subsp camaldulensis	river redgum
Melaleuca lanceolata subsp lanceolata	moonah
Eucalyptus largiflorens	blackbox
Melaleuca styphaloides	paperbark
Atriplex nummularia	old man salt bush
Acacia stenophylla	black wattle
Eucalyptus occidentalis	swamp yate
Chenopodium nitrariaceum	nitre goosefoot
Casuarina glauca	
Casuarina cunninghamii	
Muehlenbeckia cunninghamii	lignum
Eucalyptus camaldulensis subsp subsinera	plains redgum
Acacia salicina	native willow

Appendix 2. Monitoring protocol.

Monitoring Protocol Proposal for Project I6053 Blighty pilot site

Background

A site has been established to assess the potential for the pumping of groundwater for salinity control. The pumped groundwater is reused for irrigation of pasture and a tree woodlot. This results in the pumped salts being distributed over the soil which overlays the pumped aquifer. The groundwater pumping and irrigation results in the movement of salts through the rootzone and prevents rootzone salinisation. This practice has the potential to extend the life of current irrigated farms without the need to export salts off-farm.

Site Objectives

- To assess the impact on soil salinity of pumping saline groundwater, and managing groundwater on farm.
- To assess the sustainability of pumping saline groundwater for salinity control.

Site Information

The site is established on the property of Colin and Shelley Ogilvie located at Blighty in NSW.

The current status of the site is:

- The site has an existing spearpoint system.
- The pump extracts groundwater of 4000 – 6000 EC and yields 3 – 4 Ml/day.
- A disposal area of 2.2 ha has been allocated.
- Local knowledge indicates that the area of influence covers some 30 – 35 ha.
- Local knowledge indicates that the disposal area is well within the area of influence of the pump.
- Colin estimates that water application would be close to 4 Ml/ha.
- There are 7 piezometers on site that will be used for watertable measurements. Four of these piezometers are nested at three depth.

The operational requirements to make the project successful are:

- Long term monitoring and evaluation of the impacts of the proposed management on rootzone and groundwater salinity.
- The site is to be operated in a manner consistent with this project and the local land and water management plan recommendations.
- The landowner(s) are to be fully committed to the project, and believe that the project is going to benefit their farms and district.
- The project was developed with the intention that the farmer as part of their daily operations would manage the site.

Site Monitoring

Aims

Measure the impacts on farm productivity.
The benefits of pumping saline groundwater will result from increased productivity and reduced export of salt off-farm. Measurements of soil salinity will be used to assess the change in soil salinity both within the area protected by the pump and in a control area not protected by groundwater pumping. Any change in soil salinity relative to the control area will provide information on the effects of groundwater pumping. ‘Steady State’ soil salinity is typically reached in 3 to 5 years after change in surface management practices. Therefore, soil salinity at the site needs to be monitored for the next 5 years to assess the short-term impact of pumping saline groundwater.

Assess the sustainability of pumping saline groundwater

The main threat to sustainability of groundwater pumping is increases in groundwater salinity. Short-term increases in groundwater salinity may result from saline regional aquifers 'leaking' into the pumped aquifer. Groundwater salinity will be monitored over the 5 years to assess the short-term threat of pumped aquifer salinisation.

Monitoring protocol

Objectives of monitoring protocol:
The main objective of the monitoring protocol is to assess the long-term impact of pumping saline water on:

- soil salinity
- groundwater salinity
- soil sodicity (if highlighted as a potential hazard at the site)

Soil/Water Sampling of Pilot Site

Soil Sampling:

45 sites will be included in yearly soil sampling. These samples would consist of bulk sampling intervals of 0-30cm and 30-60cm and 60-90cm. The 60-90cm interval would not be included in the general analysis but collected for possible future determination of leaching fraction.

Samples will be analysed for electrical conductivity ($EC_{1:5}$), pH, Chloride (Cl). Soil sodicity and $EC_{saturated\ extract}$ will be monitored on a selection of samples over the site (30 individual samples will be included in this analysis).

Associated costs associated with soil sample analysis are attached in Table 1.

Manual sampling is expected to take 1-1.5 days.

a) Water sampling:
Water samples will be tested by the landholder from the groundwater pump and at the irrigation bay outlet points using a portable salinity meter to ensure the salinity of applied water does not exceed 0.8 dS/m. The landholder has been provided with the EC Meter.

The landholder will also be responsible for collection of a groundwater sample each month when pumping, and a sample of the applied irrigation water when irrigating. The landholder will also be responsible for the recording of the distribution and EC of the applied water. Watertable water samples will be collected by DNRE in May each year while undertaking the soil sampling.
This sampling regime will be maintained throughout project.

All water samples will be analysed for EC, pH, Cl and for SAR_w to monitor any sodicity hazard.

Associated costs with water sample analysis are attached in Table 2.

b) Watertable Response to Pumping:
Watertable level will be determined on a annual basis by DNRE.

4.3 The responsibilities of all parties for the collection and analysis of field data/samples

Works	*Responsibility*	*Time for Completion*
Monitoring		
Soil sampling	DNRE	May each Year
Groundwater testing/sampling	Landowner	Monthly while pump is running
Irrigation water: testing/sampling/recording distribution	Landowner	At each irrigation
Piezometer level testing	DNRE	May
Piezometer salinity sampling/testing	DNRE	May each year
Ongoing Works/Responsibilities		
Groundwater pump running costs/maintenance	Landowner	Ongoing for term of project

Costs Associated with Collection of Samples

Table 1. Soil Sampling Intensity and Costs per sample

Soil Sampling at Site:			
	Sampling Frequency:	**Analysis of:**	**Cost $ / sample:**
	May.00	$EC_{(1:5)}$, pH, Cl	20.40
	May.01	$EC_{(1:5)}$, pH, Cl, $ESP_{(extract)}$	41.40 (tot. analysis) 20.40 ($EC_{(1:5)}$, Cl, pH)
	May.02	$EC_{(1:5)}$, pH, Cl	20.40
	May.03	$EC_{(1:5)}$, EC_{sat}, pH, Cl, $ESP_{(extract)}$	60.40 (tot. analysis) 20.40 ($EC_{(1:5)}$, Cl, pH)
	May.04	$EC_{(1:5)}$, pH, Cl	20.40
	Total Cost Over 5 years		**15,270**

- In years 1, 3 and 5, 30 samples will be have a total analysis performed. The other 60 samples will have a standard analysis performed.

- **Over the 5 years this is a total cost of $15,270 or $3,054 per year.**

Table 2. Water Sampling Intensity and Costs per sample

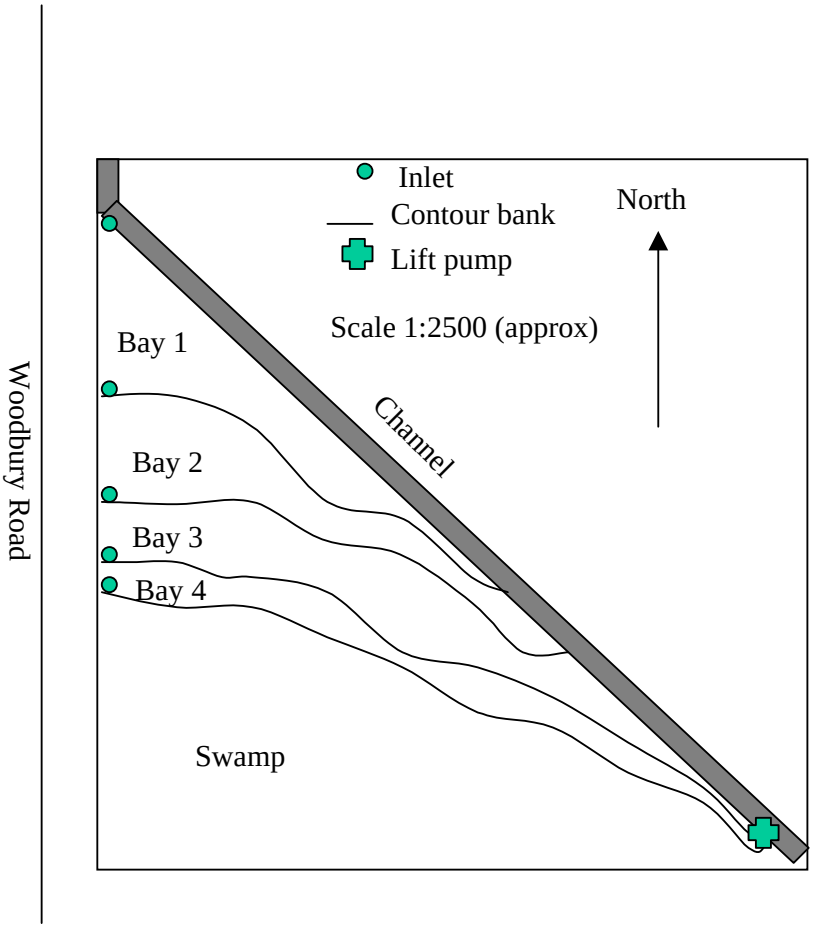
Water Sampling at Site: Groundwater, Irrigation water and watertable			
Year:	**Sampling Frequency:**	**Analysis of:**	**Cost $ / sample:**
Each year	12 pumped groundwater (monthly while operating) 27 watertable samples (once per year)	EC, pH, Cl, SAR_w	17.20
	TOTAL COST Over 5 years		**3,354**

- **Over the 5 years this is a total cost of $3,354 or $670.80 per year.**

Table 3. Associated Costs for Sampling Blighty Site

	Year 1 00-01 $	Year 2 01-02 $	Year 3 02-03 $	Year 4 03-04 $	Project Total $
Salaries and Wages					
Salaries and on-costs	1,000	1,000	1,000	1,000	
Travel	700	700	700	700	
Total Salaries	**1,700**	**1,700**	**1,700**	**1,700**	**6,800**
Sample Analysis					
Soil samples	3,054	3,054	3,054	3,054	
Water samples	670.80	670.80	670.80	670.80	
Total Yearly Costs	**3,724.80**	**3,724.80**	**3,724.80**	**3,724.80**	**14,899.20**
Total Use of Funds	**5,424.80**	**5,424.80**	**5,424.80**	**5,424.80**	**21,699.20**

Appendix 3. Layout of plantation area at Blighty Pilot site



Appendix 4. Schedule 1 completed activities

ACTIVITIES COMPLETED

COLUMN 1 WORKS	COLUMN 2 WORK RESPONSIBILITY	COLUMN 3 FUNDS PROVIDER	COLUMN 4 TIMING
Base line Soil Sampling EC (1.5), EC sat, pH,Cl,ESP (extract) Base line Soil Analysis	Secretary Secretary	Secretary Secretary	1999 1999
Baseline Water Analysis EC, pH, Cl, SARw	Secretary	Secretary	1999
Groundwater Pump: - pump and vacuum pump installation -supply electric motor - supply & install discharge line - supply & install flow meter	Riverina Watermatic Riverina Watermatic Riverina Watermatic Riverina Watermatic	BLWMP BLWMP BLWMP BLWMP	October 1999 October 1999 October 1999 November 1999
Electrical installation -supply & install from dairy to pump	T.A Maher Electrical Contractor	Secretary	October 1999
Remodelling of channel to tree site	B Henderson Earthmoving contractor	Landowner	September 1999
Trees and shrubs produced	Mckinley Nursery Riverina trees	Secretary Secretary	
Supply & installation of piezometers	Kevin Wright Drilling	Secretary	October 1999
Formal approval for BLWMP funding	BLWMC	N/A	September 1999

SCHEDULE 2
FUTURE ACTIVITIES

COLUMN 1 WORKS	COLUMN 2 RESPONSIBILITY	COLUMN 3 FUNDS PROVIDER	COLUMN 4 TIMING
Site design	Landowner/Riverina Trees	Secretary	Nov 1999
Trees delivered (Nursery) 2000 (approximate)	Secretary	Secretary	Nov 1999
Tree Plantation Prepared: - Deep ripping - Rotairing - Mounding - Pre-planting weed control - Irrigation infrastructure - Pickets & fencing -End assemblies & gates	 Landowner Landowner Landowner Riverina Trees Landowner Landowner Landowner	Landowner Landowner Landowner Landowner Landowner Landowner Greening Aust Landonwer	Nov 1999 Nov 1999 Nov 1999 Nov 1999 Nov 1999 Nov 1999 Nov 1999 Nov 1999
Trees planted	Landowner/Secretary	Landowner/ Secretary	Nov 1999
Soil & detailed water monitoring and analyses	BLWMP	BLWMP	Ongoing as per agreed program
Post planting feral animal Control -Hares/Rabbits	Landowner	Landowner	Oct 1999 to April 2000
Management of Groundwater Pump: - timing of pumping - maintenance of pump	 Landowner Landowner	 Landowner Landowner	 Ongoing Ongoing

Irrigation of both Tree Plantation and pasture (10 ML or more Megalitres/Ha/year)	Landowner	Landowner	Ongoing
Irrigation monitoring of Tree Plantation (volume, salinity and dates of irrigation)	Landowner	Landowner	Immediately post-planting, then regularly each irrigation
Post planting weed control **CRITICAL** - Constant monitoring necessary: first summer weed control of both bays and mounds	Landowner	Landowner	Dec 1999 ongoing to April 2001
Ongoing Tree Plantation maintenance - fencing maintained - stock excluded until year 6	Landowner Landowner	Landowner Landowner	Nov 1999 ongoing
Possible thinning regime	Landowner	Landowner	Ongoing