

Farm management of saline groundwater for controlling salinity problems

Report on pilot site establishment at Mt Scobie, Northern Victoria

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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.

This report summarises the establishment of a pilot site developed to assess the impact of farm management of saline groundwater. The site is located at Mt Scobie, near Kyabram in Northern Victoria. The Mt. Scobie pilot site establishment was completed in December 1998. Prior to establishment, the site had high watertables and had evident salinity problems. Groundwater salinity at the site is 10 dS/m. A groundwater pump was installed at the site to provide salinity control. 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 4 Ha tree plantation. 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

Two additional trials were conducted at the pilot site. The first trial was a species-provenance salinity resistance trial of *Casuarina cunninghamiana*, *Casuarina glauca* and *Eucalyptus occidentalis*. A separate field trial of eucalypt hybrids produced under the XYLONOVA Research and Development Program was run at the NRMS project site.

The pilot site will be monitored from 1999 to 2004 for farm impacts on rootzone salinity, soil sodicity and groundwater salinity. This data will 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, Shepparton Land and Water Management Plan, the Murray Darling Basin Commission and the Department of Natural Resources and Environment, Victoria.

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Table of Contents.

EXECUTIVE SUMMARY	2
INTRODUCTION	4
OBJECTIVES OF PILOT SITE	5
PROCESS FOR THE DEVELOPMENT OF TRIAL SITE	6
1. SITE LOCATION AND DESIGN	6
2. SITE DEVELOPMENT	6
3. IMPLEMENTATION OF IRRIGATION AND GROUNDWATER MANAGEMENT	6
4. MONITORING	6
RESULTS AND DISCUSSION	7
SITE LOCATION AND DESIGN	7
<i>Site assessment</i>	7
<i>The concept plan</i>	7
<i>Approval by SIRLWMP</i>	7
<i>Formal agreement – Contract</i>	7
SITE DEVELOPMENT	9
<i>Groundwater pump</i>	9
<i>Piezometers</i>	9
<i>Pump test</i>	9
<i>Plantation site preparation</i>	9
<i>Species choice and planting layout</i>	9
IMPLEMENTATION OF IRRIGATION AND GROUNDWATER MANAGEMENT	10
MONITORING	10
<i>Irrigation volume record</i>	10
<i>Soil and Water Monitoring</i>	10
<i>Species survival in plantation</i>	11
CONCLUSIONS.....	12
ACKNOWLEDGMENTS	12
<i>Appendix 1. Site Layout</i>	13
<i>Appendix 2. Species-Provenance Salinity Resistance Trial at Mt Scobie Pilot site.</i>	14
<i>Appendix 3 Layout of tree plantation.</i>	15
<i>Appendix 4. Monitoring protocol.</i>	17
<i>Appendix 5. Schedule for works undertaken to establish pilot site</i>	19
<i>Appendix 6. Report on pump test</i>	21

Introduction

With the continuing development of high watertables within the Murray Darling Basin, considerable importance will be placed on the management of the farm salt budget. Reuse of pumped groundwater for irrigation (conjunctive water use) is the most cost-effective means of controlling irrigation salinity in many areas. However, at higher salinities, not all pumped groundwater can be reused “safely” on pasture. Current groundwater pumping guidelines in the Shepparton Irrigation Region Land and Water Management Plan (SIRLWMP) recommend that groundwater pumping be confined to areas with groundwater salinity less than 5 dS/m. However, large areas of the Shepparton Irrigation Region (SIR) are underlain by aquifers of considerably higher salinity.

This project proposes that considerably higher salinity groundwater can be reused if some surface disposal of undiluted pumped groundwater is incorporated into the farm salt management system. This report documents the establishment of the Mt. Scobie Groundwater Research Site, including the design of the groundwater pumping system and tree plantation, and the ongoing monitoring program to assess the site’s sustainability.

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), Shepparton Irrigation Region Land and Water Salinity Management Plan and the property owner Mr Lewis Watson .

Definition.

For the purposes of this report, water salinity will be expressed in $\mu\text{S}/\text{cm}$ (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 SIRLWMP to upgrade and enhance the existing Plan.

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 SIRLWMP
- Finalise concept plan through development of a 'Formal contract'

2. Site development

Groundwater pump establishment

- Install groundwater pumping system
- Piezometer installation
- Pump test and approximation of area of influence of groundwater pump

Tree plantation

- Species selection and plantation layout
- Planting

3. Implementation of irrigation and groundwater management

4. Monitoring

Establishing and implementation of monitoring protocol

Results and discussion

Site location and design

The Mt. Scobie Groundwater Research Site was established on the property of Mr. Lewis Watson located approximately 11 km west of Kyabram (Figure 1). The groundwater pump and tree plantation lie on the south side of Webb Road (Kyabram – Rochester Road) and east of the Girgarre – Rushworth Road. Dairy is the main enterprise of the landowner who manages an area of some 400 hectares with help from two sharefarmers.

Site assessment

The groundwater water salinity is high at 10.1 dS/m (measured in the wellpoint system) and ranges from 5.1 dS/m – 9.2 dS/m around the property as measured in piezometers. Watertable levels varied from 0.40m – 1.85m across the property.

Soil salinity over the area where the pumped groundwater will be re-used for irrigation of pasture ranges from 0.50 dS/m – 2.0 dS/m. Where the tree plantation was established, soil salinity values increase from 6.0 dS/m to 12.0 dS/m going down the bays (values dependent upon soil texture group as described in Salt Kit: A “do-it-yourself” salinity identification kit for farmers of the Northern Victorian Irrigation Region, 1995).

The concept plan

The groundwater pumping component of this project was installed to demonstrate salinity control in areas outside current pumping recommendations of the SIRLWMP, 1989. Pumped groundwater will be combined with surface supply water (conjunctive water use) for irrigation of pasture within the area of influence of the pump. A pump test was conducted prior to installation of the full pumping system. The area of influence to the outer limits of the 0.1m drawdown contour had a radius of about 400m.

From the pump test it was determined that pumping 60 ML of groundwater would provide 0.1 m drawdown over a 60 Ha area. The volume of groundwater that can be diluted to 0.8 dS/m is 35ML. The other 25ML of pumped groundwater will be used to irrigate a 4 Ha tree plantation. All pumped groundwater is reused for irrigation within the area of influence of the pump. Conceptual layout of property is given in Appendix 1.

Approval by SIRLWMP

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 SLWSMP.

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.

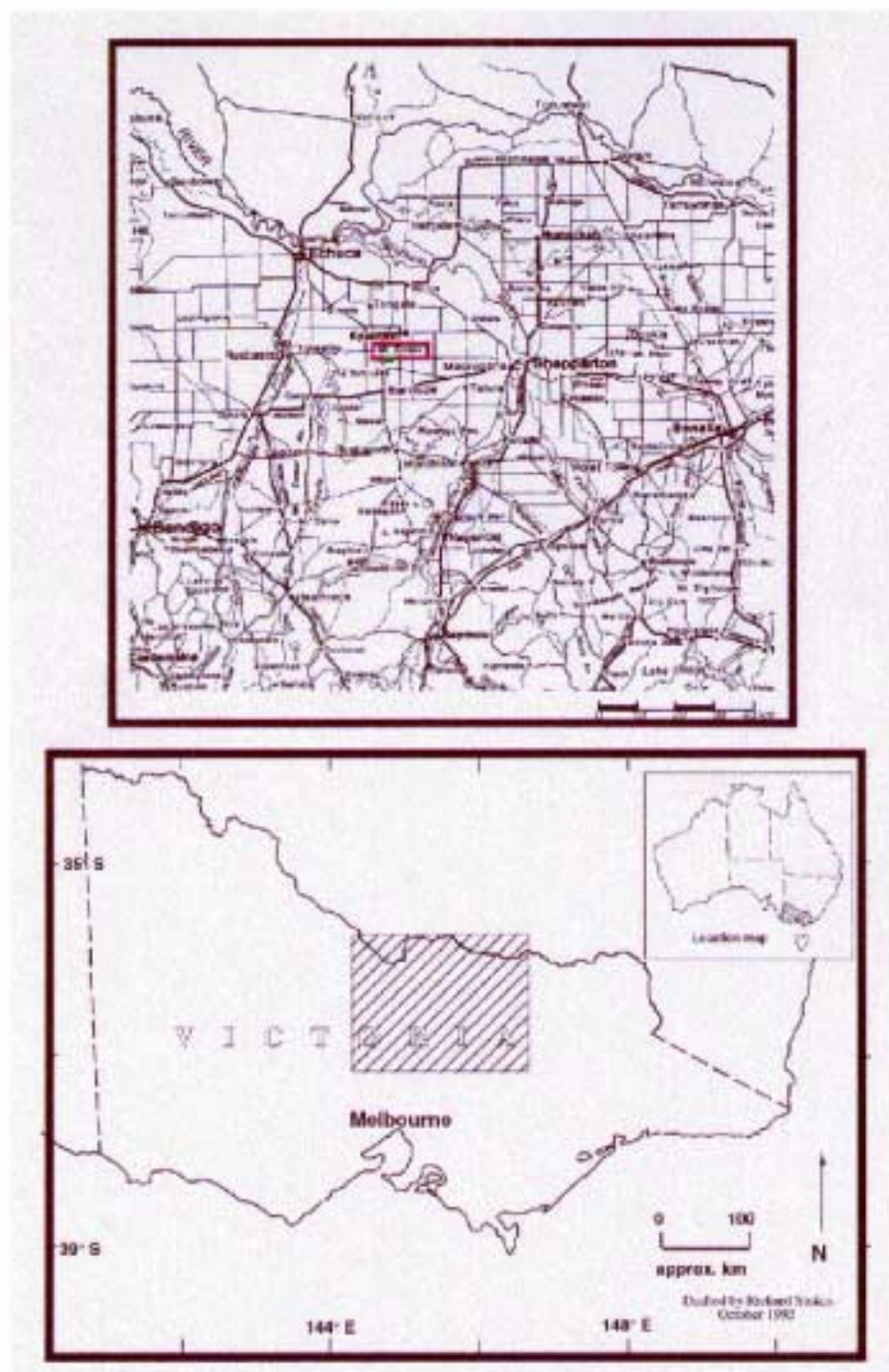


Fig 1. Location of pilot site.

Site development

Groundwater pump

The groundwater pump consists of a surface mounted Southern Cross 100mm x 65mm pump coupled to a 3 kilowatt, 3 phase electric motor. The groundwater pump draws on a series of five 80mm wellpoints installed to a depth of 11.5m. The wellpoints are spaced over 120m and connected by a 100mm diameter PVC headerline. Pump installation was finalised in July when three phase power was connected to the pump.

Piezometers

A total of 14 piezometers were installed during the development of the pilot site. Piezometer details including depth, location, groundwater level and groundwater salinity are detailed in the report on the Pump Test (appendix 5).

Pump test

Sinclair Knight Merz (SKM) designed, conducted and analysed a pump test. The report prepared by SKM on the pump test is attached (appendix 5). The pump test was of seven days duration. From the test it was determined that a 0.30m drawdown could be achieved over 41.6ha and 0.10m over a further 20.7ha. The radius of the area received a drawdown of 0.1m from the pump was approximately 400 m. Pump test results and measured rate of recovery in the piezometers ascertained that a maximum annual volume of 60ML could be extracted from the aquifer. Transmissivity was estimated to be 220 m²/d and storativity was calculated to be 0.012 from the pump test.

Plantation site preparation

The area designated for the tree plantation had already been laser-graded some time ago and required construction of new supply channel and fencing off initially. In May 1998, a D8N dozer was hired to rip the site to a depth of 0.60m with a single-tynd wingless ripper. Rip lines were spaced approximately 4m apart. The site was Rotaired to break up the larger clods of soil before mounding on the rip lines. After completion of earthmoving activities the entire site was sprayed with 10L of Roundup CT in June 1998 and follow up applications of 12L Simazine in August, and a further 10L Roundup CT in October prior to planting of the Xylonova hybrids.

Species choice and planting layout

A species-provenance salinity resistance trial shows off seventeen provenances of *Casuarina cunninghamiana*, eleven of *Casuarina glauca* and eight of *Eucalyptus*. Each provenance was laid out in a 25 tree plot (5 x 5) which measured 20m (row) x 8m (column). The three species combined gave a total of thirty-six provenances that were completely randomly distributed within each of the four replications (Figure 3).

The trial was established on land previously irrigated to sub pasture, however, increasing salinity and reduction in depth to the watertable meant the landowner was getting virtually zero productivity over 4ha of land.

A demonstration block representing several recommend farm forestry species was also incorporated into the trial (a full list of species and provenances can be found in appendix 2).

The planting area for the trees associated with the species-provenance salinity resistance trial and the demonstration plots was marked out using aluminium droppers cut in half. The start and finish of each replication was marked using larger droppers for ease of recognition and differentiation from individual plots. All planting spots were marked using spray-paint.

The planting area was pre-irrigated to get moisture in the mounds on Thursday, December 10th. The seedlings were delivered to the Mt. Scobie site on Wednesday 16th December, 1998. Seedlings were then sorted into provenances and seedlot numbers before being laid out in the field for planting. Over the next three days (Wednesday 16th – Friday 18th) the planting crew of Terry Batey, Alex Sislov and Rhodey Bowman (ISIA) with help from the William Bucklin Foundation (Dookie) trees were planted using shovels and Pottipruki's. During planting it was found that inadequate labelling from seedling source made it impossible to plant with any accuracy seedlots for *Casuarina cunninghamiana* (162321) and *Casuarina glauca* (16362).

After completion of planting the demonstration plots on Friday 18th, all seedlings received their first irrigation. Subsequent irrigations took place on December 23rd and 30th. The whole 4ha planted to trees took on average 1.25Ml to irrigate over a period of 6 hours.

Separate to the species-provenance trial which is part of the larger groundwater project, the Xylonova Research and Development Program planted their first field trial testing salt tolerant eucalypt hybrids. These hybrids are an integral part of the Xylonova research program aiming to establish commercial plantations on saline, waterlogged and polluted land, initially in the Murray-Darling Basin. For further information regarding the Xylonova Research and Development Program refer to "Report on the establishment of the 1998 field trial of the Xylonova hybrids at Mt. Scobie, near Kyabram, northern Victoria" (Jo Sasse, Centre for Forest Tree Technology, Heidelberg, Victoria, 3084). Refer to Appendix 3 for a complete view of the Mt. Scobie Groundwater Research Tree Plantation.

Implementation of irrigation and groundwater management

Groundwater pump establishment was finalised in July 1998. Groundwater pumping with farm reuse of the groundwater commenced at the start of the following irrigation season. The groundwater is diluted to 0.8 dS/m for irrigation of pasture. The Landowner has a hand held salinity meter to assist in obtaining the correct dilution of groundwater.

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 SLWSMP 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 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 150 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.

Species survival in plantation

A survival count of the species-provenance trial was completed on 26/1/99. Overall survival rate over the plots was 90.1% over the 3 species. Total survival for the four replications is shown in Table 1 below

Table 1. Survival Assessment for Replicates in Species/Provenance Salinity Resistance Trial

Replicate	Dead Plants	Survival Rate %
I	20	97.8
II	64	92.9
III	103	88.6
IV	169	81.2
Total	356	90.1

Most of the losses were observed at the bottom of the bays in replicates III and IV. A similar trend was found for the XYLONOVA plots. This might have been associated with the higher salinity levels at these locations and/or loss of topsoil, caused by landforming.

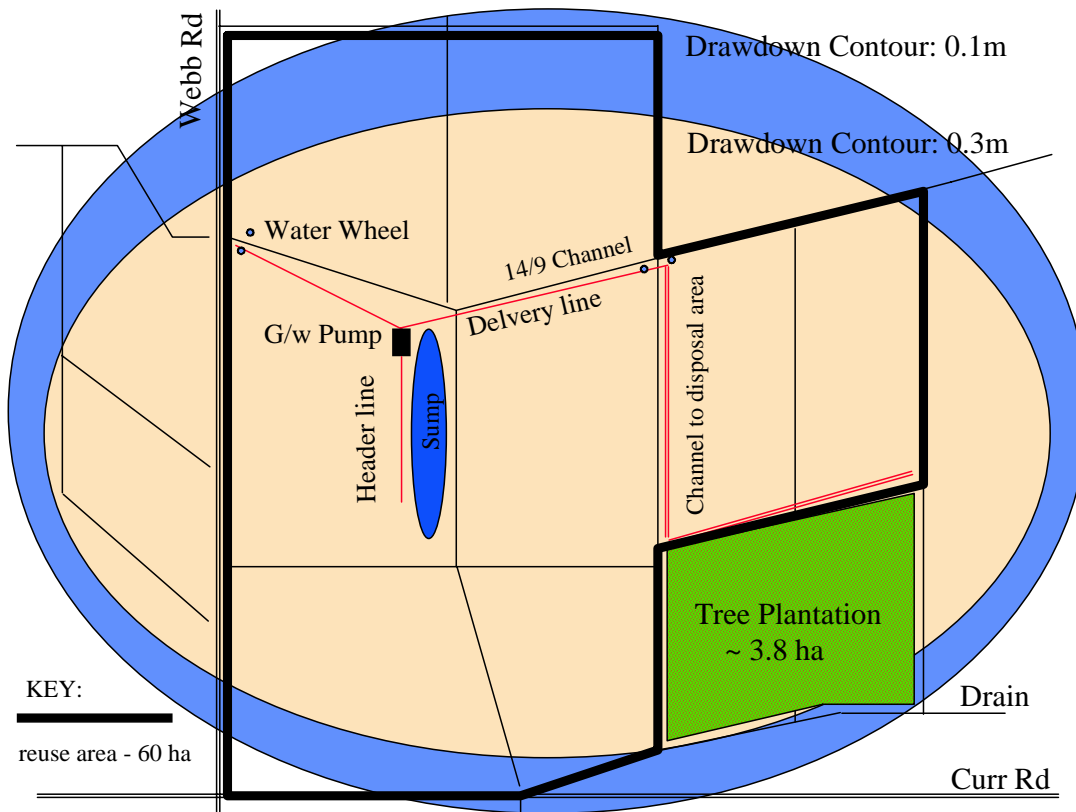
Conclusions

- A pilot site was developed at Mt Scobie, near Kyabram in northern Victoria.
- The site development involved a collaborative arrangement between the Shepparton Irrigation Region Land and Water Management Plan, the Landowner and the Department of Natural Resources and Environment.
- The pilot site demonstrates that pumping saline groundwater to control salinity problems with farm containment of the groundwater is possible in the short term.
- A monitoring protocol has been developed and implemented.
- This monitoring will provide the information necessary to assess the long term impacts of farm containment of saline groundwater on groundwater salinity, soil salinity and soil sodicity.

Acknowledgments

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

Appendix 1. Site Layout

SITE DETAILS:

Landowner:	Lewis Watson
Property Location:	Mt. Scobie, Kyabram
Watertable Depth:	1.0m
Groundwater Salinity:	10 dS/m
Predicted Area of Influence:	62.3 Ha gross
	Groundwater drawdown of 0.41m was observed approx. 350m from the pump site
Area of Reuse:	60 Ha
Applied Water Salinity:	0.8 dS/m on perennial pasture
Volume Reused on Pasture:	35 Ml
Disposal Area (Trees):	3.8 Ha
Applied Water Salinity:	10 dS/m
Volume Disposed of to Trees:	25 Ml groundwater @ 10 dS/m

Appendix 2. Species-Provenance Salinity Resistance Trial at Mt Scobie Pilot site.

Species-Provenance Salinity Resistance Trial

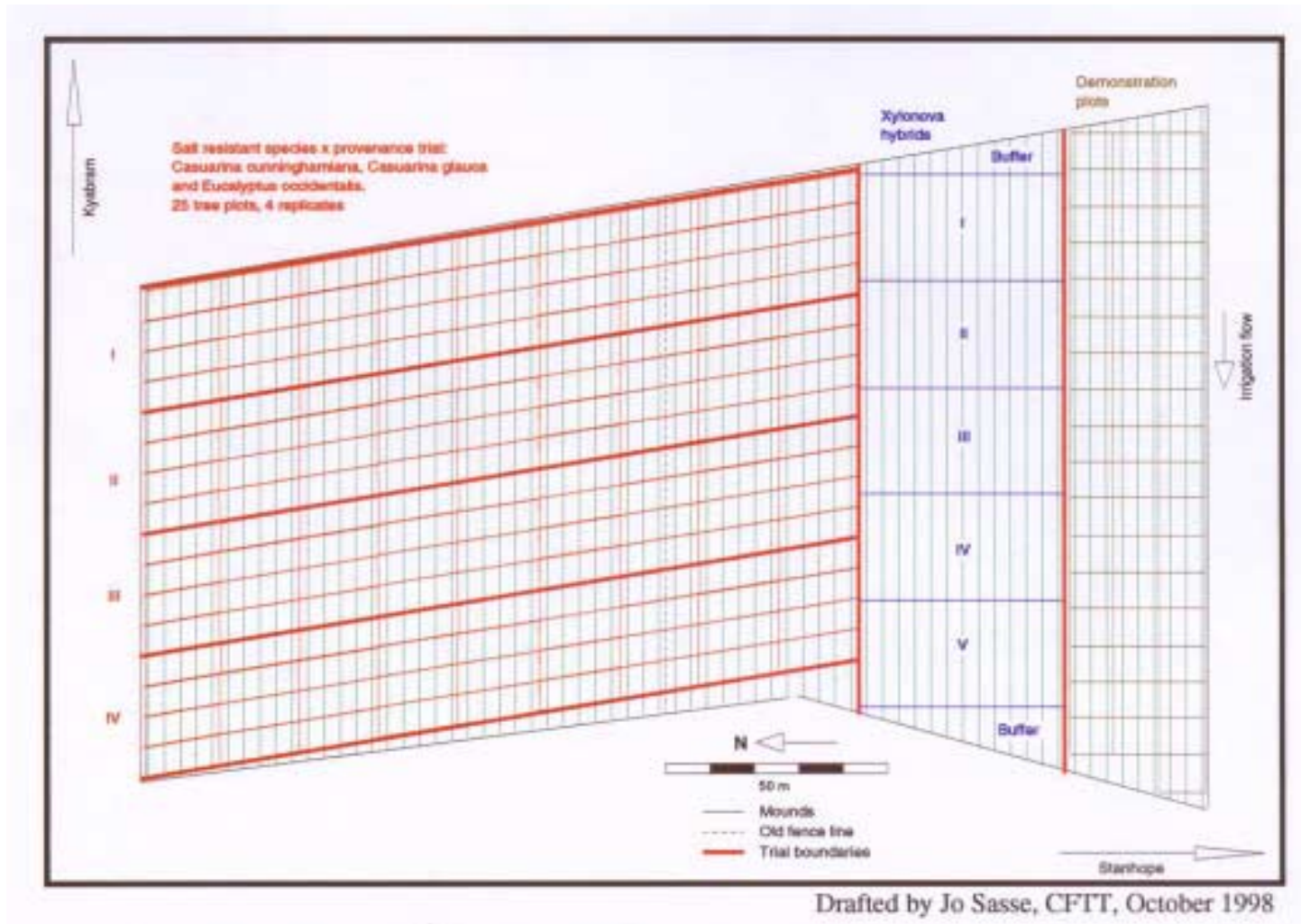
<i>Eucalyptus occidentalis</i>	<i>Casuarina glauca</i>	<i>Casuarina cunninghamiana</i>
Bremer Bay, WA Cape Richie, WA Lake Magenta Rd, WA Gordon River, WA Katanning, WA Gibson, WA Dumbleyung Lake, WA Stirling Range, WA	Coffs Harbour, NSW Burrill Inlet, NSW Tomago River, Mossy Point, NSW Local Seedlot (Girgarre) Tuross Lake, NSW Myall Lakes, NSW Tuckean Swamp, NSW Wagong Inlet, NSW Singleton, NSW Upper Hawkesbury River, NSW Aberdare Colliery, QLD	Uriarra Crossing, ACT Augathella, QLD Murrumbidgee River, Wagga, NSW Lachlan River, Cowra, NSW River Lett, Hartley, NSW Macquarie River, Dubbo, NSW Connabarabran, NSW Blaxlands Creek, Grafton, NSW Singleton, NSW Shoalhaven River, Nowra, NSW Brogo River, Bega, NSW Kangaroo Valley, NSW Armidale, NSW Glen Innes, NSW Ettrema Gorge, NSW Flagstone Creek Rd, QLD Local seedlot (Girgarre)

Demonstration plots

Species/Provenance

<i>Acacia salicina</i>	(1)
<i>Acacia saligna</i>	(2)
<i>Acacia stenophylla</i>	(2)
<i>Casuarina cristata</i>	(2)
<i>Casuarina cunninghamiana</i>	(2)
<i>Casuarina glauca</i>	(3)
<i>Eucalyptus camaldulensis</i>	(3)
<i>Eucalyptus grandis</i>	(1)
<i>Eucalyptus kondininensis</i>	(1)
<i>Eucalyptus occidentalis</i>	(3)
<i>Eucalyptus spathulata</i>	(2)

Appendix 3 Layout of tree plantation.



Monitoring Protocol Proposal for Project I6053

Mt Scobie 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 Lewis Watson, located at Mt Scobie, near Kyabram, in Victoria.

The current status of the site is:

- ❖ The site has an existing spearpoint system.
- ❖ The pump extracts groundwater of 10 EC and yields 1 ML/day.
- ❖ A disposal area of 4 ha has been established.
- ❖ A pump test indicates that the area of influence of the pump covers 60 ha.
- ❖ The disposal area is contained within the area of influence.
- ❖ There are 14 piezometers on site that will be used for watertable measurements.

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

a) Soil Sampling:

150 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 $EC_{\text{extract}}^{\text{saturated}}$ will be monitored on a selection of samples over the site (50 individual samples will be included in this analysis).

b) 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.

c) Watertable Response to Pumping:

Watertable level will be determined on an annual basis by DNRE.

Appendix 5. Schedule for works undertaken to establish pilot site.

<u>WORKS</u>	<u>RESPONSIBILITY</u>	<u>TIMING</u>
1. Pump Test: -installation of spear points -connection of header line -seven day pumping trial -collection of water samples	Goulburn Valley Bore Construction "" Sinclair-Knight Mertz DNRE / SKM	Oct. 1997/Dec. 1997 Dec. 1997 Dec. 1997/Jan. 1998 Jan. 1998
2. Installation of Groundwater Pump: -pump and vacuum pump installation -shed -discharge line	Goulburn Valley Bore Construction "" Rob Rye	July 1998 July 1998 August 1998
3. Connection of Power to Site: -Powercor assessment of site (quote) -installation of poles and associated fittings	Powercor Australia Ltd. ""	May 1998 June/July 1998
4. Tree Plantation Development: -area for disposal of pumped g/w -species/provenance selection -layout of site	DNRE / Landowner DNRE “ “	June 1998 August 1998 Sep./Oct. 1998
5. Management of Groundwater Pump: -timing of pumping -maintenance of pump	DNRE / Landowner Landowner	Ongoing Ongoing
6. Monitoring of Pump and Site: -measurement of groundwater salinity -monitoring of soil salinity -monitoring of water quality leaving the site	DNRE / Landowner DNRE DNRE	Ongoing Ongoing Ongoing
7. Site Prepared: - Deep ripping - Rotairing - Mounding - Pre-planting weed control - Irrigation infrastructure - Fencing	DNRE Landowner Landowner DNRE / Landowner Landowner Landowner	Autumn 1998 Autumn 1998 Autumn 1998 Late Winter 1998 Sept/Oct 1998 Sept/Oct 1998
8. Seed for local Trials obtained	DNRE	May 1998
9. Trees produced and delivered (Nursery) - Local Trial Sites (4200) - Xylonova (1200) approx.	DNRE FORBIO	Oct / Nov 1998
10. Trial / Demo. Sites design developed	DNRE / FORBIO (All 1 day)	Sept 1998
11. Follow-up pre-planting weed control - CRITICAL: must be done immediately to allow for with-holding period prior to planting. Broad-acre control of mounds and bays required	DNRE / Landowner	September 1998 (immediately)
12. Tree guards obtained	DNRE FORBIO (for Xylonova plants)	Oct 1998
13. All Trial / Demonstration Sites marked out on ground	DNRE FORBIO (Xylonova trial)	mid-Oct 1998
14. Trees planted and guarded - 4200 trees Local Trials - 1000 trees (approx.) Xylonova	DNRE FORBIO (Xylonova trial)	late-Oct 1998 (if possible)

Appendix 6. Report on pump test.