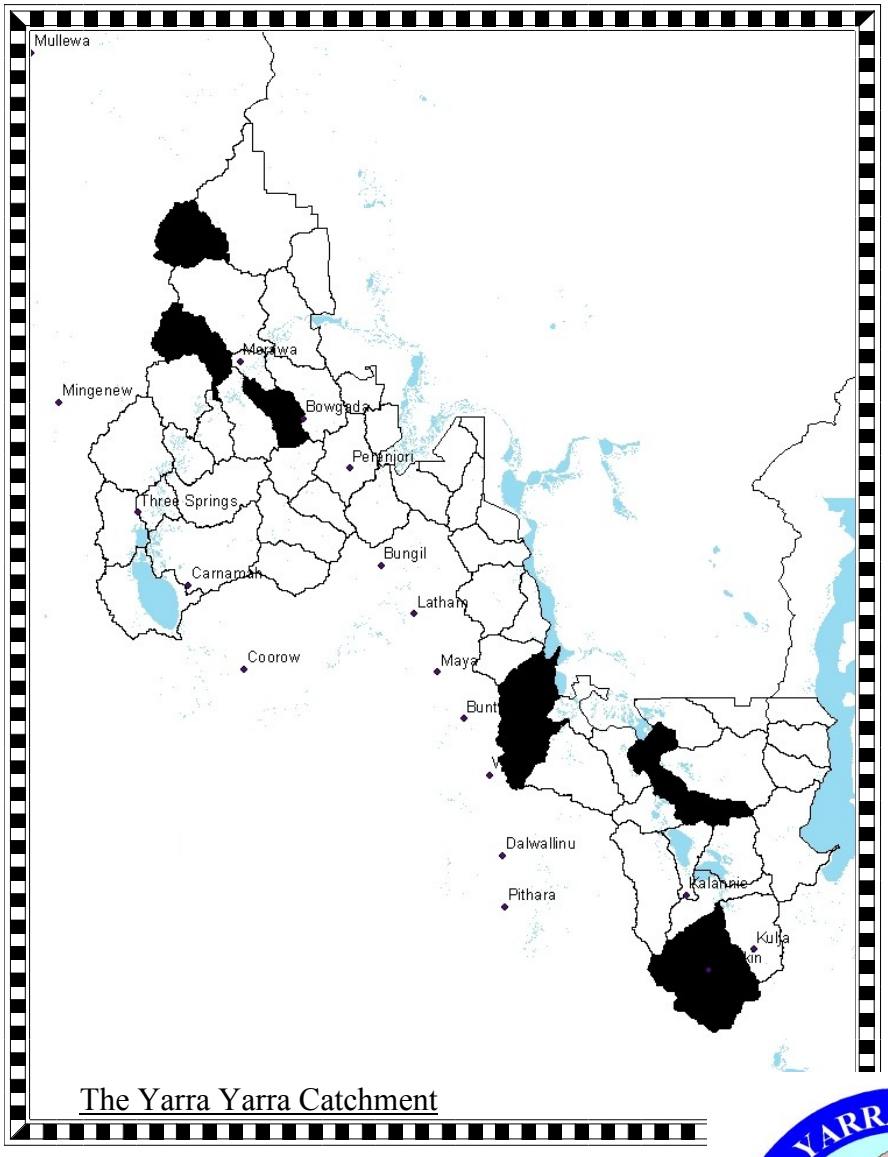
STAGE 2 YARRA YARRA REGIONAL DRAINAGE & RESEARCH PROGRAM



The Yarra Yarra Catchment

March 2008
Version 1.1

Contents

Part One - Introduction

Stage Two of the Yarra Yarra Regional Drainage Program

Executive Summary

The Yarra Yarra Catchment Management Group has spent the last ten years evaluating the status of the drainage networks within the agricultural areas of the Yarra Yarra Basin. The investigations concluded that most major drainage lines were in urgent need of rehabilitation. After a period of community consultation it was agreed by stakeholder representatives that the preferred course of action was to prepare a **Regional Drainage Program** that should be implemented with some urgency.

The agreed plan for the program is to drain the saline groundwater from selected valley floors using a network of leveed deep drains in conjunction with surface water channels, allowing landholders access to deep drainage. For logistical and management reasons the program is to be undertaken in three stages, targeting the main drainage lines in ten sub-catchments distributed along the 300 km length of the Yarra Yarra lake system. Each drainage line has been selected under a prioritisation process which is part of the Yarra Yarra Drainage Policy.

An integral part of the program will be a series of **research projects** that will be conducted within and adjacent to the nominated drains. The studies will be comprehensive, recording and processing data from selected demonstration and monitoring sites along the full length of each drain including the discharge areas. We will compare variables from within catchments and between catchments which will provide information relating to a selection of geographical and ecological situations, relating to many landscapes in the Wheatbelt of WA. Currently these **research projects** are being supported by the Department of Water and other government agencies (see Appendix One, Report by the Department of Water, 2006).

Stage 1 commenced in December 2006 and is due for completion by the end of June 2008. We are seeking funds for Stage 2 so that it can follow on directly from Stage 1. At the completion of Stage 2, all necessary monitoring infrastructure will have been put in place, which will allow for ongoing research. We will make provision to continue the monitoring program for at least 15 years.

It is important to understand that it will take a number of years to evaluate the full effects of these major earthworks. We need to ensure that Stage 2 of this program will follow on directly from Stage 1 so that information can be collated and disseminated for maximum impact in a minimum time frame.

OVERVIEW OF THE 3 STAGES OF THE REGIONAL DRAINAGE PROGRAM

Stage 1	• Establish 100 km of deep drains with surface water management, in seven subcatchments • Stage 1 is currently being implemented at a cost of **$2,100,000** • Commencement of infrastructure set-up for research program • Scheduled for completion by the 30th June 2008
Stage 2	• Finalise the infrastructure requirements for the research and monitoring program • Stage 2 will extend Stage 1 drains in six sub-catchments and will establish new drains in two sub-catchments, totalling 129 km • We require further funding of **$2,954,000** from NHT3 or a similar source for Stage 2 • Establish vegetation within easements containing the drainage networks • Stage 2 is scheduled to follow on from Stage 1, commencing 1st July 2008
Stage 3	• Identify any gaps in Stage 1 and 2 works and address any other sub-catchments or tributaries that meet the criteria of our prioritisation process, i.e. as more land owners wish to become involved with deep drainage • Continue research and monitoring program • Stage 3 will also concentrate on revegetation of the drain easements and drain banks.

The Importance of Stage 2 of the Yarra Yarra Drainage Program

1. Stage 1 will be completed by the end of June 2008 and it is important that we move straight onto Stage 2. If we do not, our "whole of catchment" study will be incomplete and we will fail to fulfil one of the main criteria of the Drainage Program which is to research the effects of deep drainage at **all levels of the catchment**, from high in the landscape to the final receiving wetlands.

The research will provide information on the following:

- Overland flows
- Capacity and out-flows of receiving wetlands
- Drainage costs
- Environmental and downstream impacts
- Drainage effectiveness
- Drainage water quality
- Soil reclamation following salinity amelioration
- Long-term sustainability of soil rehabilitation
- Provide on-ground data (in addition to that gained through the EEI) that can be used in:
  - Drainage planning
  - Drainage assessment
  - Decision making

2. The Yarra Yarra Catchment basin provides a unique opportunity for drainage research:
The combination of all three stages of the Yarra Yarra Drainage Program is perceived as a **potential pilot scheme** that can be used to set standards for other regional drainage initiatives. The Department of Water in particular has recognised this potential and has supported the program to the extent of $250,000. Because the project is already underway, the Yarra Yarra Group is in a position to be able to fill gaps in the knowledge regarding drainage design and planning. Together with the research program the Yarra Yarra governance initiative (see below) will provide a complete package of drainage management that can be used to establish benchmarks for other drainage regions in the Wheatbelt. This will include policy development, procedure establishment, compliance, regulation and reporting, with particular emphasis on monitoring programs.

The Governance System

The Yarra Yarra Catchment Management Group (Inc.) (YYCMG) has accessed legislation from within the "Local Government Act" and the "Soil and Land Conservation Act" to establish two statutory bodies that will work in unison to provide perpetuity of governance, regulation and management for the **Yarra Yarra Regional Drainage Program.** These two bodies share a common geographical boundary defining a specific area of interest within the Yarra Yarra Catchment Basin. This area is registered as a deposited map.

a) **The Yarra Yarra Catchment Regional Council (YYCRC)** has been established under the Local Government Act and provides for:
   - Accountability
   - Perpetuity
   - Administration
   - Compliance with government sector standards.
   - Credibility
   - Staff management

The membership is made up of one representative from each of the six participating shires that have land within the specific area of interest.

b) **The Yarra Yarra Land Conservation District Committee (YYLCDC**) will be established under the Soil and Land Conservation Act and provides for:

- Regulation for the establishment of drains (Notice of Intent to Drain etc.)
- The ability to serve a covenant on a specially nominated area of land e.g. a service area on either side of the arterial drain
- Provision to strike a specific area rate to pay for the maintenance of the drains within the covenant
- Enforcement to comply with Land Conservation Standards
- Provision for recovery of arrears for payments due

The membership is made up of one delegate from each of the eleven Catchment Zones within the area of interest.

Combined, these statutory organisations provide strong legislation to manage and service a **Regional Drainage Program.** As the governance structure evolves, the Yarra Yarra LCDC will supersede the current community group, the YYCMG, as a management committee. The LCDC will then work under the umbrella of the YYCRC. We are currently going through this transition period.

3. **Providing valuable information for the Wheatbelt Drainage Council**

Taken from the Wheatbelt Drainage Council Overview, 2007:

> "*The Western Australian Government has established the Wheatbelt Drainage Council (WDC) to provide strategic planning, governance and implementation advice on drainage… From this information a policy framework for inland drainage will be developed".*

It is clear that there is very little information available regarding drainage design and the effects of drainage. There is also very limited documented information that could assist in developing policy regarding governance and management of a regional drainage program. A combination of the strategic planning, governance strategy and implementation of Stages 1 and 2 of the **Yarra Yarra Regional Drainage Program** will provide essential information which can be used by the **Wheatbelt Drainage Council** to help establish this framework.

As information becomes available from the Yarra Yarra research program it can be fed into the policy framework, which will be an ongoing or " live" document.

4. Advantages of the Yarra Yarra Catchment

- Very few Wheatbelt catchments have the advantage of an enclosed inland lake system where landhoders can experiment with drain design with little likelihood of any downstream degradation.
- A substantial proportion of the discharge from proposed drains is either alkaline or neutral, which will minimise the risk of contamination by heavy metals and other pollutants at disposal points (acidic water has the potential to mobilise heavy metals).
- The salt lakes within the system equate to 20% of the total agricultural land in the catchment so combined with the evaporation rate (average 2.5 metres/annum) this is more than adequate to cope with the discharge from the drains and overland flows.

<u>Stage 2 - Funding required</u>

We require $2,954,000 to implement Stage 2 which will cover the cost of:

- **Construction,**
- **Operating costs,**
- **Salaries & consultancy,**
- **Monitoring & research,**
- **Fencing materials**
- **Revegetation**

Activity	Percentage	Total ($)
Construction	**61%**	**$1,802,000**
Operating Costs	**5%**	**$148,000**
Salaries & Consultancy	**13.5%**	**$399,000**
Monitoring & Research	**6%**	**$177,000**
Fencing Materials	**10%**	**$295,000**
Revegetation	**4.5%**	**$133,000**
Total	**100%**	**$2,954,000**
	An additional 10%	**$295,000**
Total	**110%**	**$3,249,000**

We require contingency funds of 10% to be available in the event of unforeseen circumstances and possible cost rises. This would be $295,000 making total requested funding $3,249,000.

Part Two
Background to the Yarra Yarra Catchment Management Group (Inc.)

The YYCMG (Inc.) was founded in 1997, as a sub-region of NACC. Following the inaugural meeting, a series of workshops were held with community members throughout the Yarra Yarra Basin to establish a working committee and also to set the boundary of the management area. At these workshops, a Strategy and Action Plan was endorsed along with the following mission statement.

"We will have a strategy in place that will stimulate actions to enhance social, economic and environmental well being in the region; this will achieve an agronomic and ecological balance that will provide a sustainable future for our lifestyle, economic viability and natural environment. We will meet these objectives by applying our strategy on a whole of region basis constantly involving all the community in the process of communications, decision making, planning and implementation"

Resource Assessment
Since its inception the Yarra Yarra Catchment Management Group has managed over $1,000,000 of public funds to conduct a series of investigations into the status of the environment and the relationship between biodiversity and the farming industry within the Yarra Yarra Catchment Basin. The Resource Assessment revealed that the majority of the valley floors harbour arterial waterways that will not sustain commercial crops or deep rooted plants. This is due to the shallow hyper-saline water tables that have developed as a result of land clearing.

The Plan
The agreed plan is to rehabilitate the natural arterial waterways and at the same time create a network of vegetated corridors (alongside these waterways). The hyper saline water must be removed before the Revegetation Program can continue successfully. This will be achieved by constructing a network of deep drains and surface water channels throughout the catchment. The vegetated corridors will provide a link between significant patches of remnant native vegetation, nature reserves and the extensive bushland that constitute the verges of the vast Yarra Yarra salt lake system. Desktop studies carried out using information gathered during the assessment indicated that with strategic planning, environmental assets can be preserved and enhanced so as to coexist with a viable agricultural industry.

Preliminary in-house evaluation
As part of the assessment process, preliminary studies were conducted by two environmental scientists (Regeneration Technology and Dr. Ian Fordyce) to analyse five existing deep drains that had been operating in the catchment for a number of years. These drains are similar in design and structure to the ones currently being constructed as part of Stage 1 of the Yarra Yarra Regional Drainage Program. The drains selected are dispersed fairly evenly along the length of the lake system to ensure that a representative coverage of the catchment basin is achieved. The consultants concluded that from the drains studied, they were unable to detect any negative outcomes caused by the drainage discharge into the surrounding wetlands. Further to this, it was noted that as many of the major lakes in the chain are land-locked, is little likelihood of associated downstream effects from the drainage discharge.

The plan becomes a reality
The results of these investigations gave the Yarra Yarra Group the confidence to proceed with a comprehensive drainage and revegetation program with the knowledge that drainage works can be carried out within this catchment with managed risk. Consequently, an application for funds was submitted to NACC which resulted in the approval by the Joint Steering Committee (JSC) for a pilot drainage study to go ahead. This consisted of 16km of deep drains with associated surface water channels being constructed in the sub-catchment Mongers 55 (see Maps 4a and 4b) This work was started in May 2006 and completed in August 2006.

The main objectives of this pilot drain were:

- To carry out a cost-benefit analysis
- To investigate draw-down effects of the drain
- To investigate the drainage water quality
- To carry out analysis of sediment at disposal points
- To investigate the effect of drainage water on vegetation

Yarra Yarra Catchment Regional Drainage and Water Management Evaluation
Following the Mongers 55 pilot study both NACC and the Department of Water recommended that a "whole of catchment" evaluation was needed before funding for a **Regional Drainage Program** would be approved. Subsequently the engineering company GHD was commissioned to conduct the "Yarra Yarra Catchment Regional Drainage and Water Management Evaluation". The decision to undertake this study was greatly influenced by the fact that deep drainage was becoming an increasingly contentious and political issue.

The GHD project was fundamentally flawed because apart from the data the YYCMG had collected, there was no local information available on which to base an informed environmental or economic assessment. Various models were applied based on assumptions derived from case studies remote from the area of interest. When compared with the real data provided by the Yarra Yarra Group, there were enormous discrepancies and gaps. The GHD project, if anything, highlighted the need for a comprehensive research program throughout the Yarra Yarra Catchment to gain a better understanding of the behaviour of deep drains within a typical wheatbelt environment.

The lack of data is proving to be a pivotal aspect in delaying the planning and advancement of engineering options and drainage for saline areas of catchments in the Wheatbelt of WA. Whilst the Department of Water is conducting the "Engineering Evaluation Initiative" (EEI), data collected from this has been from mostly small-scale drainage schemes that are not related to a regional network.

Since the GHD evaluation it has been acknowledged by the Department of Water that additional data from a whole of catchment program is necessary to support the EEI. They also acknowledge that the scheme proposed (and already underway) by the YYCMG will help provide on-ground data (in addition to that gained through the EEI) that can be used in drainage planning, assessment and decision making, particularly for the Yarra Yarra and other wheatbelt catchments.

Stage 1 approval
The Yarra Yarra Regional drainage program was initiated by the implementation of the pilot scheme conducted in Mongers 55 sub catchment in May 2005. Following this it was agreed by NACC and the JSC that Stage 1 of the Yarra Yarra **Regional Drainage Program** should be initiated, provided it incorporated a comprehensive research program into the effects of deep drainage. Implementation commenced in December 2006 and is on schedule to be finished by the end of June 2008.

Stage 1 and 2 will provide a broad coverage of the Catchment Basin
By the completion of Stage 1 we will have established deep drains in eight catchments from Burakin in the South to Canna Gutha in the North, a distance of around 250 km. With the funds available for Stage 1 and applying the prioritisation process we have been able to establish up to 15 km of drain in each of these eight catchments, totalling around 100 km. Five of these catchments are considerably larger than the others and the implementation of Stage 2 will allow us to proceed higher up into the landscape, (up to around 25 km in some cases). With the completion of Stage 2 we will have a relatively good coverage of each of the targeted catchments to enable us to collect sufficient information so that we can assess a whole of catchment situation.
By using a progressive approach to the implementation of the larger catchments the main flush from Stage 1 will have time to disperse and it also gives us the opportunity to observe the effectiveness of our drain design before proceeding with Stage 2.
Stage 1 is currently in progress. Even at this stage of development we have gained a wealth of knowledge with a number of thought-provoking situations developing. Below are some of the observations we have made and further investigations that we would like to carry out, in order to increase our understanding of the processes at work.

Part Three

Observations and Further Investigations

The preceding pages have given us a summary of the Yarra Yarra Regional Drainage Program and also given us an insight into the background of how the program has evolved. We have explained how it is imperative for Stages 1 and 2 to be consecutive.. The following pages will describe observations we have made so far from Stage 1, and further investigations we wish to carry out in Stage 2.

Deep drain design: We will observe and experiment with varying design methods
We will endeavour to isolate ground water from surface water, where possible, and concentrate on the robustness of levee banks. We will study and develop relief strategies in the event of blow-outs to levee banks during severe rainfall events. We need to study the effects of drainage yield performance over short and long distances for both surface channels and deep levied drains. It is important that Stage 2 is completed so that we can gauge the effects of deep drains over longer distances. For examples see Maps 1a & 1b (Burakin) and Maps 6a & 6b (Merkanooka). We plan to continually improve drain design in order to observe the effects of these modifications during severe rainfall events. We do not wish to have a drain design that will create excessive velocity in such an occurrence. There is a need to experiment with the design of surface water channels to control velocity and to redirect surface flows across the valley floors so as to gain full effect from the design of our constructed earth works.

Fig 1a

Fig 1b

Figure 1a above, shows the construction of the surface water channel and Figure 1b shows the position of the surface drain in relation to the main drain. Two surface water channels are constructed, flanking the main drain.

Surface water studies

There is limited information available regarding overland flows, except for various computer models which are not especially relevant or reliable when applied to the varying conditions throughout the Yarra Yarra Catchment. We will be inserting weirs at strategic delivery sites in four of the sub catchments so that we can obtain accurate information regarding overland flows in relation to rainfall events. From this data we will be able to develop computer models and formulae that will reflect actual measurements. This information will be invaluable for developing drain design by providing useful predictions for establishing projects in other catchments in the wheatbelt.

Ground water monitoring

We will continue with our present program of ground water monitoring. This consists of regularly checking the observation bores in proximity to the drains to monitor the effects of deep drainage on the local ground water levels, and also to determine the distance of the draw-down affect. We have a number of control bores off site to use as bench marks. The bores are also used to monitor the affect of rainfall on the rise and fall of ground water levels. (See maps on pages 11 to 23 for positions of bores throughout the studied catchments).

We are also undertaking a long term study on general (the affects of climate change) water levels in the region monitoring around 900 bores with some records dating back to 1990. The observation bores are also used in the prioritisation process for ascertaining the catchments that require deep drainage. One of our main criteria for drainage is where the ground water is within 2 metres of the surface.

Drain Water Monitoring

Our policy is to mount flumes in each drain. We have five flumes currently in operation and plan to set up another five within the next 12 months. These flumes measure EC (salinity), pH, and flow rate (see Fig 11, page 24)

The movement of ground water in the landscape

Our investigations of the ground water levels in the valley floors have revealed that the ground water does not gravitate to the lower reaches of the landscape but is inclined to be held in-situ. Ground water levels in bores at AHD 340m (for example) at the top end of the catchment can be the same or even closer to the surface than those at the discharge end or AHD 280 m which is 60 m lower in the landscape.

In some cases in the longer valley floors (25- 40 km) the salt damage can be more extensive near the ridge divide (highest part of the catchment) than in the mid slopes and/or discharge end. We plan to investigate this in several sub-catchments with a series of core samples taken from the sub soil along the valley floors. With this information coupled with the information from our observation bores we will be able to ascertain with more certainty which are the impermeable soils that are stopping the ground water from gravitating to the lowest point in the catchment. We would like to support these observations with a geophysical survey of the areas of interest giving us the opportunity to investigate the effectiveness of both methods.

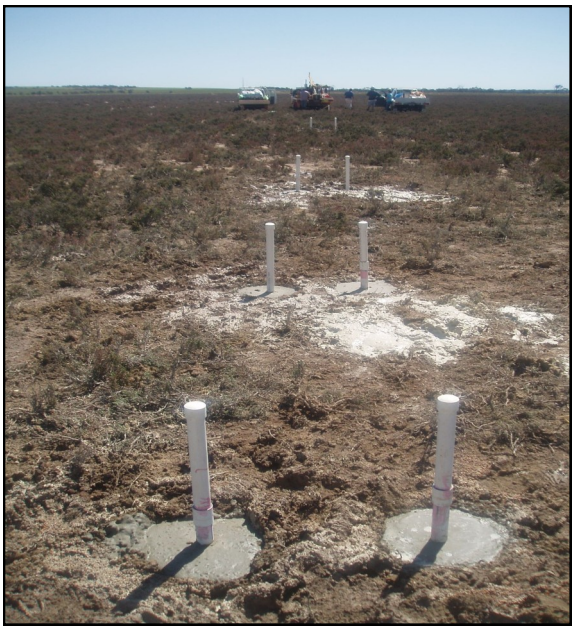


Fig 2

Figure 2 depicts a typical bore transect. These are set up at various locations perpendicular to the drain (their positions are marked on the maps, pages 11 to 24).

Indications so far from the pilot study have shown that the drains have a draw-down effect on the groundwater table to a distance of 300 metres either side of the drain. This is a larger effect than was predicted.

Investigate ways of treating sediment collected from drain discharge

The Yarra Yarra Management Committee is investigating the possibility of establishing a facility within the Burakin drain where sediments can be collected and possibly treated if necessary. This will take the form of a settlement pond. The Burakin groundwaters appear to have the lowest pH in the region and could carry the highest level of pollutants in the Yarra Yarra Basin. The Department of Water have undertaken to assist in establishing this facility. This project is still in the early stages and we plan to carry out further research into this. Currently the 15 Hectare Lake, in sub-catchment Mongers 55 is our main site for sediment monitoring (see page 18).

Salt lake ecological assessments

There is virtually no data available from the Yarra Yarra catchment relating to aquatic biota of the Lakes. This includes macro-invertebrates, micro-invertebrates, submerged macrophytes and benthic microbial communities. Consultants will be required to assist our in-house botanist carry out the salt lake ecological assessments. Monitoring the biota will allow us to study any effects of drainage water on native fauna.

<u>Vegetation</u>

The draw-down effect of deep drainage on salt reduction and plant growth

We will be leasing 200 hectares of mostly saline land and will be conducting crop trials, for distances up to 500m flanking both sides of the drains. This is to establish how soon crops can be established on rehabilitated land. This will be a very useful yardstick to evaluate the decline in salinity due to the effects of the drain. These trials will take place in the Canna Gutha subcatchment, see Map 7b (page 24)

for further information.
We will experiment with different species of perennials that could be of ecological and commercial value to determine how soon and how close to the drains plantations can be successfully established. Over time as the drains become more effective, and the soil improves, more trees and shrubs will be established.
We will re-vegetate the actual levee banks surrounding the drains to stabilise them and also to prevent runoff into the drains. We will use salt-tolerant plants such as saltbush and bluebush and ground cover such as creeping saltbush. Any vegetation cover will help prevent windblown debris from lodging in the drains.
The YYCRC plans to experiment with salt-tolerant tree crops within the drain easements in an endeavour to generate some income to help support the maintenance of the drains. We have already planted 100,000 broombush seedlings in drain easements in the Morawa Shire. Unfortunately, due to the drought, only 50% of these have survived. We believe under normal conditions the broombush have a good commercial potential.
We are also conducting extensive botanical surveys relating to the impact of deep drainage on the natural vegetation with a series of transects set up at the delivery end of each drain with before and after observations.
We are conducting ongoing surveys of remnant bush in all sub catchments. This program has been established mainly to develop community awareness of the native species that are prolific in their region. We maintain a branch of the State herbarium plant collection at our Kalannie office to help with this program.

Maintenance
The Regional Council will take an easement over the strip of land that contains the drain. This land is set aside as a service area as well as an area to establish vegetation, and conduct research and monitoring programs. The width of this strip of land will be decided upon by the committee but generally will vary from 50 to 100 metres wide depending on whether the land is arable or not. Arable land will only require a 50 metre wide strip. Revenue will be collected annually in the form of a service fee and will be used to maintain the drains as this becomes necessary. The rate will be equivalent to $150 per km of drain that passes through the landowners property, and will be payable by the owner. The easement will be registered on the title of the land through which the drain passes. All decisions concerning drain design and management are made at committee level in debate with delegates from all Zones. Once decisions are made they are adopted as policy.

As laid out in the Strategy document of the YYCMG;
One of the YYCRC's main strategic aims is to rehabilitate the natural arterial waterways and at the same time create a network of vegetated corridors (alongside these waterways).
To rehabilitate these waterways the hyper-saline water must be removed before the revegetation program can continue successfully. This will be done by constructing a network of deep drains and surface water channels throughout the catchment.
The corridors will provide a link between significant patches of remnant native vegetation, nature reserves and the extensive bushland that constitute the verges of the vast Yarra Yarra salt lake system.

Policy and procedures
Collecting the information is one thing, but putting it into workable policies with associated procedures and compliance guidelines is another. We are currently working on a policy document. This work will continue for the duration of Stage 2 of the Drainage Program.

Prioritisation is of the utmost importance
Stage 1 and 2 together will be targeting 10 of the 60 sub catchments in the Yarra Yarra drainage network and will provide an excellent snapshot of the behaviour of drains in the region. The sub-catchments selected are the ones that are at greatest risk from salinity encroachment and degradation and the ones that will cumulatively service the biggest area of degraded land. There are a number of other factors taken into consideration too. These are shown in the table on the following page.

Stage 2 Prioritisation Process, Developed by Yarra Yarra Staff for ratification by the Regional Council

	Sub-Catchment Number	45		41		4		55		19		33		27	
Loading	Sub-Catchment Name	**Canna Gutha**		**Merkanooka**		**Bowgada- 4**		**Mongers- 55**		**Jibberding**		**Goodlands**		**Burakin**	
5	Total Catchment Area (Ha)	19,079	**4**	18,785	**4**	12,230	**1**	17,754	**3**	15,831	**2**	14,796	**2**	44,911	**5**
25	Extent of Salinity (Ha)	2,346	**13**	1,980	**10**	1,758	**10**	1,926	**10**	2,592	**14**	1,350	**7**	4,626	**25**
*	Approved Disposal Area	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
5	Disposal Area	small salt lake	**4**	playa	**2**	small salt lake	**4**	large salt lake	**5**	large salt lake	**5**	large salt lake	**5**	existing drain	**2**
*	Surface Water Management Plan	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
5	Threatened Public Infrastructure	Yes	**3**	Yes	**3**	No	**0**	No	**0**	No	**0**	Yes	**3**	Yes	**3**
5	Threatened Private Infrastructure	Yes	**3**	Yes	**3**	Yes	**3**	Yes	**3**	Yes	**3**	Yes	**3**	Yes	**3**
5	Threatened Native Vegetation	No	**0**	No	**0**	No	**0**	Yes	**3**	No	**0**	No	**0**	No	**0**
NA	Number of landowners involved	2		6		4		3		4		4		5	
*	Demonstration Value of Project	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
*	Potential for recovery	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
*	Agreeable to Easement	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
	Engineering Issues														
	Average Gradient	0.2		0.19		0.23		0.2		0.21		0.1		0.1	
*	Workable Gradient for All Sections	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
	PITS														
10	Inflow	Med-Fast	**9**	Med-Fast	**9**	Medium	**8**	Fast	**10**	Slow-Med	**7**	Fast	**10**	Slow	**5**
NA	Depth of Topsoil (cm)	85		85		70		81		54		72		37	
10	Firmness	Med-Soft	**9**	Medium	**8**	Medium	**8**	Soft	**10**	Med-Hard	**7**	Med-Hard	**7**	Soft	**10**
	BORES														
25	Average Depth to Ground water (m)	1.02	**25**	1.37	**20**	1.76	**13**	2.00	**8**	1.27	**23**	1.48	**18**	1.50	**18**
3	pH	7.5	**3**	7.9	**2**	6.5-7.6	**3**	3.1-7.2	**2**	3.3-7.4	**2**	3.7-7.2	**2**	4.8-6.2	**2**
2	Salinity (mS/cm)	34	**2**	44	**2**	18 - 59	**2**	34 - 77	**2**	5 - 98	**2**	18 - 110	**2**	4 - 11	**2**
*	MOU signed (Memo of Understanding)	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
*	NOI (Notice of Intent)	Yes		Yes		Yes		No		submitted		in progress		submitted	
*	Clearing Permit	Yes		Yes		Yes		No		submitted		Not required		submitted	
*	Aboriginal Heritage Clearance	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
100	Total Score		**75**		**63**		**52**		**56**		**65**		**59**		**75**

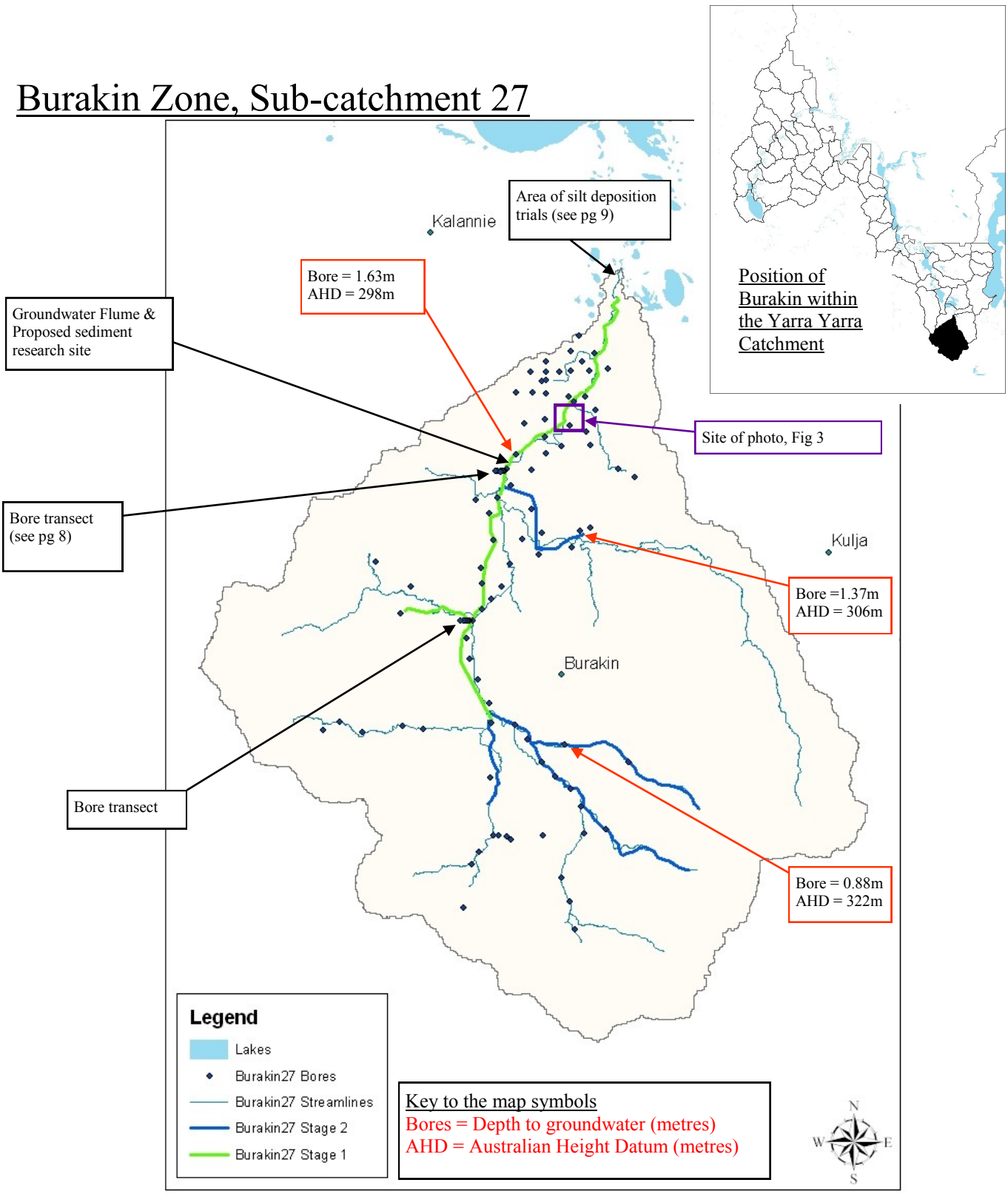
NA	Not Applicable	*	Essential

Part Four

Sub-Catchment Maps and Case Studies

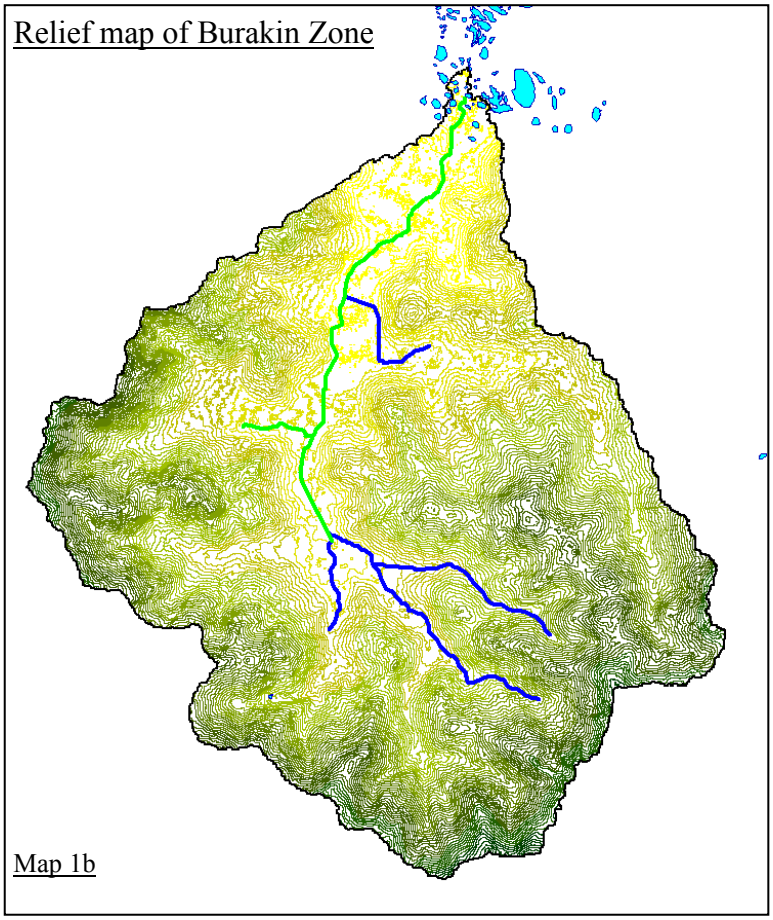
The following pages look in more detail at the progress so far and the proposed works in each of the sub-catchments involved in Stage 2 of the Regional Drainage Program.

Burakin Zone, Sub-catchment 27



Map 1a

Note that the bore holes and the drainage lines follow the same path as the streamlines.
All the bores along the drainage lines are less than 1.75m from the surface, making Burakin a high priority.



Legend

Stage 1 Works

Stage 2 Works

Stage 2 Drain Length

28.85 km

This relief map clearly highlights the drainage lines within the Burakin Zone, and also shows that all the drainage from the zone works its way toward the top of the lake chain at the Northern end of the sub-catchment.
Stage 1 and Stage 2 will provide arterial drainage for the whole sub-catchment, allowing landholders access to a drain if they wish to install their own spur drains. When completed this sub-catchment will have undergone substantial work and will represent a whole of catchment evaluation and research program.

Borehole readings show that there is widespread shallow groundwater within the Burakin zone
As shown on the map opposite, the depth to groundwater is not influenced by the height of the land, as may be expected. In this sub-catchment, the presence of a shallow groundwater table is common in the higher reaches of the landscape.

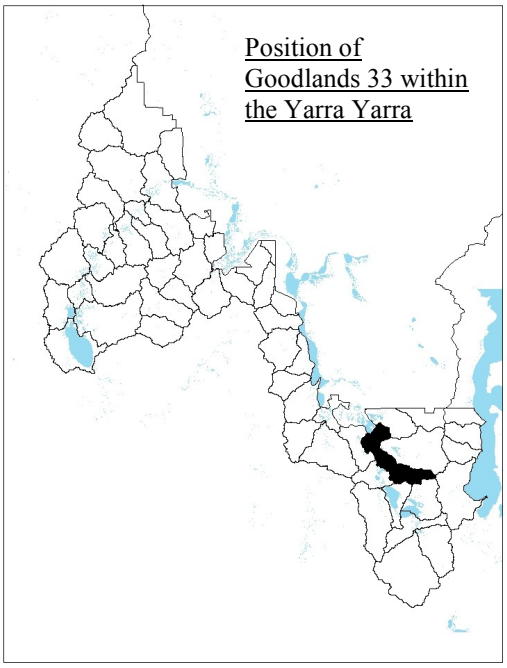
Fig 3

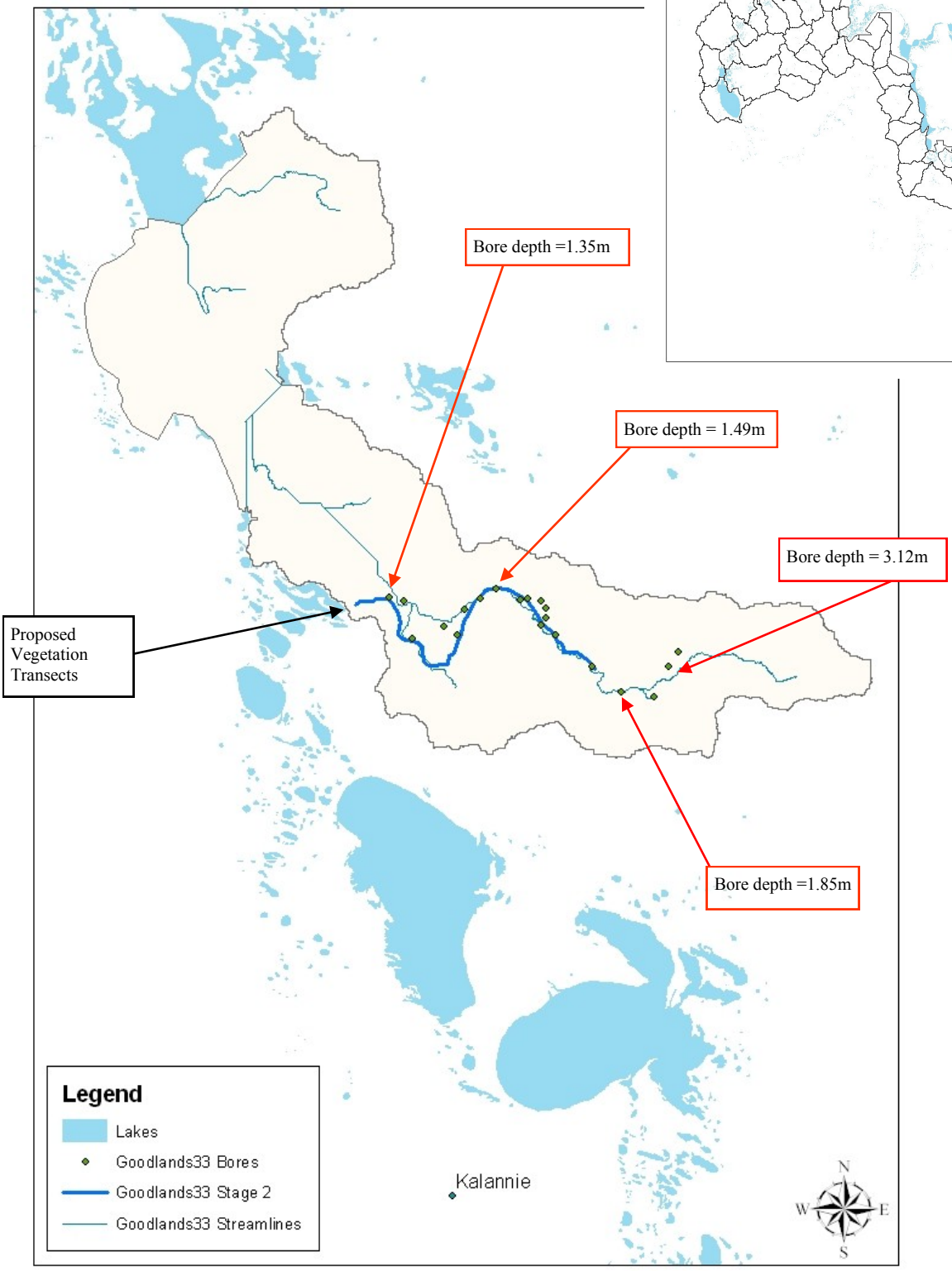
Fig 3 shows the rail crossing for the surface channel in the Burakin Zone. This is the first rail crossing undertaken in the project. A surface water monitoring weir will be located on the far side of this crossing.
The surface water follows a different path to the groundwater at this site.

Fig 4 shows Yarra Yarra staff meeting with local landholders in the Burakin Zone.
They are carrying out an RTK (Real-Time Kinematic) survey. This is accurate to within 2cm (used for measuring the land height).

Fig 4

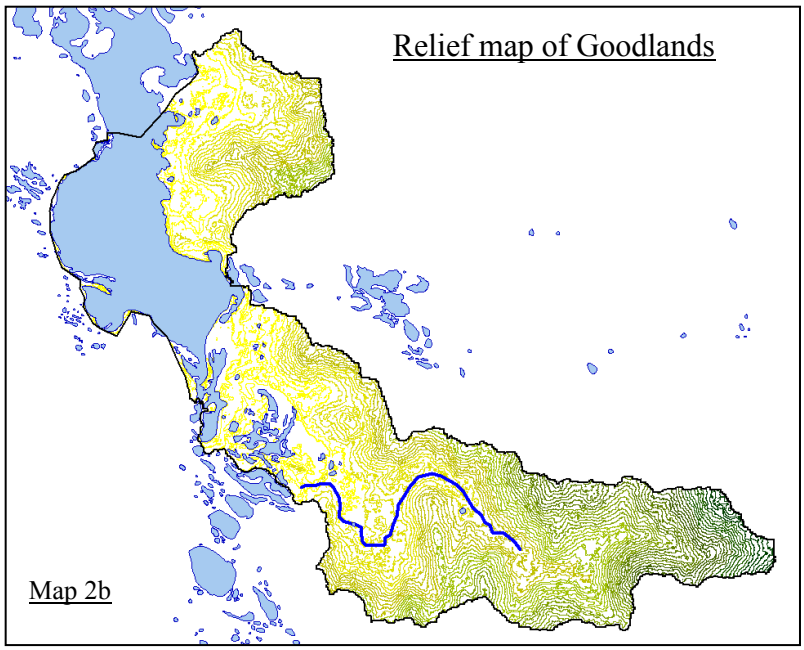
Goodlands Zone, Sub-catchment 33





Map 2a

The bore depths shown on the maps on pages 11 to 23 have been selected randomly.
Vegetation transects are set up in the area surrounding the disposal points of the drain. This is to monitor whether the drainage water affects the local vegetation. There will always be a control transect in the nearby area in order to compare results. Vegetation transects are monitored prior to construction of the drain, and bi-annually thereafter (see page 18 for further information)



Map 2b

Legend

Stage 2 Works

Stage 2 Drain Length

14.06 km

Note that the drain does not go through the whole sub-catchment. This is because the bores have shown that the groundwater is more than 2 metres from the surface higher in the catchment. This does not fulfill the criteria for draining.
The contours show that there is a large proportion of low lying land in the Goodlands Zone.
No drain in the northern part of the Zone due to prioritization criteria, i.e. insufficient landholders, lack of threatened public infrastructure etc.

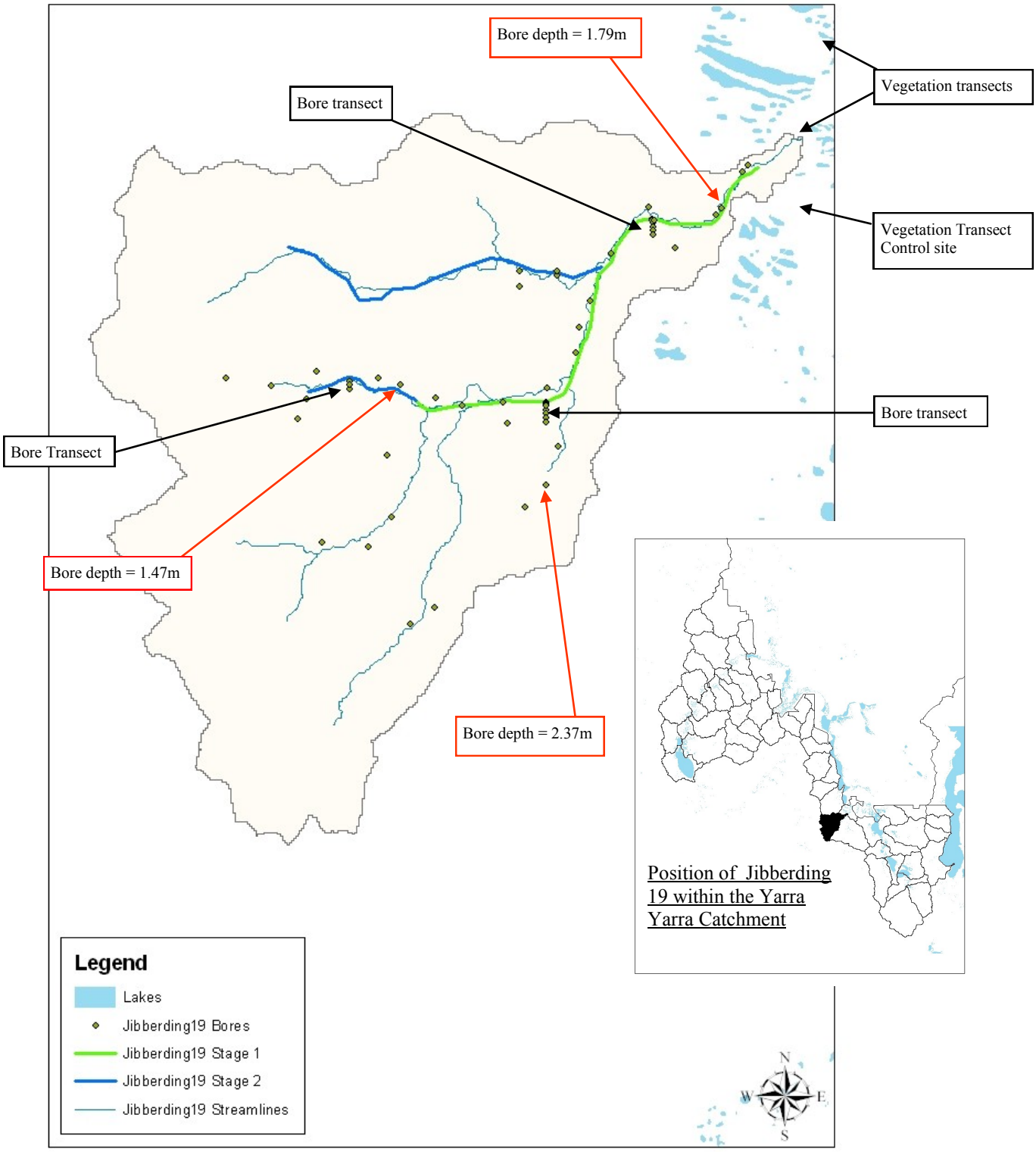
Fig 5a

Fig 5b

Figs 5a and 5c show part of the vegetation corridors in the Goodlands sun-catchment. In 1998, trees were planted in a 60 km long corridor through the Goodlands area.
This was funded through the Gordon Reid Foundation (assisted by Lotteries West), it was part of the 1 million trees initiative (see Fig 5b)
These photos were taken in 2007.

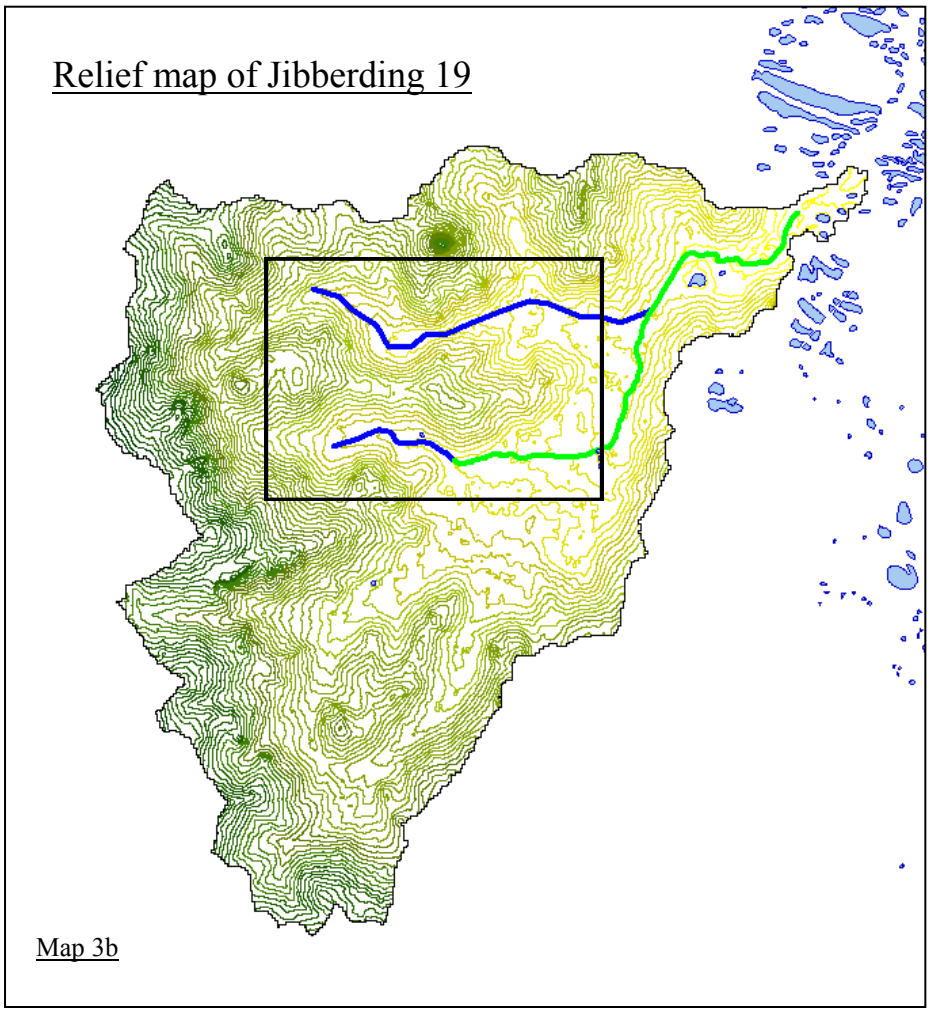
Fig 5c

Jibberding Zone, Sub-catchment 19



Map 3a

As shown on the map above, the Stage 2 drain will not cover the whole of the Jibberding 19 sub-catchment. This is because the area in the south of the catchment is not badly affected by salinity encroachment. This is reinforced by the measurements taken from the bore holes in this area. Many of which show the groundwater to be more than 2 metres away from the surface.



Legend

Stage 1 Works

Stage 2 Works

Stage 2 Drain Length

11.19 km

Two of the main criteria for site selection are the ones that are at greatest risk from salinity encroachment and degradation, and the ones that will cumulatively service the biggest area of degraded land

Aerial photographs have also been used to help identify areas affected by salinity encroachment. These would be followed by site visits.

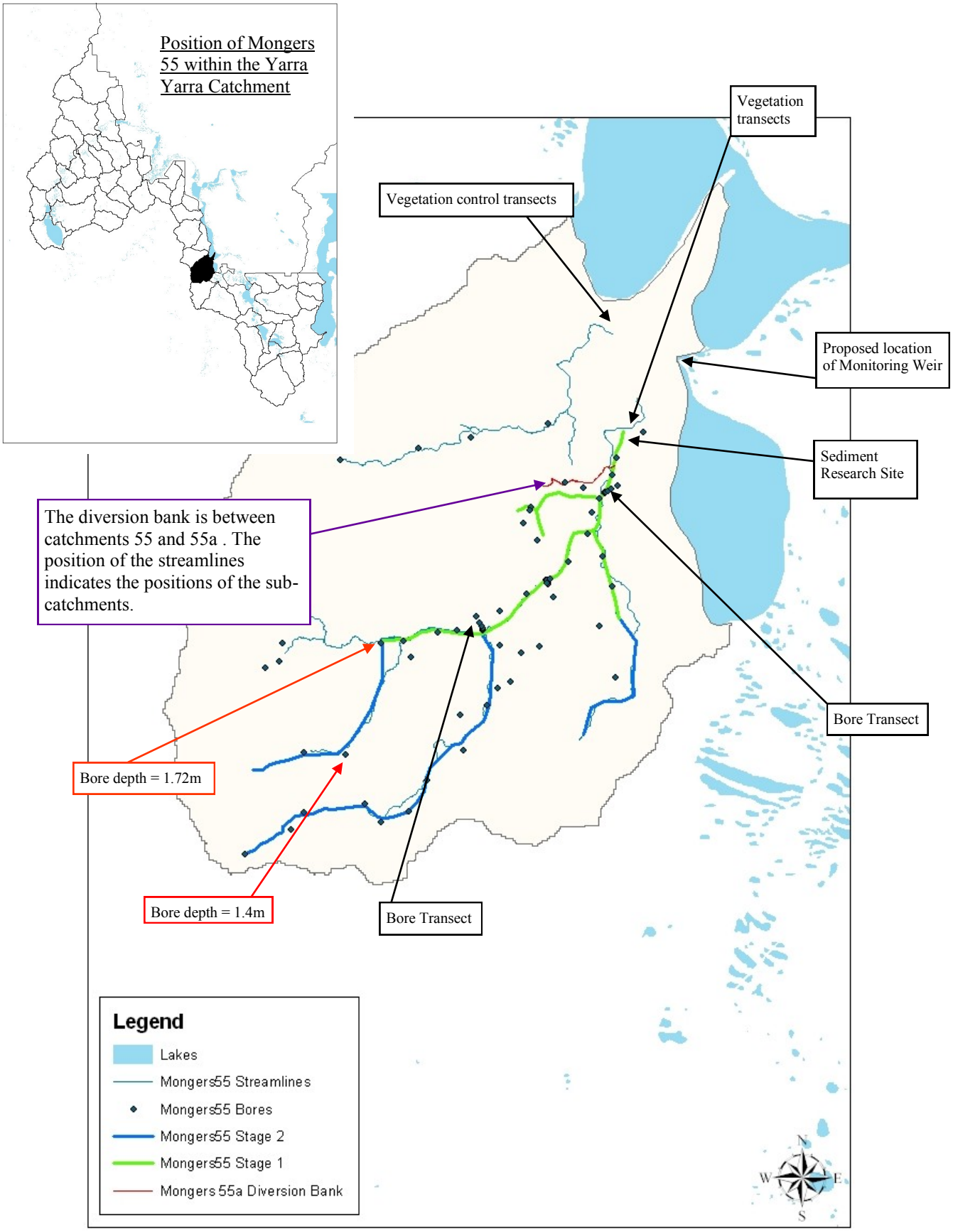
Fig 6a

Fig 6a is an aerial photograph of the area shown on Map 3b.
Note the salt degradation in the areas circled, Stage 2 should address this problem.

Fig 6b

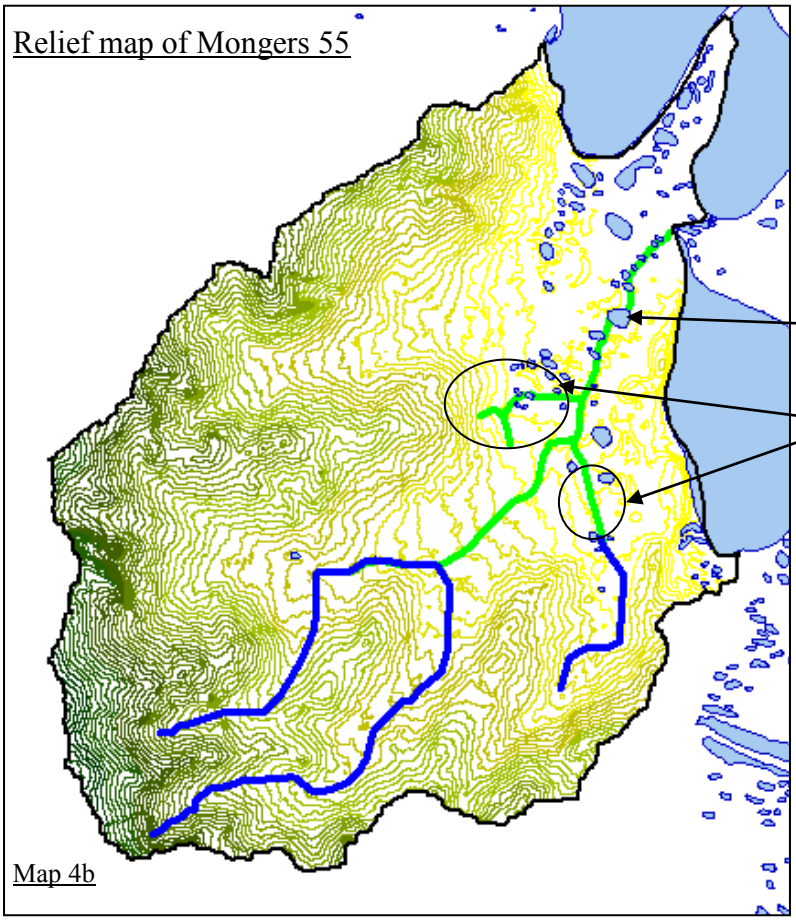
Fig 6b shows how close the salt affected land is to the farm homestead. These buildings are counted as threatened private infrastructure (see page 10).

Mongers Zone, Sub-catchment 55



Map 4a

The diversion bank exists to prevent water flowing between the sub-catchments 55 and 55a. This is to ensure that the monitoring weir gives us an accurate measurement of the flow within sub-catchment 55, and that none of the water from this catchment has been lost to sub-catchment 55a. This is important if the data is to be used for accurate modelling.



Individual farmers have added their own spur drains to the main drain. If they do this, their drain design must be of the same standard as the main drain, and must include surface water management.

The 15 Hectare Lake, is the site of the vegetation transects and sediment monitoring (see Figs 7a and 7b). The Mongers pilot drain enters this lake, and then from here passes out towards Mongers Lake.

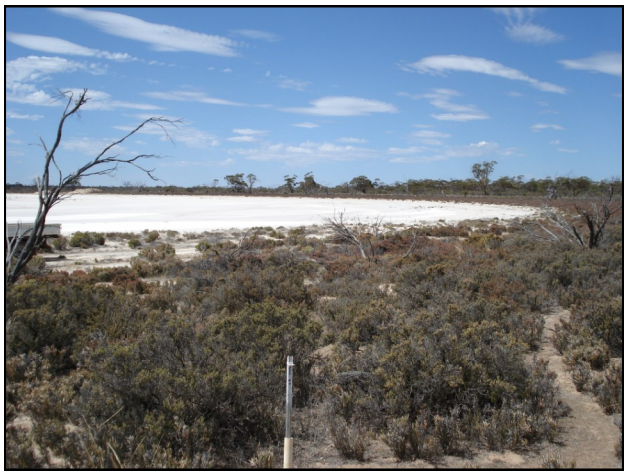


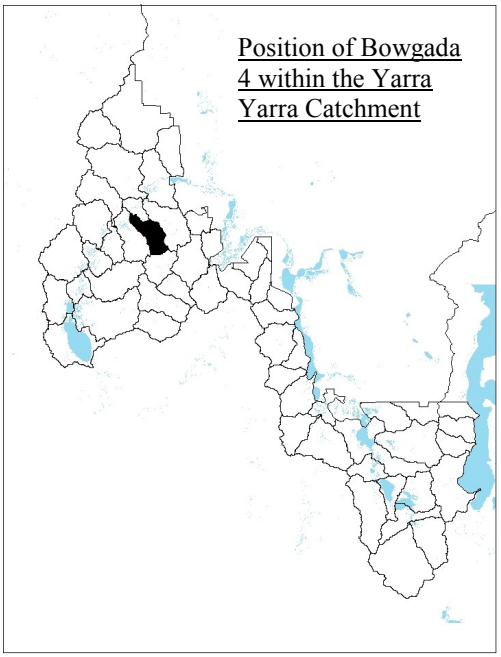
Fig 7a

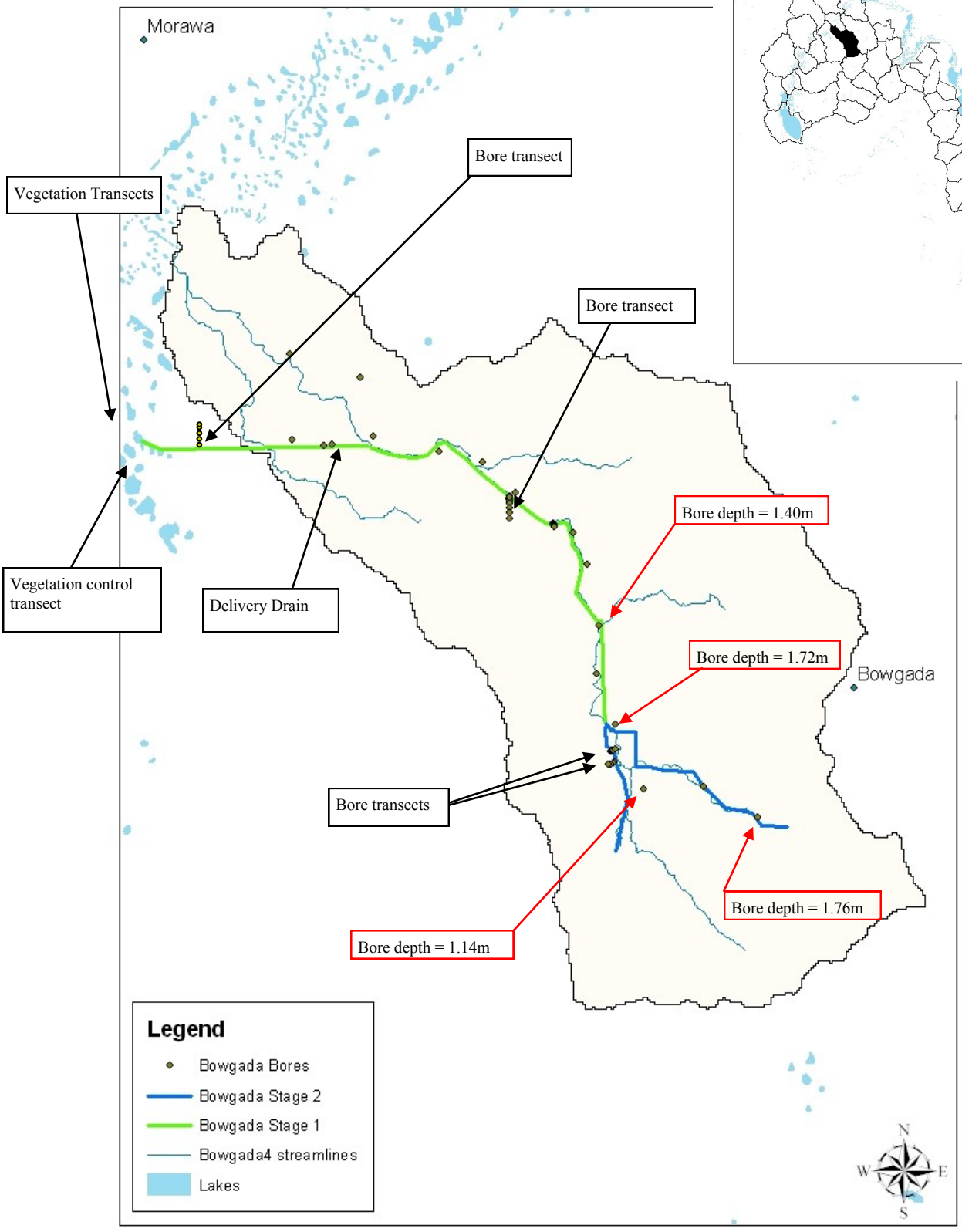
Fig 7a shows the site of a vegetation transect on the edge of the 15 Hectare Lake. There are three transects at this site. There are also control transects, which are set up in an area where there is no drain, in order to compare results and determine whether the drain is affecting the local vegetation.
The transects are surveyed annually to monitor the vegetation species and percentage coverage.

Fig 7b shows the delivery area of the Mongers drain where it reaches the 15 Hectare Lake. This is also the site of our main sediment monitoring program. Sediment samples are collected from the disposal point and these are sent away to a laboratory for analysis.
This picture also helps to show that the evaporation rate of the lake is more than able to keep up with the rate of inflow from the drain.

Fig 7b

Bowgada Zone, Sub-catchment 4

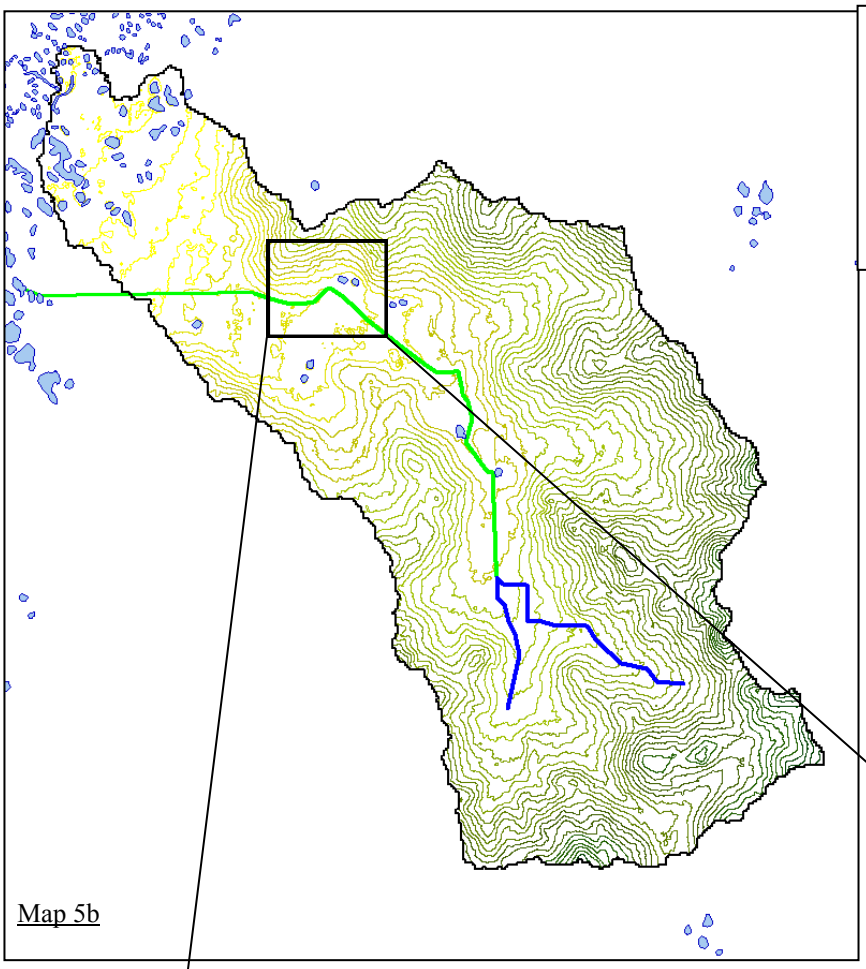




Map 5a

We would expect the groundwater to be deeper at the site of the delivery drain (bore depths around 3m) because at this point, the drain does not follow the route of the streamlines. You can see this clearly on the map above.

Relief map of Bowgada 4



Legend

Stage 1 Works

Stage 2 Works

Stage 2 Drain Length

11.5 km

Bowgada was one of the first areas in the Yarra Yarra catchment to look at re-vegetation on a large scale in an effort to combat salinity.
This endeavour was not a failure but it did show that vegetation alone is insufficient to tackle the salinity problems.
Following this, plans for deep drainage were set in motion.

Map 5b

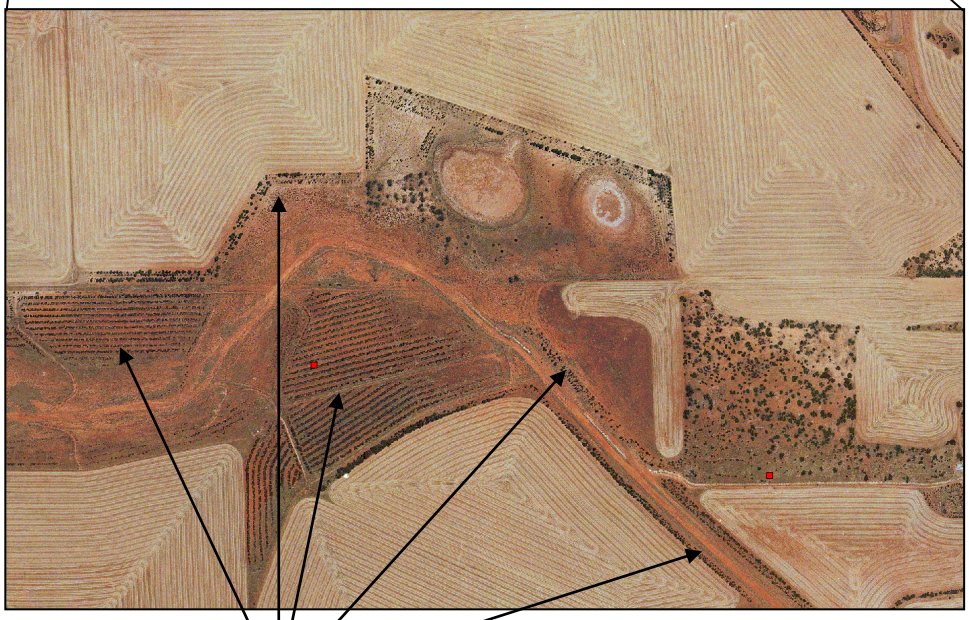
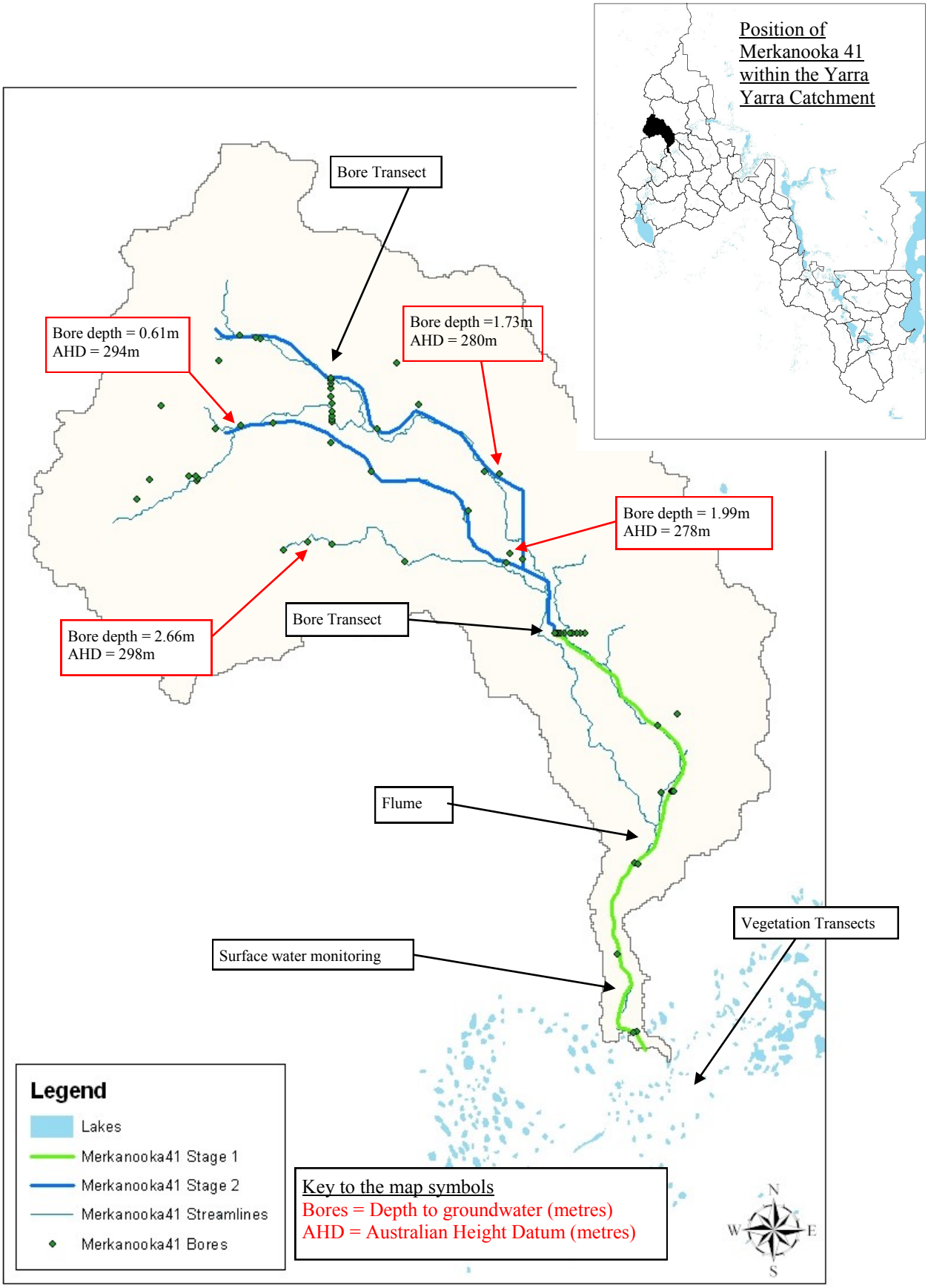


Fig 8

Fig 8 is an aerial photograph depicting tree plantations alongside a surface water drain. This re-vegetation scheme has not been as successful as was hoped in lowering the water tables. In places it has worked, but in large areas the trees have died. This has led to the decision to undertake deep drainage.

Merkanooka Zone, Sub-catchment 41



Map 6a

As you can see from this map, and also on Map 1b (Burakin), the height of the land may change but this does not necessarily have any bearing on the depth to groundwater. This is due to a number of factors including the relief of the land, the soil type and the soil structure. This highlights the need in some instances for the deep drains to be extended further back into the landscape, as the salinity problems are not restricted to the lower lands.

Relief map of Merkanooka 41

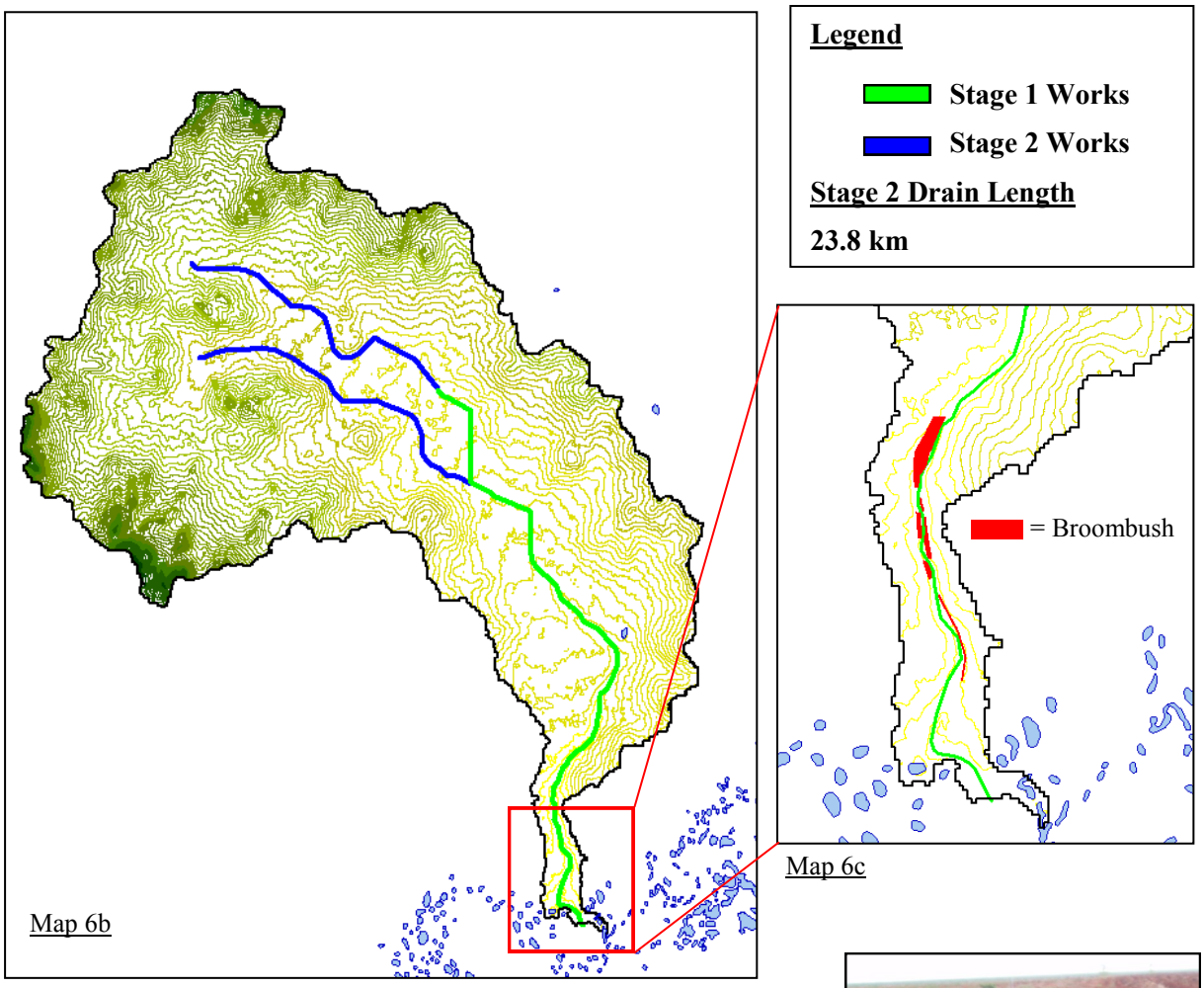


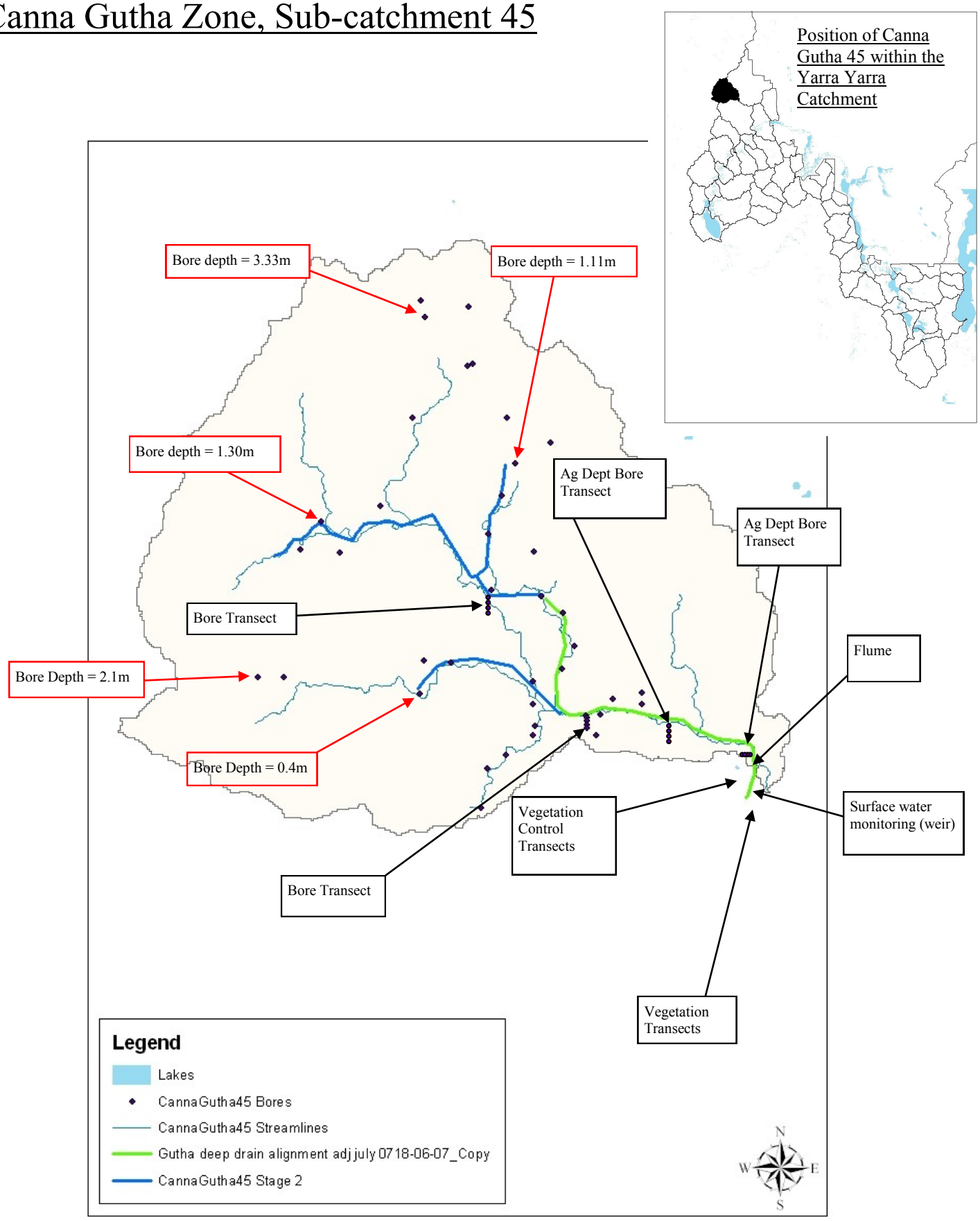
Fig 9, depicting the easement area alongside the drain

Fig 10, Broombush seedlings

Re-vegetation Program

In August 2007, 100,000 Broombush seedlings were planted within the Merkanooka zone, in the easements alongside the drains. Seedlings were subsidised and cost 4c each. Strike rate was around 50%, drought conditions and the extent of the salinity had the most bearing on this. Broombush was chosen because of its salinity tolerance and also because of its potential commercial value as brushwood fencing. If income can be generated from the easements, then their will be more money to spend on further re-vegetation throughout the Yarra Yarra Catchment. Most importantly though, the vegetation will help to stabilize the soil structure, preventing erosion. It should also maintain or lower the water table which should prevent further salt degradation.

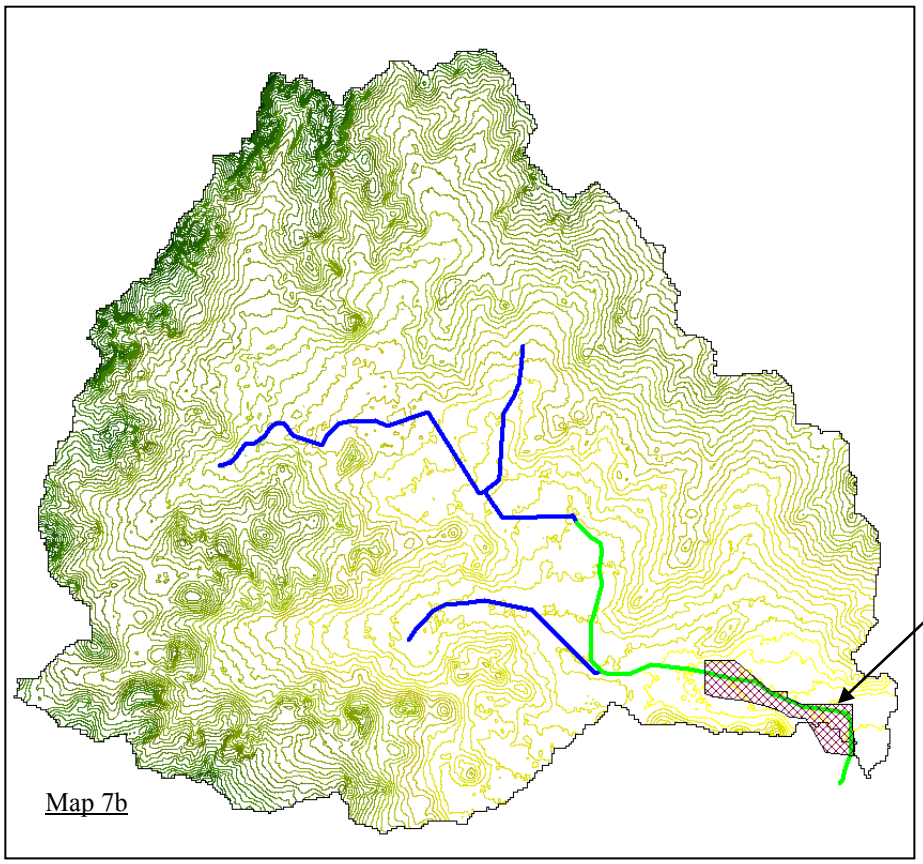
Canna Gutha Zone, Sub-catchment 45



Map 7a

The discharge area for the Canna Gutha drain is a series of Playa Lakes, which eventually flow into the Yarra Yarra Lake chain (depending on volume of flow)

Relief map of Canna Gutha 45



Legend

Stage 1 Works

Stage 2 Works

Stage 2 Drain Length

17.43 km

Area of Stephen's Lease

Yarra Yarra are negotiating an agreement with a farmer in the Canna Gutha Zone to lease 200 hectares of salt affected land (as shown on the map above). The lease agreement will be in lieu of the annual payment for the maintenance of six kms of drain that passes through his property. This land will be utilised for research programs that will monitor the rehabilitation process of the landscape surrounding the drain. Income generated from tree and cereal crops planted will contribute toward the cost of drain maintenance.

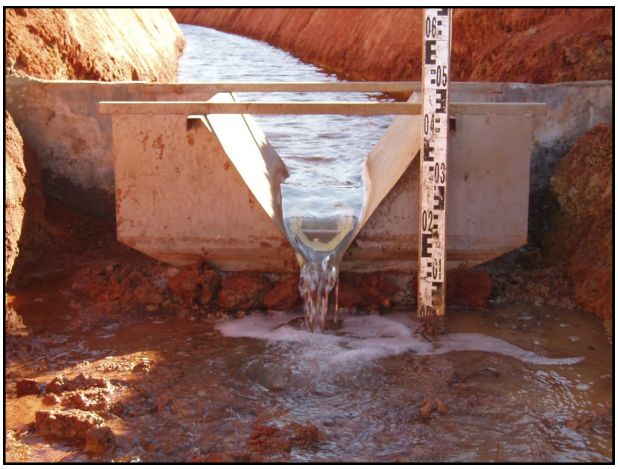


Fig 11, The flume at Canna Gutha

This flume is set up in order to measure the volume and velocity of flow over time. They can also measure the salinity and the pH of the drainage water. The data is recorded electronically and can be downloaded when the site is visited. There are 5 of these flumes already in existence and their positions have been marked on the maps on previous pages. As part of Stage 2, a further 5 will be constructed, to give us one in each drain.

Part Five

Appendix

Wheatbelt Drainage Evaluation, Catchment Feasibility Studies

Yarra Yarra Subcatchment Monitoring proposal

Introduction

The Wheatbelt Drainage Evaluation (WDE) has been funded by the National Action Plan on Salinity and Water Quality to study drainage issues supplementary to those looked at within the Engineering Evaluation Initiative, such as Regional Drainage and Governance.

The aims of the WDE are as follows:

- Develop approach to drainage management and governance consistent across all relevant NRM regions
- Undertake catchment and regional scale drainage assessment across NRM regions
- Assess wheatbelt wetlands in relation to salinity threat and drainage concerns
- Develop engineering drainage guidelines applicable to all relevant NRM regions.
- These activities will enable the implementation of sustainable catchment and regional scale drainage across relevant NRM regions.

Point two in the above is the most relevant to this proposal.

Background

Salinity encroachment is recognised by the Yarra Yarra Catchment Management Group (YYCMG) as a pressing issue within the cropping regions of the catchment (approximately ¼ of the total catchment). As such, a regional drainage scheme of 300 km has been proposed by the YYCMG. This major arterial drainage scheme will be in addition to farm-scale drainage already constructed across the catchment.

In August of 2006, 5.19 km of drainage works under this scheme were completed in Mongers 55, the first subcatchment scheduled for the scheme. Further construction is hoped to continue in catchment-by-catchment phases, as funding becomes available.

This large scale drainage scheme aims to move saline groundwater from cropping land into some of the numerous salt lakes present in the catchment. This raises several issues, including the quality of the disposal water, and the environmental value of the accepting lakes. Also in question is the likely success of such a scheme to bring saline or borderline saline land back into agricultural production.

Feasibility studies undertaken to date by consultant GHD under the WDE (Yenyening, Yarra Yarra) have highlighted that there is a significant lack of data regarding many aspects of drainage, including the following:

- Overland flows
- Capacity and out flows of receiving wetlands
- Drainage costs
- Environmental and downstream impacts
- Drainage effectiveness
- Soil reclamation following salinity amelioration
- Long term sustainability of soil rehabilitation

This lack of data is proving to be a fairly pivotal aspect in delaying the planning and advancement of engineering options / drainage for saline areas of catchments.

The Engineering Evaluation Initiative (EEI) aimed to answer questions regarding drainage effectiveness and drainage water quality. While data has been collected for the mostly small-scale drainage schemes built under the EEI, further data would greatly assist in planning and assessing the scheme proposed (and already underway) by the YYCMG.

For example, a large-scale feasibility study was undertaken this year by GHD, the *Yarra Yarra Regional Drainage and Water Management Evaluation*. Due to a lack of data, this study was required to make many assumptions in assessing water and salinity management options for the catchment.

Funding has been allocated under the Catchment Feasibility portion of the WDE for a study on a Yarra Yarra subcatchment. However, we believe it is not worthwhile pursuing another desktop study with the current lack of reliable data.

In light of this, we would like to alter the project from a feasibility study to a monitoring project. This will help provide on-ground data (in addition to that gained through the EEI) that can be used in drainage planning, assessment, and decision making, particularly for the Yarra Yarra Catchment.

Proposal for Monitoring Works

We have outlined a monitoring project (see table) based upon recommendations made by GHD in the *Yarra Yarra Regional Drainage and Water Management Evaluation Discussion Paper 4: Environmental Assessment of Preferred Options* (see attached summary of recommendations). Monitoring data in the areas indicated by GHD would greatly enhance assessments of engineering options for salinity amelioration in the Yarra Yarra catchment, and provide indicator data for other such engineering works.

Note that proposed monitoring relates to the sections of the YYCMG drainage scheme that are scheduled next for construction. These works would address some of the data gaps indicated by GHD, and assist in monitoring the effectiveness of drains that are near to being implemented.

Funding for this monitoring project will provide capital costs to establish the monitoring sites, and to get monitoring underway. The YYCMG will continue to carry out monitoring in the longer term, while consultants may be required to carry out the salt lake ecological assessments.

	Yarra Yarra Subcatchment Monitoring Proposal	
	currently allocated under WDE	**$175 000**
1	**Salt lake ecological assessment**	
	Mongers 55	20,000
	Merkanooka	20,000
	Burrakin	20,000
		60,000
2	**Surface water flow monitoring stations**	
	Mongers 55	25,000
	Merkanooka	25,000
	Burrakin	25,000
	Mongers 55 surface water channel re-alignment	5,000
		80,000
3	**Geochemical testing**	
		AG2
4	**Monitoring bore transects/network**	
	Merkanooka	10,000
	Burrakin	10,000
		20,000
5	**Rain gauges** or **pluviometers**	
	Mongers 55	1,000
	Merkanooka	1,000
	Burrakin	1,000
		3,000
6	**Contingency**	
		12,000
	TOTAL	**175,000**

Attachment 1

Recommendations for further work, as outlined in GHD's *Yarra Yarra Regional Drainage and Water Management Evaluation Discussion Paper 4: Environmental Assessment of Preferred Options* (2006).

Study of long-term, cumulative impacts of deep drains

- of broad scale drainage plan (larger than single drain)
- contaminant loadings on disposal area

Cultural and European heritage

- Detailed search to identify sites within the catchment
- Consultation with local indigenous groups over planed route of drain

Flora and Fauna

- data on ecology of cropping system
- data on ecology of salt lake system
- identify presence of rare or high value flora/fauna
- identify role the lakes play in wider region
- impacts of salinity

Drainage effectiveness and Characteristics

- data on discharge water quality
- implication of discharge on landscape
- data on effectiveness of drains to lower groundwater
- in particular:
    - ◊ volume of flow discharge from drainage system
    - ◊ number of months that drain flows
    - ◊ average pH and salinity of discharge water
    - ◊ level of erosion and sedimentation associated with drainage systems
    - ◊ quantify acid generation and mobilisation of heavy metals
    - ◊ depth and number of months the receiving body contains water
    - ◊ average pH and salinity of the receiving body
    - ◊ condition of wetland-associated vegetation around the receiving body
    - ◊ costs and benefits associated with drainage network : area of land reclaimed and degree of reclamation ; how productive it becomes and number of years taken for productivity to stabilise.