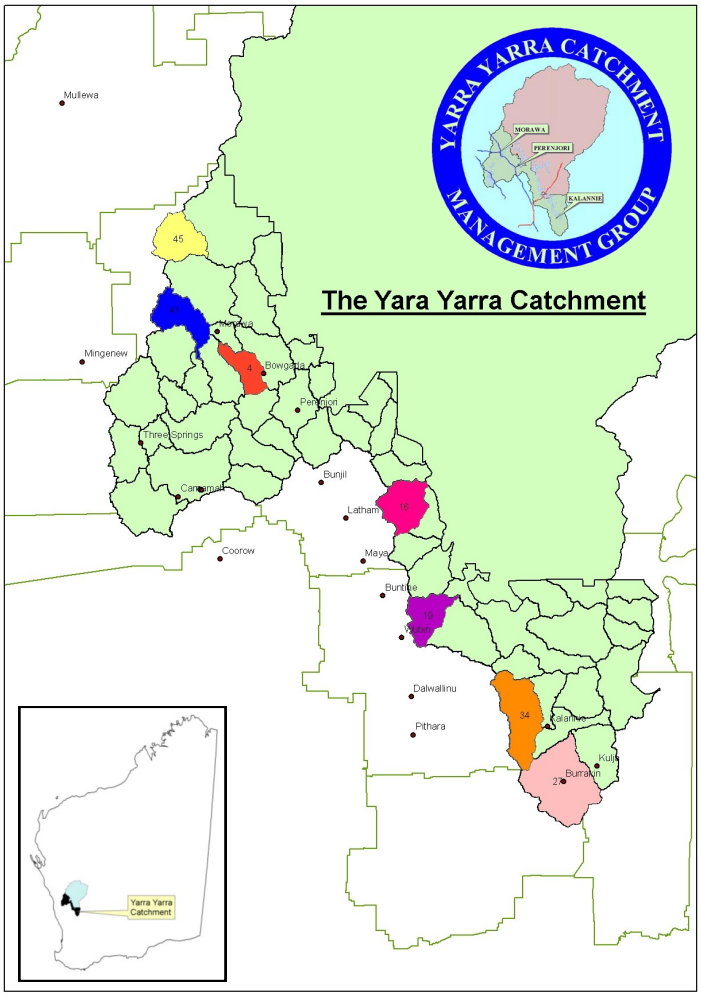
Progress Report of the Yarra Yarra Regional Drainage and Research Project

Produced by the Yarra Yarra Catchment Management Group



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Contents

Part One

Progress Report on Stage 1 of the Yarra Yarra Regional Drainage Program

Summary

The purpose of this booklet is to provide a progress report on Stage 1 of the 3 stage Yarra Yarra Regional Drainage program. Stage 1 is due for completion by June 30th 2008. The report is particularly directed towards the organisations that have supported the current project (Stage1) and also funding bodies that may be potential supporters of Stage 2.

Stage 1 of the program has been split into two parts referred to from hereon as phase 1 and phase 2. Phase 1 started in December 2006 and was completed in June 2007 during which time 33.9 kilometres of drains were excavated at a total cost of $700,000. This figure includes operating costs and wages. The budgeted figure for phase 2 is $1,460,000.

Phase 1 was followed by an extensive review which took several months to complete. Following the review, implementation of phase 2 started in mid December 2007. These works are on schedule to be completed by the end of June 2008.

The Yarra Yarra catchment is divided into a number of subcatchments, as shown on the map below (Fig 1). The subcatchments highlighted are the subject of this report, and show the locations of Stage 1 excavation sites.

- At the time of writing, deep drains have been completed on five of the seven sites. The Mongers 16 drain started on the 28th April 2008 and the estimated start date for the Burakin drain (the last one) is the 17th May 2008.
- Quarterly reports have been produced and sent to NACC, which lay out the dates that milestones and targets have been achieved. These are in accordance with the project schedule agreements. An overview of these can be seen the Appendix.
- The Yarra Yarra Regional Drainage Program is strongly focused on research into all aspects of deep drainage in the Wheatbelt of WA, from drain design to environmental impacts. Scientific information relating to drainage issues is sadly lacking throughout Australia. Data gleaned from Yarra Yarra research will be invaluable for the establishment of future drainage projects throughout WA.

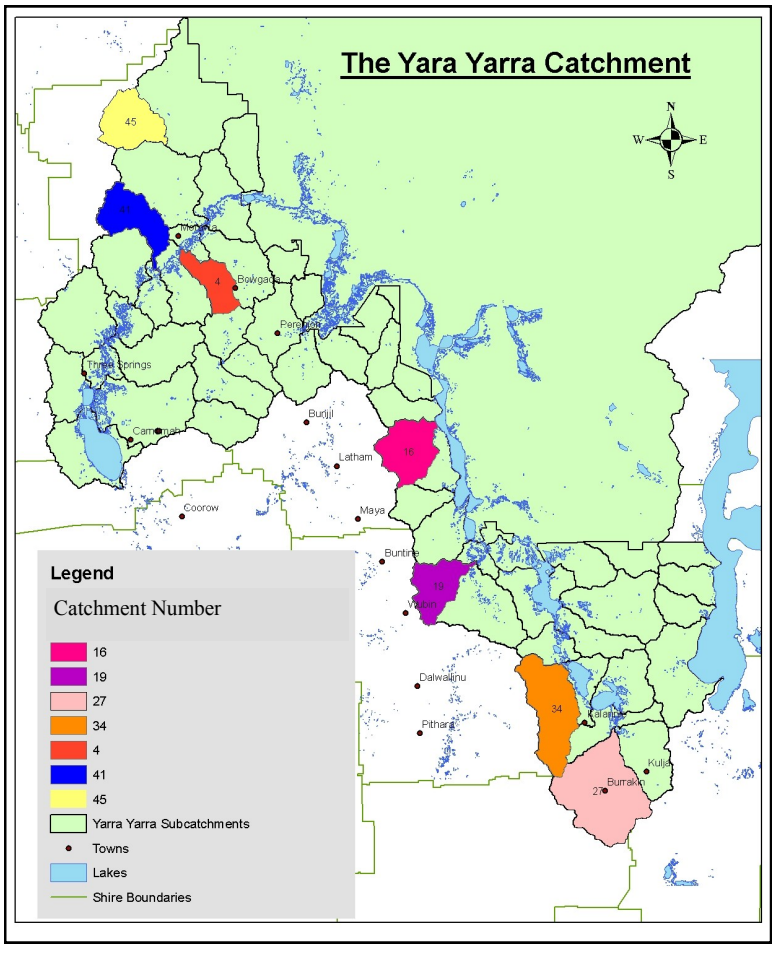


Fig 1: The Yarra Yarra Catchment, showing locations for phases 1 and 2, of Stage 1 of the Yarra Yarra Regional Drainage Project.

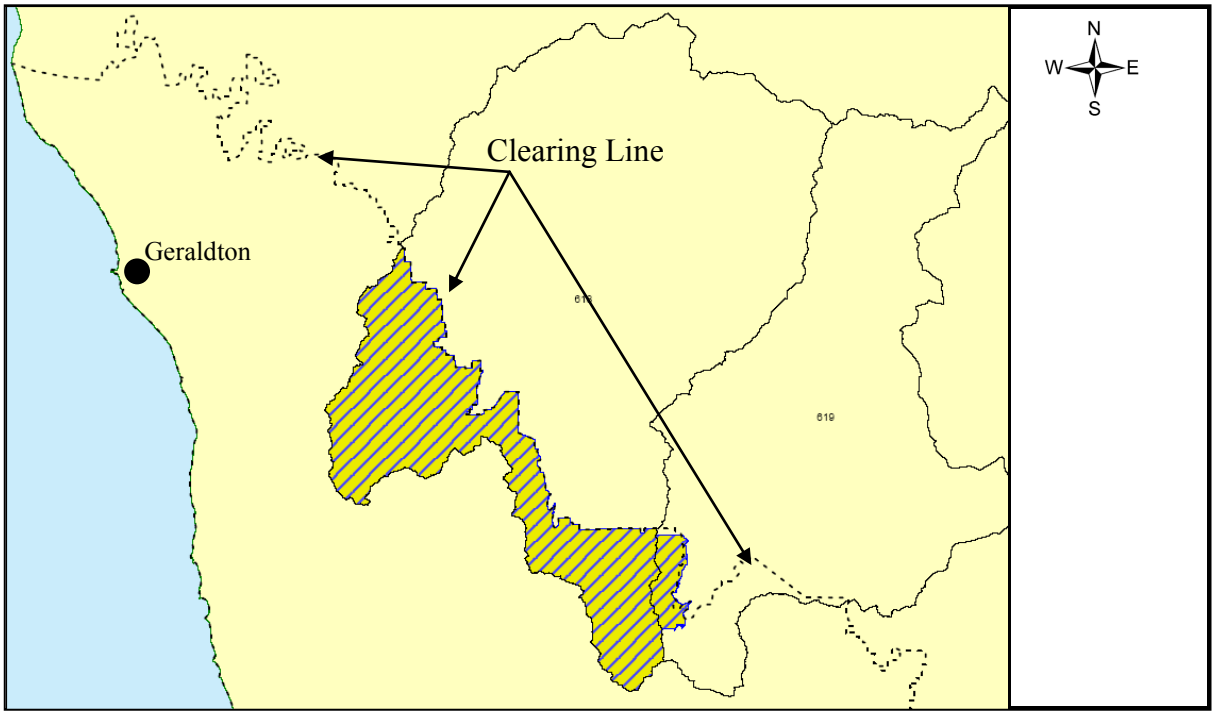


Fig.2. Location map, showing the Yarra Yarra catchment, the clearing line and the jurisdiction of the Yarra Yarra Catchment Management Group (the shaded section)

1. Introduction

The Yarra Yarra Catchment Regional Council (YYCRC) is a local government body representing the wheatbelt shires of Dalwallinu, Perenjori, Morawa, Koorda, Wongan-Ballidu and Three Springs. It was formed in 2007 to take over governance of landcare projects initiated by the Yarra Yarra Catchment Management Group (YYCMG), a community-based natural resource management group which continues to act in an advisory role to the YYCRC.

The area of involvement for the YYCRC and YYCMG is that portion of the Yarra Yarra catchment basin lying west of the 'clearing line' (Fig 2). (For historical reasons, a small part of the adjoining Ninghan catchment basin is also included.) This area can be divided into about 60 first-order 'subcatchments', and individual landcare projects are considered at this subcatchment scale (Fig 1).

Over the past decade, YYCMG has focussed on drainage, rehabilitating the pre-clearing drainage lines and moving ponded groundwater out of the farming land along leveed deep drains. The YYCRC has inherited this focus. This booklet deals specifically with the drainage issue.

2. Outline

A useful approach is to consider that each drainage project takes place in three phases.

1) Pre-construction: design, collecting baseline data, and securing permits
2) Construction
3) Post-construction: monitoring, evaluation, and rehabilitation

3. Pre-construction

3.1. Design

Once a particular subcatchment has been selected for engineering works (the prioritisation process is described in an earlier report), a drainage layout plan is prepared. This design phase requires detailed topographic surveying to identify the natural fall in what appears at first glance to be a flat landscape. Our in-house surveyor prepares a precise contour model, using RTK (real-time kinematic) instruments (Fig 7). This layout plan is designed so that guidelines of the Western Australian Department of Agriculture & Food are satisfied

(e.g. for maximum gradient and slope length). Engineering plans are drawn up as required, e.g. for road/rail crossings (Fig.12). New bores are drilled (Fig.10) and soil pits dug (Fig.4) to test subsurface attributes along the proposed route.

3.2. Baseline Data

Hydrological information (e.g. depth to watertable, groundwater quality) is collected from bores and pits over the entire subcatchment. Particular attention is paid to the proposed discharge area. Samples of any surface water and sediments from the outfall site are collected for chemical analysis. Natural vegetation is described along fixed transects (Fig.11). Finally, a network of photoreference points (Figs. 5a & 5b) is set up throughout the subcatchment, particularly at sites that are likely to be impacted by the drain.

3.3. Regulatory Issues

The design information is assembled to present to landholders for individual drainage agreements, then eventually to the Soil and Water Commissioner with formal application for a Notice of Intent to Drain (NOID). Shire and state agency engineers need to approve plans for road/rail crossings and disturbance to public infrastructure. Any proposed damage to native vegetation, even bluebush or samphire on abandoned cropland, needs to be exhaustively considered by the Department of Environment & Conservation before they issue a Clearing Permit. Even when the permit is finally granted, there are likely to be special conditions. To date, we have been instructed to carry out surveys for threatened flora and fauna, set up close-spaced fauna-crossings, erect additional fencing, and map potential acid sulphate soils. For each permit, we have also been required to lodge an offset revegetation plan.

Aboriginal heritage is the subject of statutory correspondence with the Department of Indigenous Affairs and with the relevant regional Land Council. In addition, informal permission is required from traditional owners or other custodial groups.

3.4. Pre-construction Summary

The entire pre-construction process is unlikely to be completed in less than 12 months. Realistically, we allow at least two years for this phase.

4. Construction

The construction phase includes the actual earthmoving work (Figs. 13-15, 35, 36 and 44), the supervision of contracts, and site inspections by government agencies. It is also an opportunity for heightened local interest (there's nothing like a working excavator for drawing a crowd!) Groundwater levels in observation bores and piezometers along the drainline are monitored at increased frequency during construction.

5. Post-construction

The post-construction phase includes “as constructed” (ascon) surveys to accurately measure engineering works, monitoring (hydrological, geochemical, and biological), evaluation to track project achievements, and rehabilitation. This phase is strongly focused on research.

5.1. As Constructed (Ascon) Surveys

Typically, these surveys are completed immediately after construction and are used to verify invoices before the final payment. At regular intervals along the constructed drain, measurements are taken. These include GPS location, depth and width of the groundwater drain, water depth, berm width, height of the levee bank, and depth and width of the surface-

water drain (Fig. 42).

5.2. Monitoring

5.2.1. Hydrological

Flumes measuring water depth across a narrow V-notch weir are set up in each of the drainwater streams (Fig. 18a & 18b). Results are recorded at regular intervals on data loggers (Fig. 19a & 19b). Since the dimensions of the weir are known precisely, flow-rates (in litres per second) across the V-notch can be calculated. In turn, this allows us to make reasonable estimates of discharge volumes (e.g. megalitres over an entire year).

Groundwater depth is measured repeatedly in bores near each drain to test the drain's effectiveness in lowering the watertable. Some of these test bores are laid out in groups of 4-8 on transects placed at right angles to the drain. The transects are spaced at 2-4 km intervals along the drain-length. Additional bores (typically 5-10) are also scattered throughout the subcatchment. Most of these are located on the valley floor, close to the drain; some are located further from the drain and are intended as 'controls'. All the transect bores are dipped at weekly intervals during and immediately after drain-construction. This interval is extended to fortnightly after a few months (depending on the hydrograph pattern), then finally to monthly about six months after drain-construction.

In each subcatchment, groundwater-monitoring begins at least five months before drain-construction. We intend to continue monitoring for several years.

Surface flows are being recorded at sites in Mongers 55, Merkanooka, Burakin, Darling Creek, Canna Gutha and Jibberding. At Mongers 55, Merkanooka and Burakin, all of the runoff (and some of the groundwater too, now that a deep drain has been dug) leaves the subcatchment through a single, narrow channel. Flow rates are measured using doppler recorders (Fig. 3, below) and export volumes are calculated from these results. All sites are instrumented for automatic logging.

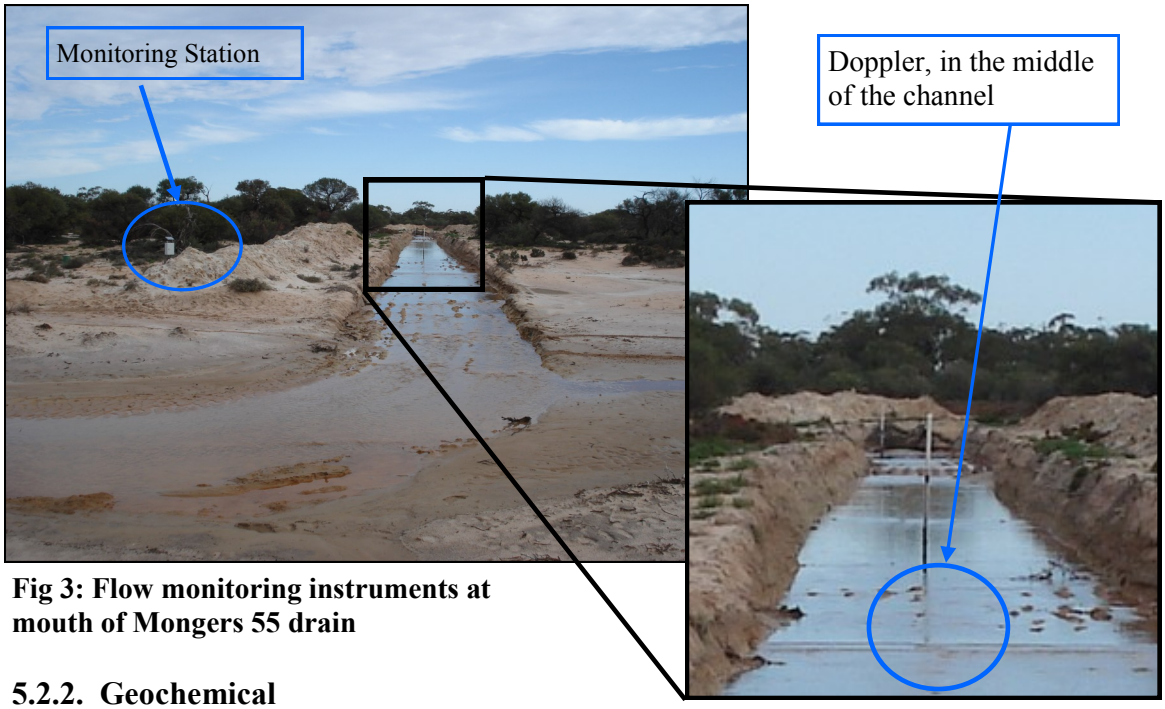


Fig 3: Flow monitoring instruments at mouth of Mongers 55 drain

5.2.2. Geochemical

Samples of water and sediment are collected at annual intervals from the outfall site in each subcatchment and analysed for major ions, a suite of 40 metals, and radionuclides. Where the groundwater is acidic and contains high iron and/or aluminium levels, additional drainwater samples are collected every few months. Currently, all analyses are carried out at CSIRO (Land & Water) laboratories in Adelaide. In future though, some of these samples will

go to commercial laboratories in Perth. Whether acidic or neutral, water from each of the drains is periodically tested in the field for pH, Eh and EC, using appropriately calibrated portable electrodes (Fig.21).

Samples of drain-sediments and drain-precipitates are collected opportunistically for mineralogical analysis by x-ray diffraction. There have been two recent post-graduate studies of precipitates in Yarra Yarra drains, one study of valley-floor sediments exposed in drains, and an on-going study about the alteration of kaolin clays exposed to saline groundwater – all by the University of Western Australia. A CSIRO/Department of Water research team is currently investigating the acid-groundwater phenomenon, using sites in the Yarra Yarra catchment as models.

5.2.3. Biological

Vegetation transects (Figs 22 & 39), initially set up in the discharge area before drain-construction as part of the baseline study, are monitored at approximately 12-month intervals. The survey uses belt transects of contiguous 10 m Í 10 m quadrats, laid out in a straight line at right angles to the lakeshore or creekline. In each quadrat, all plants are identified to species or subspecies level and the vegetation structure is described (e.g. height, layering, percentage cover)

There are a minimum of two transects for each discharge site (considerably more for extensive wetland systems like Jibberding and Xantippe). Additional transects (at least two per subcatchment) are laid out as controls or reference transects on nearby wetland sites that receive no groundwater discharge.

A survey has been commissioned (and will be carried out over the coming weeks) to examine the macro-invertebrate fauna 'downstream' from some of the drains. There has been very little work of this kind in the northern wheatbelt, and only sporadic research activity in inland WA as a whole. Nevertheless, we expect that invertebrate populations will resemble those described in previous studies – in particular, one near Pithara in the Avon catchment, and another in the Buntine-Marchagee district in the Moore catchment.

Although the planned survey uses a Control-Impact design, so that it can be regarded as a stand-alone study, we hope that it will be repeated on at least one future occasion to examine the effect of sustained drainage on wetland biota.

5.3 Rehabilitation

The primary aim of the drainage project is to rehabilitate the landscape. To this end, the revegetation of drain corridors is as important as the drains themselves. A condition of the formal agreement between YYCMG and local landowners before any earthworks can begin, is that all sections of the drain are fenced. Many of these fences have now been erected, with the result that a recognisable corridor is taking shape.

Close-spaced broombush plantings occupy parts of this corridor at Merkanooka (Figs. 24 to 27). A more extensive planting program is planned for the coming winter. The best areas are being allocated to broombush – those areas with few signs of waterlogging/salinity -damage, and which previously supported productive crop or pasture. An example of this is the downstream end of the Merkanooka drain-creek system.

Less-favourable sites, e.g. abandoned farmland, samphire flats, and/or areas which retain saline or sodic soils, will be left in fallow until next winter, by which time salty soils should be adequately leached. As foreshadowed in YYCMG's offset plans (submitted to the Department of Environment & Conservation for each clearing permit), these sections of the corridor will be devoted to biodiversity plantings. Annual photos are taken from fixed photoreference points in order to document the progress of rehabilitation efforts.

Pre-Construction

The following photographs show a number of examples of the work undertaken throughout the Yarra Yarra catchment during the pre-construction phase of the project.

Fig 4: Carrying out soil sampling in a backhoe pit, Canna Gutha

Soil pits are established at regular intervals (around 1.5 km) along a potential drainage line to establish the structure of the soil profile, the rate of inflow of ground water and the quality of this water. These pits are usually around 3 metres deep. The YYCMG employ a full time soil scientist to undertake these assessments as well as to oversee the monitoring program.

Fig 5a: Photoreference point, Mongers 16 looking upstream

Fig 5b: Photoreference point, Mongers 16 looking downstream

Figs 5a and 5b depict a single photoreference point. Fig 5a is looking "upstream" and Fig 5b is taken from the same area looking out across the lake. The Mongers 16 drain water will eventually discharge here. The stake will allow us to take photos from exactly the same spot every 12 months. We can then monitor any effects that the drain has on the discharge area.

Pre-Construction Continued

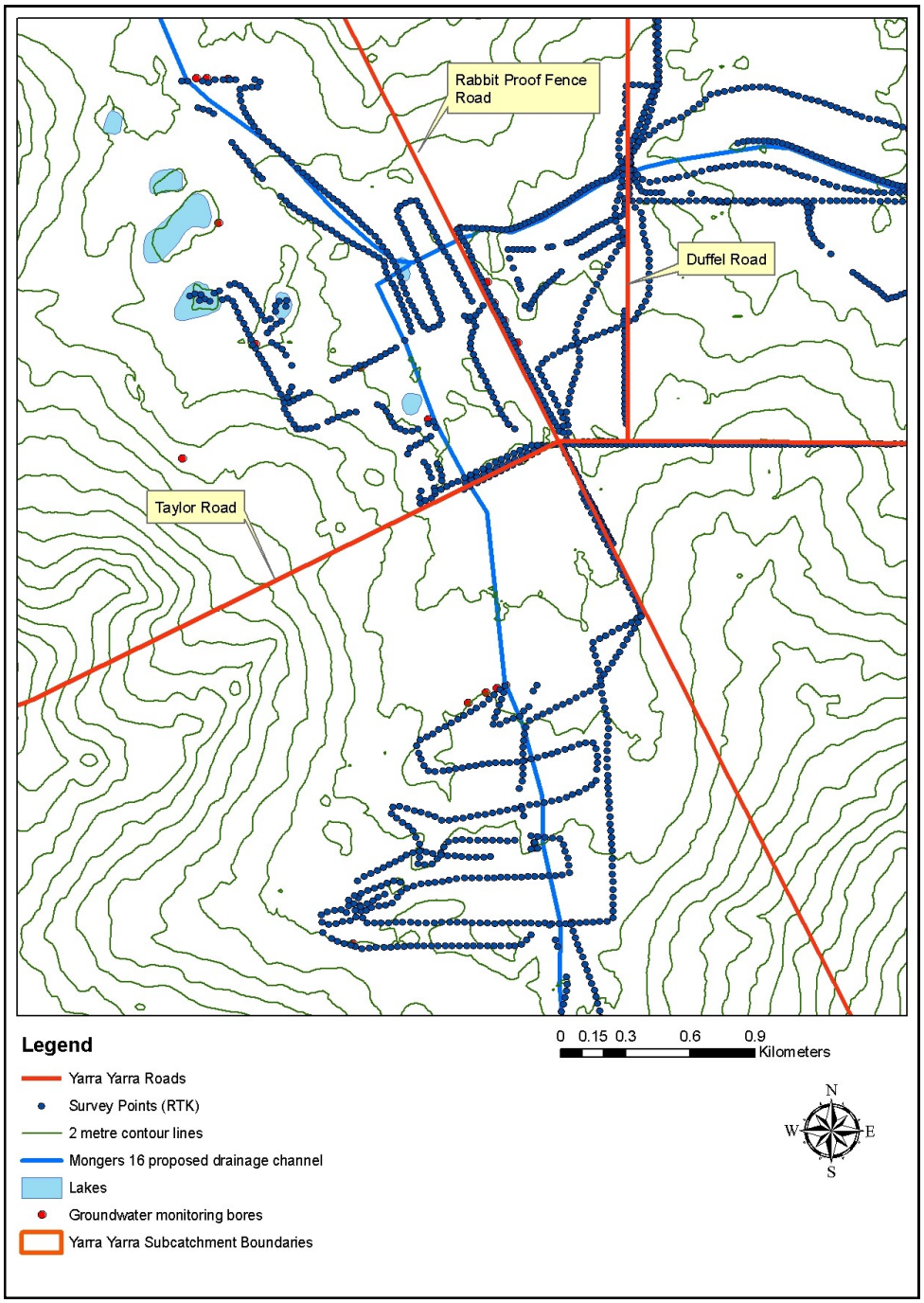
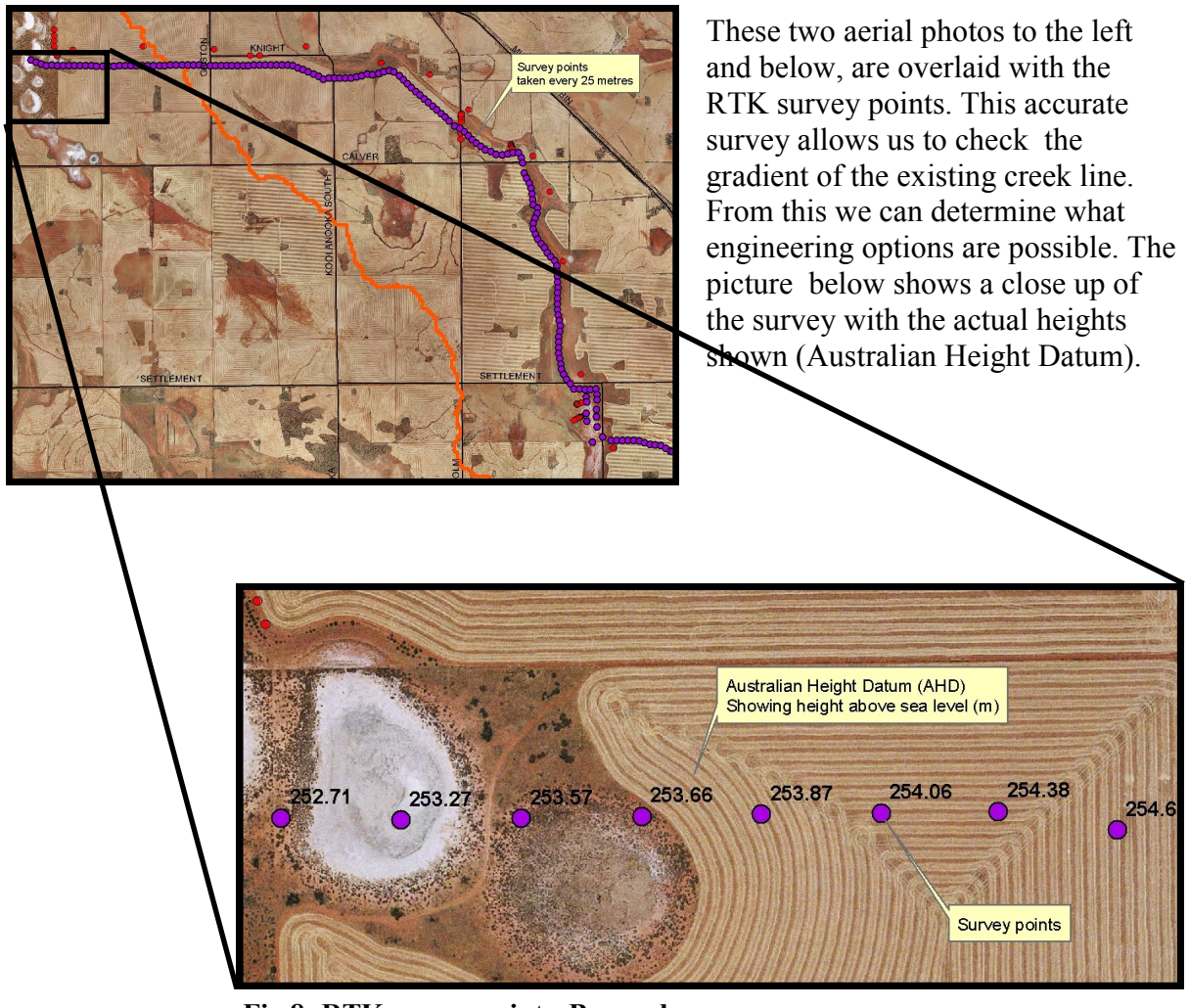


Fig 6: Surveying undertaken in Mongers 16 subcatchment

The map above shows 2m contours laid out over a potential drain site in the Mongers 16 subcatchment. This gives us a general idea of the relief in the lowest area of the catchment. The contour data is supplied by Government Agencies.
The wider the contour spacings, the flatter the area and therefore more precise surveying needs to be undertaken to ascertain the exact path the drain should take to maintain the correct gradient.
The YYCMG have a qualified surveyor as a permanent staff member who is trained in the use of Real Time Kinematic (RTK) surveying equipment. The YYCMG have purchased one of these instruments to enable us to survey with extreme accuracy (within 2cm in height AHD). Data taken at 25m intervals can be downloaded onto a map, as shown above.

Quad bike with mounted RTK equipment. The equipment includes a remote base station which is not shown here.

Fig 7: The RTK surveying set-up, Burakin



These two aerial photos to the left and below, are overlaid with the RTK survey points. This accurate survey allows us to check the gradient of the existing creek line. From this we can determine what engineering options are possible. The picture below shows a close up of the survey with the actual heights shown (Australian Height Datum).

Fig 8: RTK survey points, Bowgada

Pre-Construction Continued

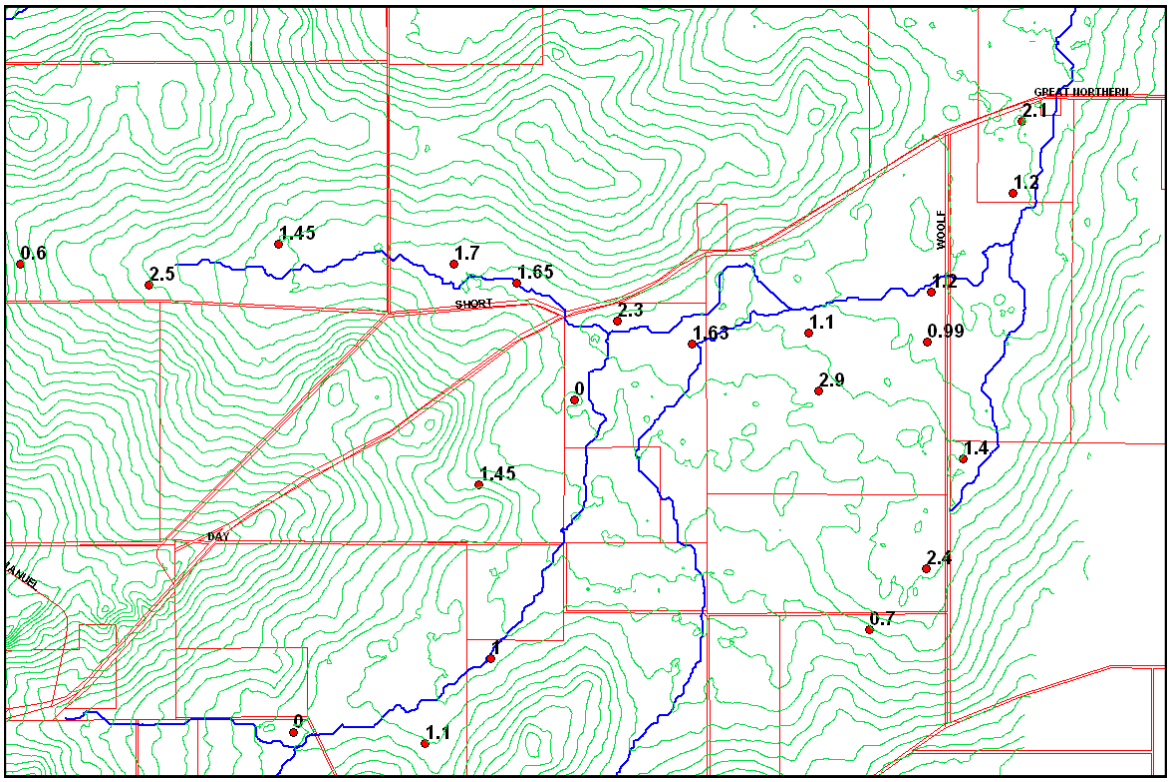


Fig 9: Map showing the location of boreholes and the depth of groundwater (metres), through a section of the Jibberding subcatchment. The blue line in the map above indicates the lowest point in the valley floor.

Groundwater level is one of the main indicators used to ascertain the suitability of a drainage site. Boreholes are used to determine the level of the groundwater throughout the catchments. These bores are located roughly at intervals of 1.5 kilometres along the valley floor. The bores are drilled to an average depth of 4 metres, and are cased with poly-pipe see below (Fig 10).

The Yarra Yarra drill rig has been used extensively throughout the catchment management area. To date, over 1000 boreholes have been established, for the purpose of measuring and monitoring ground water levels.

Fig 10: The drill rig in action

Fig 11: Vegetation transect, Bowgada

The transect shown above is one of the vegetation control sites in the Bowgada subcatchment. These control sites are essential to obtain a comparison between the vegetation sites adjacent to the drain, compared to similar sites remote to the drain.

Construction of the deep drains and on-ground works

The following photographs show a number of examples of the work undertaken throughout the Yarra Yarra catchment during the construction phase of the project. While there are many variations, the basic drain design is outlined on the following pages.

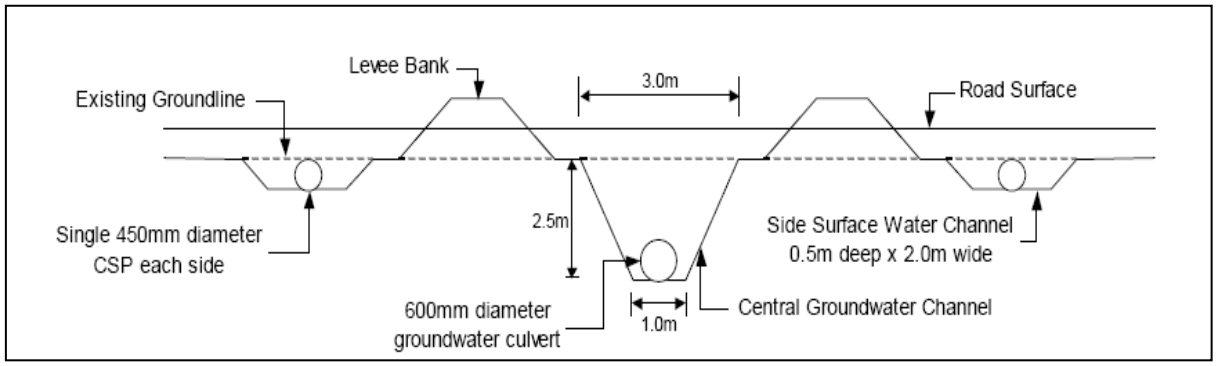


Fig 12 Cross section of a typical road crossing with surface channels either side of the deep drain

The basic design of the drain incorporates a central deep drain carrying groundwater. The drain is completely surrounded by a levee bank 1.5 metres high to exclude all surface water. This is to prevent the carrying capacity of the drain from being exceeded, and also to prevent silt from accumulating in the drain. The levee banks are set back 1.5 metres from the edge of the drain to also discourage silting. Shallow surface water channels either side convey surface water out of the catchment and also help to protect the levee bank.
The deep drains are dug to a mean depth of 2.5 metres with a batter slope of 0.5:1 (horizontal:vertical). The first drains excavated were 2.1 metres deep but experience has shown us that 2.5 metres is more effective. However this does increase the cost by $1500 per km. This has increased the pressure on our budget.

Fig 13: Taken at Canna Gutha. Surface water channels either side of the levee banks flanking the central deep groundwater drain.

The surface drains are 3 to 4 metres wide and 300mm to 400mm deep. We have found that it is prudent to establish the drain complex slightly higher than the lowest point in the valley floor, this gives the drain protection from extreme flood events.

Notice the levee bank on the left hand side. Top soil excavated from the surface channel is deposited on the levee bank for two reasons.
1. To make a more robust construction to protect the deep drain.
2. To provide a better environment for establishing ground cover on the bank for stabilisation.

Fig 14: Construction of the surface drain, taken at Canna Gutha

Fig 15: Putting the design to the test. Mongers 55 deep drain, standing up to a major flood event in February 2008. Notice that the surface water remains separated from the groundwater inside the drain.

Post Construction: Monitoring and Research

The following pages show a number of examples of the work undertaken throughout the Yarra Yarra catchment during the post-construction phase of the project.

Hydrological Monitoring

The monitoring stations (Fig 19a and 19b) enable the collection of data at a given point in the drain. The positioning is downstream of any spurs, and is close to the discharge point. This enables monitoring of all of the water produced by the deep drain.

The height of the water flowing over the weir is the critical part of measuring the volume of water the drain produces. Odyssey recorders have also been used to measure the depth of water and to allow us to double check the accuracy of the measurements taken. All data is then manually verified by alternative methods to validate data collected. This is done by using handheld water sensors to test pH, Eh and EC levels (see Fig 21) and water is collected in buckets and timed using a stopwatch to confirm the flume readings over the weir. Below are two examples of data collected over a number of months from the Merkanooka and Canna Gutha monitoring stations. Measurements are recorded several times a day, and average flows for a month have been calculated from this. The data logger stores a huge amount of information. Displayed below is an overview of the volume of flow in two of our flumes over a ten month period.

Merkanooka Flume Data

Date	HEIGHT (mm's)	Litres/s	Litres/day	Megalitres*/month
May-07	13	0.37	31,968	0.96
Jun-07	24.7	0.98	84,672	2.54
Jul-07	27	1.21	104,544	3.14
Aug-07	33	1.63	140,832	4.22
Sep-07	31	1.45	125,280	3.76
Oct-07	26	1.08	93,312	2.80
Nov-07	22	0.80	69,120	2.07
Dec-07	18.5	0.67	57,888	1.74
Jan-08	16.1	0.52	44,928	1.35
Feb-08	42	2.46	212,544	6.38
Mar-08	33	2.43	209,952	6.30
TOTAL				35.25

*One megalitre = one million litres

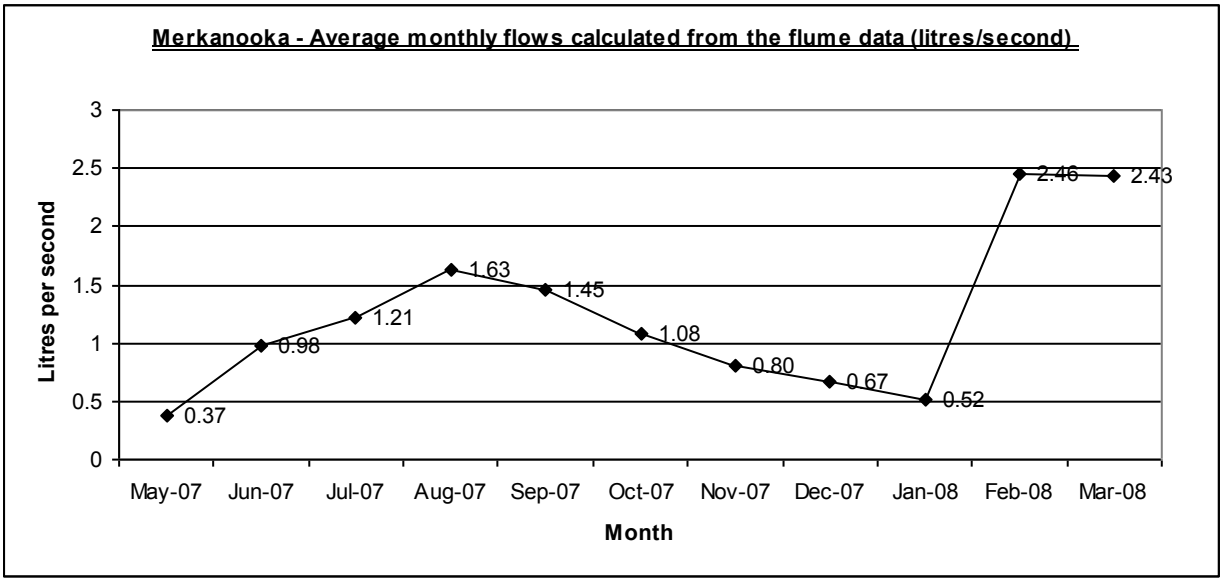


Fig 16: Merkanooka flume, average flows

Canna Gutha Flume Data

Date	Height (mm's)	Litres/s	Litres/day	Megalitres*/month
Jun-07	24	0.98	84,672	2.54
Jul-07	47	2.66	229,824	6.89
Aug-07	41	2.41	208,224	6.25
Sep-07	44	2.49	215,136	6.45
Oct-07	38	2.00	172,800	5.18
Nov-07	41	2.41	208,224	6.25
Dec-07	36	1.82	157,248	4.72
Jan-08	38	2.00	172,800	5.18
Feb-08	98	10.90	941,760	28.25
Mar-08	58	4.25	367,200	11.02
Apr-08	46	2.60	224,640	6.74
TOTAL				**89**

* One megalitre = one million litres

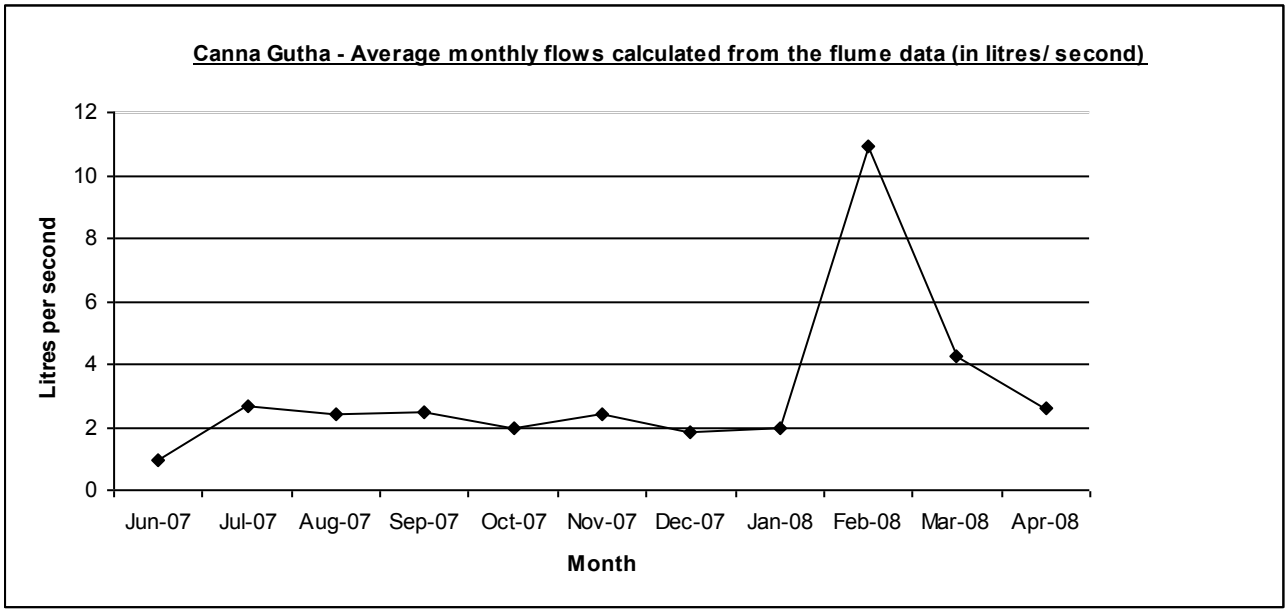


Fig 17: Canna Gutha flume, average flows

Both of the graphs show a spike in the volume of water flowing through the drain around February 2008. This is the response to two significant rainfall events during this month. Because the flume records a reading every 6 hours (every 3 hours in some of the flumes), it would be possible to show a much more detailed response to the rainfall event.

Please note
Flow Rates
One thousand litres = one kilolitre = 1 cubic metre

Post Construction: Monitoring and research continued

Fig 18a Constructing the flume at Merkanooka

Fig 18b The finished flume

A cut-off plate prevents any water bypassing the flume and therefore directs all of the water to pass through the weir for measurement purposes. You can see the plate clearly on Fig 18b

Fig 19a: Jibberding flume and monitoring station

Fig 19b: A close up of the Jibberding monitoring station

Fig 20: Downloading the data

Using an automated logger various measurements can be taken, including the following;
Ec Electrical Conductivity – to measure the salinity level of the drainage water
pH To measure the acidity of the drainage water
Height of the water (mm) - taken at regular intervals (e.g. every 6 hours), which allows flow to be calculated
All of these are logged directly into a monitor (the blue box, in Fig19b) and stored for download at a later date (Fig 20). The monitor can store up to 3 years of data. All stations are powered by solar panels and can therefore be setup in remote sites to record data without the need for constant, costly field trips.

Whilst the flume and monitoring station are very useful, they are in a fixed location. This equipment enables us to check the pH, Eh and the EC of the drainwater at any location within the drainage network.

Fig 21: Portable probes, pH, Eh and EC

Vegetation monitoring is undertaken in all of the subcatchments where drains have been excavated. All of the vegetation transects are monitored annually.

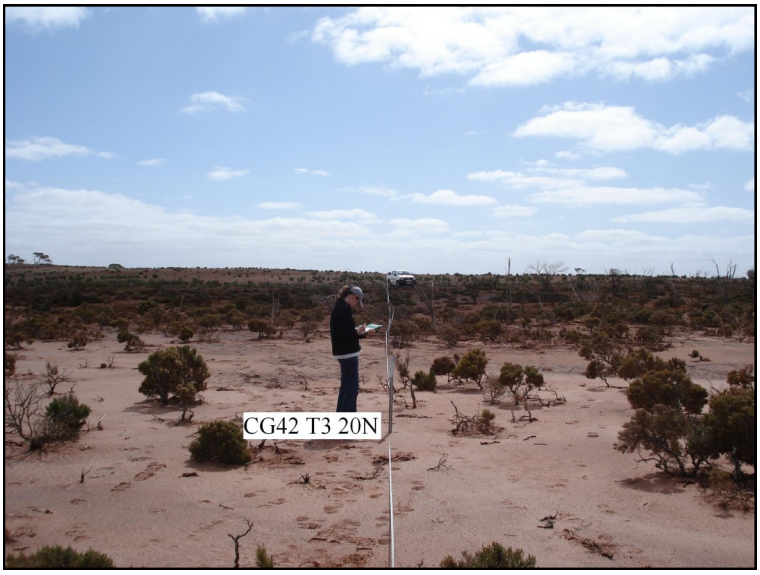


Fig 22: Vegetation monitoring in Canna Gutha

Fig 23: Fencing off the easements

The farmers are provided with the fencing materials and it is their responsibility to erect the fence. However the Yarra Yarra staff are providing support to install the strainer assemblies.
The drill rig has been modified with a post hole auger for digging the holes. We plan to have all the strainers in before the end of June. The final completion date for all fencing is the 30th September 2008.
It is essential for the areas to be fenced if the vegetation planted is to survive. Livestock must be excluded whilst the seedlings establish themselves.

Post Construction: Monitoring and research continued

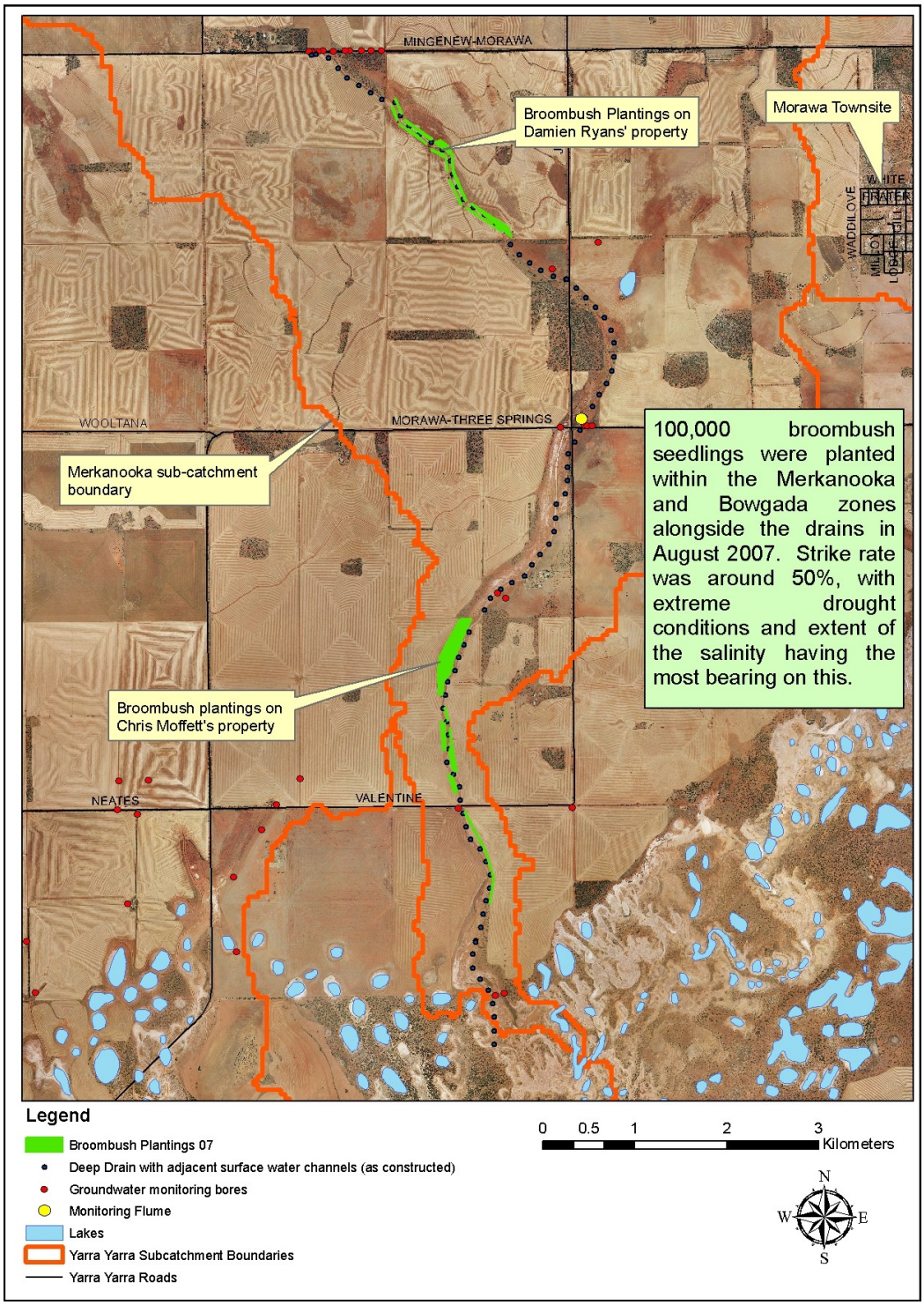


Fig 24: Planting broombush seedlings in Merkanooka, 2007

With the assistance of the "Brushwood Industry Development on Saline Land Project", supported by NACC, we have been able to plant subsidised broombush seedlings (4c/seedling), alongside sections of the deep drains in Merkanooka and Bowgada. Despite difficult conditions in 2007, we were impressed with the hardiness of the seedlings. In August 2008, we will be planting a further 125,000 broombush seedlings, in the Jibberding, Burakin and Merkanooka subcatchments. Site visits have been undertaken by the project officer (Georgie Troup) in order to assess the suitability of the new sites, and to determine which broombush species are best suited to the specific areas. Our long term plan is to revegetate corridors alongside all sections of the drains, with a mixture of tree and shrub species.

Fig 25: Broombush seedlings, August 2007

Fig 26: Broombush seedlings, May 2008

The two photographs above show the amount of growth over the past ten months. When the seedlings were planted they were roughly 10cm tall, they are now on average about 50cm tall. broombush is used for making brushwood fences that are ornamental as well as providing shelter for nurseries and garden (Fig 27). Currently the industry is quite buoyant and we hope that in 5-7 years time, we may be able to harvest the broombush, allowing us to generate income for further re-vegetation projects. Broombush has the advantage that it coppices, so it would be a sustainable industry.

Fig 27: Brushwood fencing

Part Two

Subcatchment Maps and Expenditure

The following pages give an overview of the on ground works carried out in each subcatchment, and the location of these works. They also provide a breakdown of the expenditure in each area.

Bowgada 4

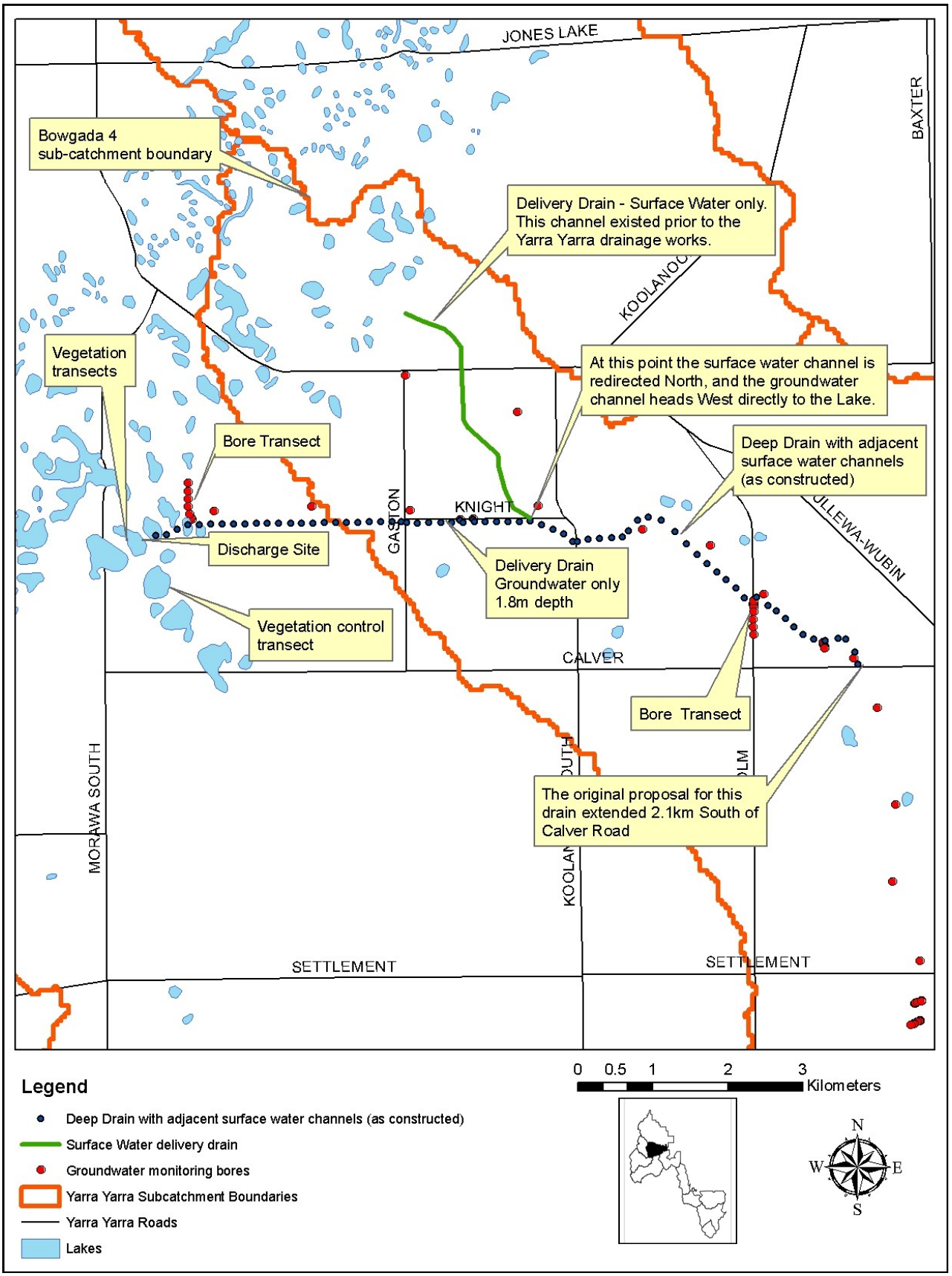


Fig 28: Bowgada 4

Expenditure, Bowgada

Bowgada - Drain completed January 2007

Capital Works	Length (km)	Budgeted Cost	Actual Cost	Under(-)/Over(+) Budget
Drain Excavation	10.4km	$128,853.00	**$115,320.00**	- $13,533
Fencing materials	10.5km	**$22,500.00**	**$17,136.00**	- $5,364

For the period of construction 1st November 2006, to 31st January 2007:

Operations

Parts and Repairs
Legal fees
Drilling
Consulting engineer
Monitoring equipment
Design and layout consultancy
Total Cost $13,320

Wages

Coordinator / Manager
Soil Scientist
Project support officer (part time)
IT officer (part time)
Finance manager (daily rate)
Field assistant
Total Cost $45,766

Notes:
The Bowgada Drain was under budget because the farmer at the top end decided at the last minute not to participate in the program. Funds were then transferred to the Merkanooka drain which required some modification to the original budget.

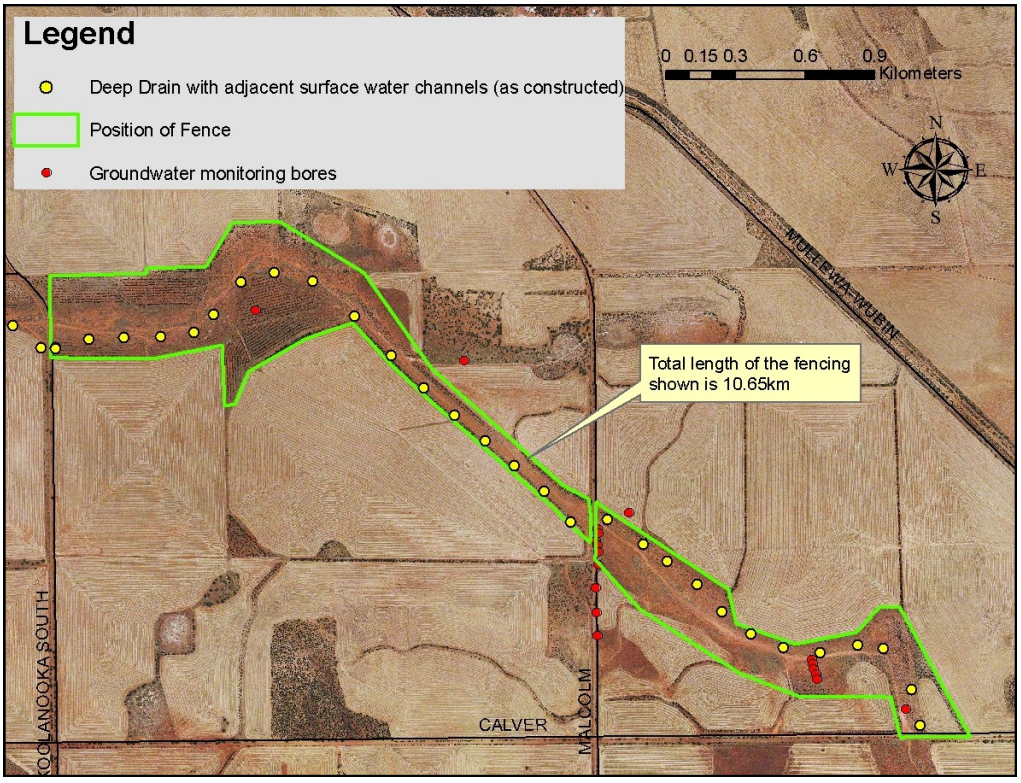


Fig 29: Shows completed fencing of the Bowgada easement. The fencing shown is just over 10.5 km in length

Merkanooka 41

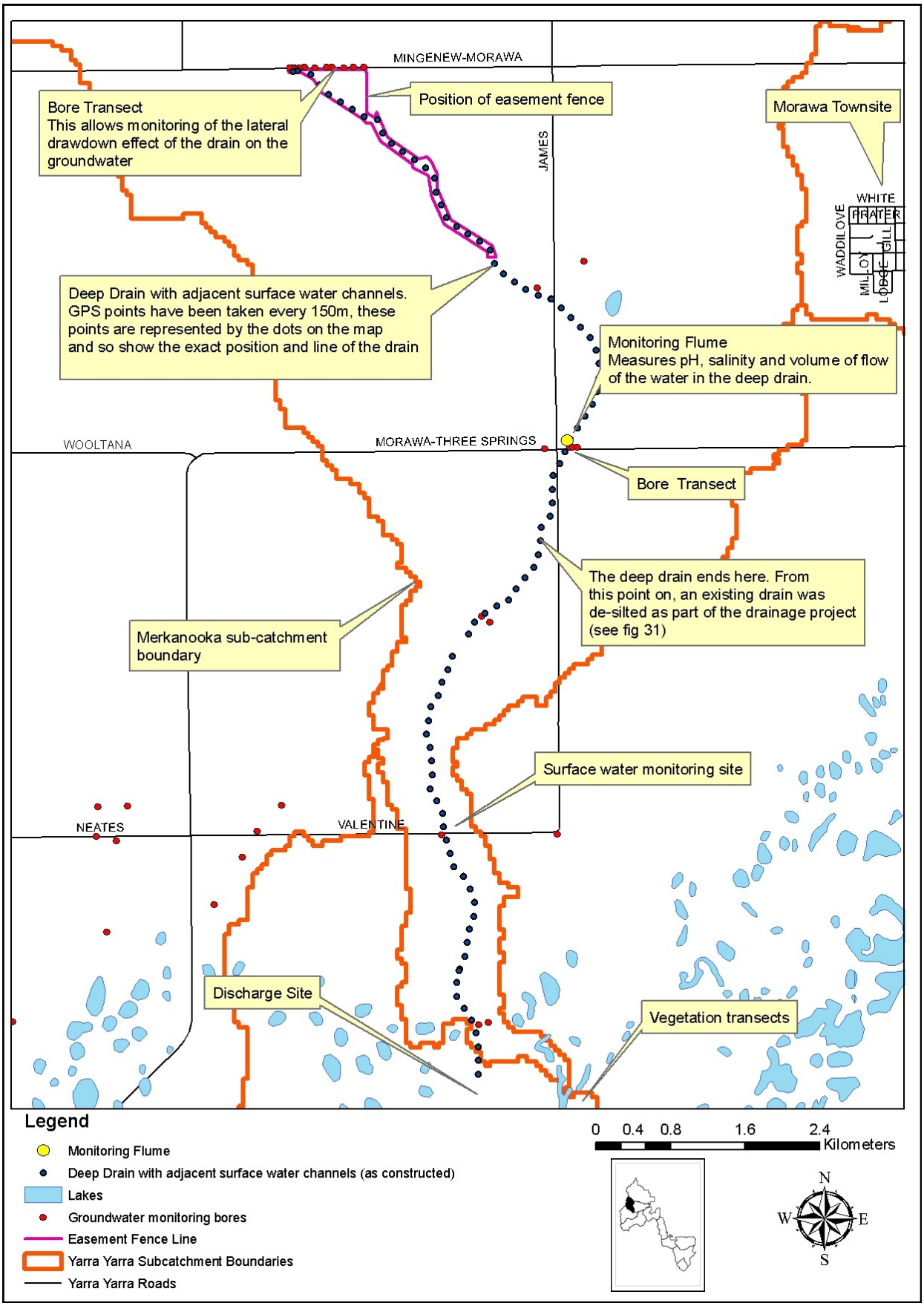


Fig 30: Merkanooka 41

Expenditure, Merkanooka

Merkanooka - Drain completed June 2007

Capital Works	Length (km)	Budgeted Cost	Actual Cost	Under (-)/Over (+) Budget
Drain Excavation	12.8km	$110,480.00	**$147,448.00**	+$36,968
Fencing materials	11.8km	$12,320.00	**$18,763.00**	+ $6,443

For the period of construction 1st February to 30th June 2007

Operations

Parts and Repairs
Legal fees
Drilling
Consulting engineer
Monitoring equipment
Design and layout consultancy
Total Cost $74,642

The high cost for this period was due to the updating of precision RTK surveying equipment at a cost of $47,000

Wages

Coordinator / Manager
Soil Scientist
Project support officer (part time)
IT officer (part time)
Finance manager (daily rate)
Field assistant
Total Cost $105,405

The high cost of wages was due to the delays explained below. Staff were working in other catchments carrying out preliminary work for other proposed drains during this delay.

The construction of the Merkanooka drain was held up for three months due to lengthy delays in obtaining permits for the regulatory requirements for drainage.

The project ran over budget because the original design allowed for de silting the creek line only, but on consultation with the farmers it was decided to make the top half of the drain a leveed deep drain and the bottom half to be de silted. The Bowgada project was under budget by $18,897 so this helped offset the extra expenditure to some degree.

Fig 31: The Merkanooka surface water channel following de-silt.

When the drain is “de-silted”, the silt is excavated and piled up into a bank alongside the channel. A layer of topsoil from the other side of this bank is then piled on top of the silt material.
This helps to stabilise the bank and also provides a layer of good quality soil to encourage successful revegetation of the bank top and sides.

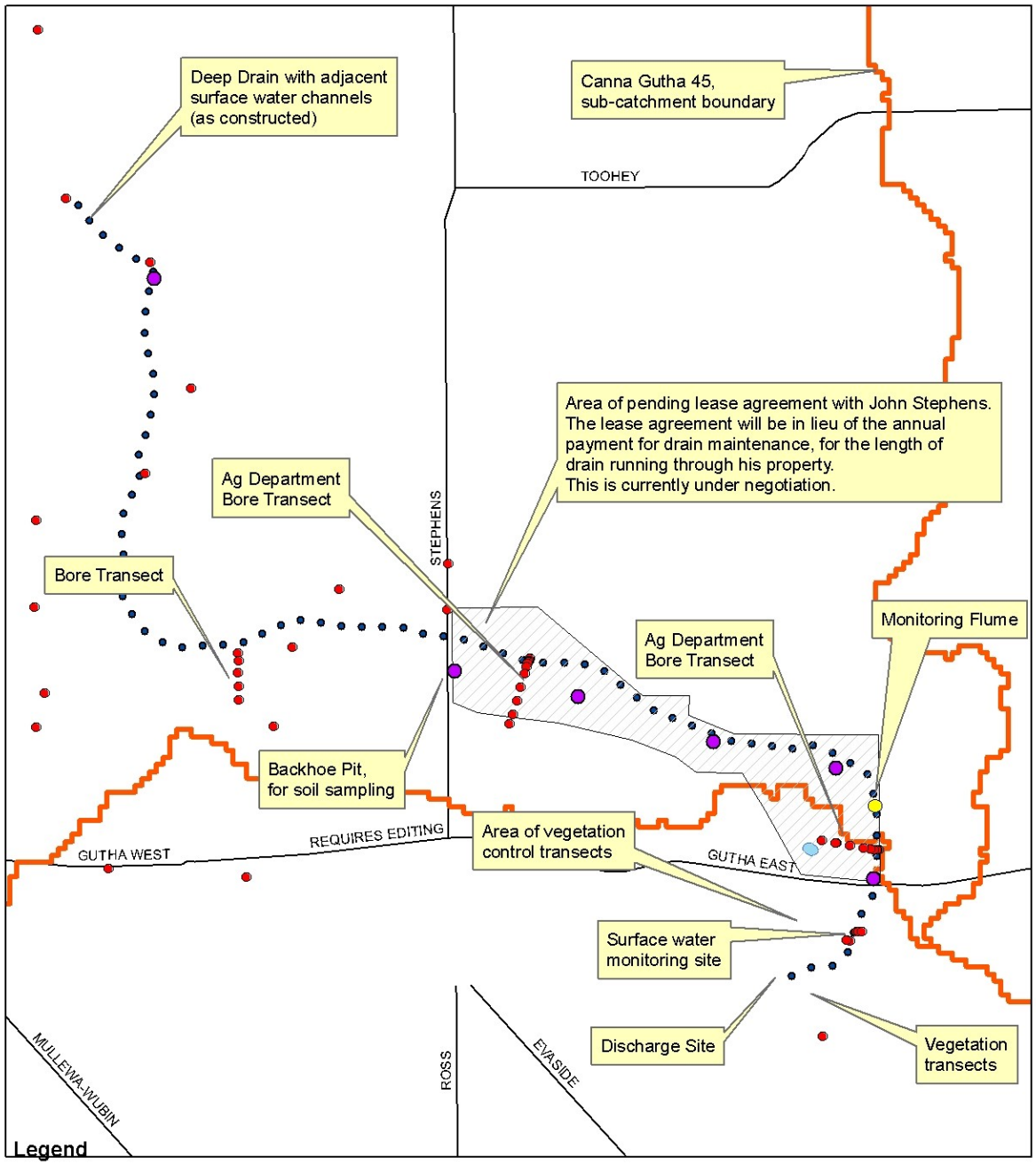


Fig 32: Canna Gutha

Stephens lease: Notice the area depicted above as a potential lease site. Mr. Stephens has offered to lease us 200 hectares of land which we will use as a research site. The area was once highly productive wheat land . We will grow and monitor different tree and cereal crops to provide some positive data on the effectiveness of the drain with runs through the middle of the area. As the land improves we plan to generate some income for Yarra Yarra by harvesting and selling the produce. The lease is currently being drawn up.

Expenditure, Canna Gutha

Canna Gutha - Drain completed July 2007

Capital Works	Length (km)	Budgeted Cost	Actual Cost	Under(-)/Over(+) Budget
Drain Excavation	10.7km	$181,217.00	**$153,930.00**	(-) $27,287
Fencing materials	10.3km	**$36,750.00**	**$17,942.00**	(-) $18,808

For the period of construction 1st - 31st July 2007:

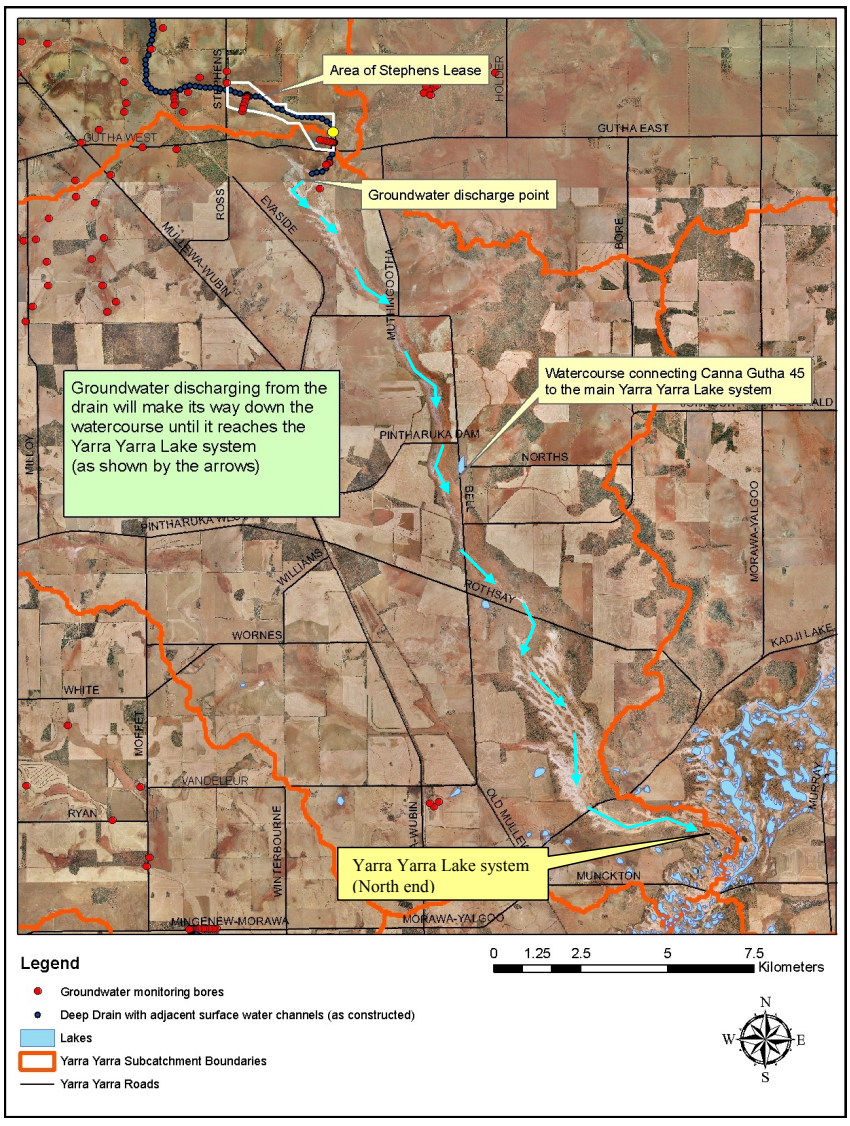
Operations

Parts and Repairs
Legal fees
Drilling
Consulting engineer
Monitoring equipment
Design and layout consultancy
Total Cost $2,152

Wages

Coordinator / Manager
Soil Scientist
Project support officer
IT officer (part time)
Finance manager (daily rate)
Field assistant
Design manager / Surveyor
Total Cost $18,346

We were under budget in this catchment because the drain was reduced by 3 km. Also a section of the drain that passes through the area of land we are leasing for research purposes will not require fencing.



The Canna Gutha drain feeds into one of a network of streamlines which typically feed into the main body of the Yarra Yarra Lake System. The blue arrows define the course of the waterway more clearly. The potential evaporation rate for the region is 2m per annum. The discharge rate from the Canna Gutha drain can be estimated at 105,000 cubic metres p.a. (see chart page 14). A general rule of thumb would be to allow 1ha of evaporation area per kilometre of drain. From the calculated discharge and evaporation rates, it appears that roughly half a hectare of evaporation area would be sufficient per km of drain. Therefore 10 ha of surface area is more than adequate to cope with the discharge from the Canna Gutha drain. This area is very small when compared to the total surface area of the Yarra Yarra Lake System and associated wetlands, which is around 250,000 ha.

Fig 33: The flow of the drain water towards the inland lakes

Jibberding 19

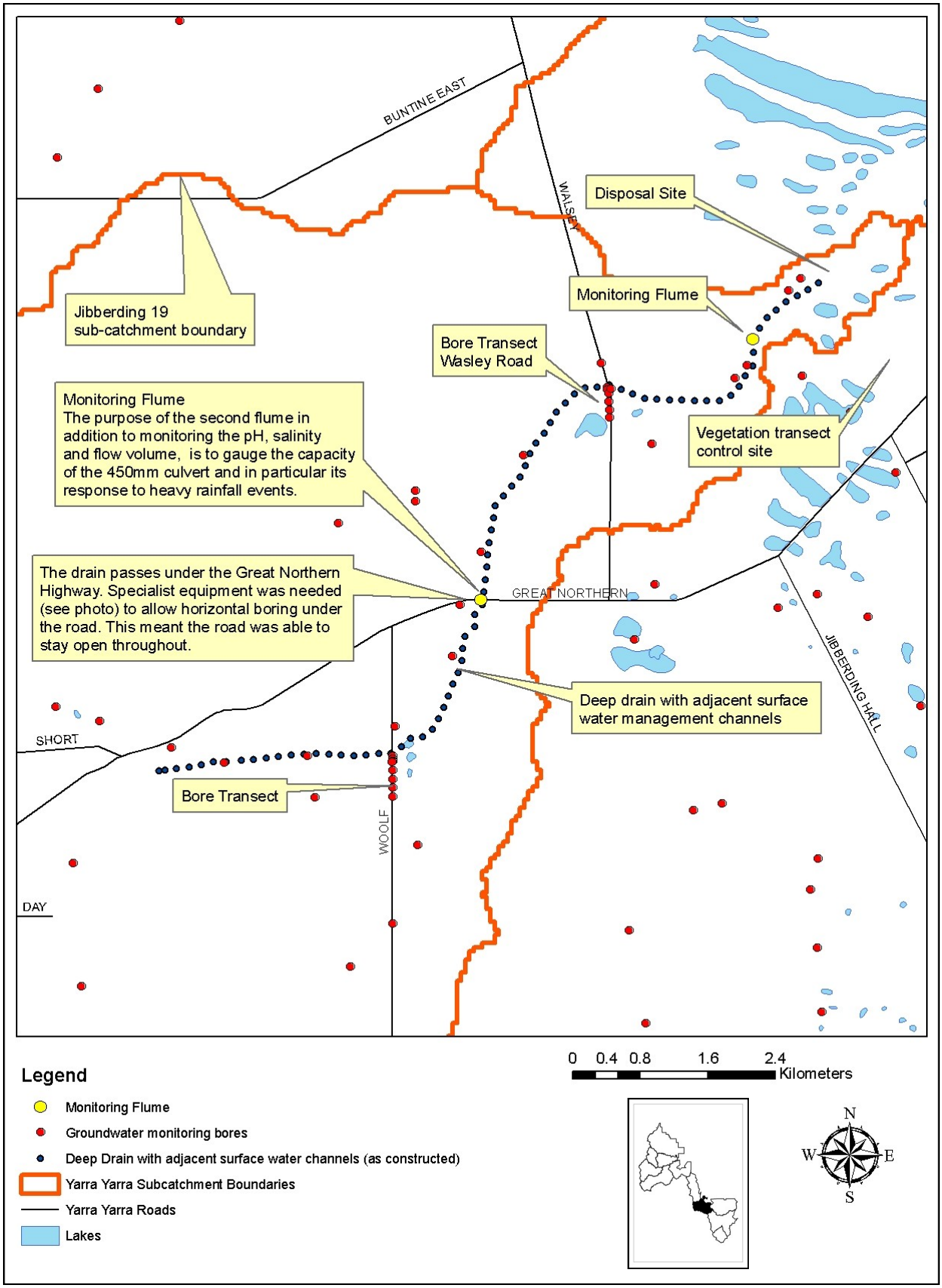


Fig 34: Jibberding 19

Expenditure, Jibberding

Jibberding - Drain completed April 2008

	Length (km)	Budgeted Cost	Actual Cost	Under(-)/Over(+) Budget
Drain Excavation	11.54km	$241,125.00	$208,422.00	(-) $32,703
	Length (km)	**Budgeted Cost**	**Best estimate at time of writing**	**Under(-)/Over(+) Budget**
Fencing materials	14.6km	$30,000.00	$25,400.00	(-) $4,600

For the period of construction 1st August 2007, to the 31st March 2008:

Operations

Parts and Repairs
Legal fees
Drilling
Consulting engineer
Monitoring equipment
Design and layout consultancy
Total Cost: $42,346

Wages

Coordinator / Manager
Soil Scientist
Project Support officer
IT officer (part time)
Finance manager (daily rate)
Field assistant
Design manager / Surveyor
Total Cost: $191,345

The Jibberding drain was the only capital works carried out over this 8 month period. Funds were withheld for capital works while an extensive review took place.
During this period a large amount of staff time was taken up drafting a series of detailed documents to outline the prioritisation process for the drains, and also the long-term management and governance procedures. These documents were to provide reassurance to the funding bodies that the best possible practises were being applied, appropriate to the large sums of public money being invested. It was also during this period that the Yarra Yarra Catchment Regional Council (YYCRC) was officially established and project responsibility was transferred to the more robust body.
The Jibberding drain was under budget because it was shortened by 3 km because a new owner at the top of the landscape did not want to drain his property.

Fig 35 The horizontal line borer

Horizontal line boring - Drilling under the Great Northern Highway 20km east of Wubin.
This technique is used where heavy traffic is encountered. A series of progressively larger drill bits are passed back and forth under the road until the 450mm polyethylene pipe is finally drawn through. The pipe is 36 metres in length with a wall thickness of 33 mm. This procedure is quite expensive but much cheaper than building a bypass for heavy vehicles while the road is dug up to lay conventional concrete pipe.

Fig 36: The local landholders discussing the new drain

Digging the trench to expose the tunnel created by the horizontal line borer. which is 2.5 metres under the ground. This is in preparation for drawing the 36 metres of pipe under the highway. You can see the pipe in the background.

Fig 37: Wasley Road culvert

A conventional culvert passing under Wasley Road in the Jibberding drain.

This site is the junction of two deep drains from two subcatchments; Jibberding 19 (the 2008 drain) and Jibberding 21. The drain in Jibberding 21 was established with the assistance of State Salinity Council funds, in 2003. This photo shows the two discharge points converging on a common delivery drain.

Fig 38: Convergence of two surface water channels, Jibberding

Fig 39 Jibberding vegetation survey

This shows the first transect in Jibberding (JB19, T1), one of six in the Jibberding wetland area. You can clearly see the transition in vegetation here from the edge of the lake (sand in the foreground) through the samphire flats and then into larger shrubs and trees as the distance away from the salt lake increases. The change in vegetation is an indication that the soil is also changing in texture and structure.

Xantippe

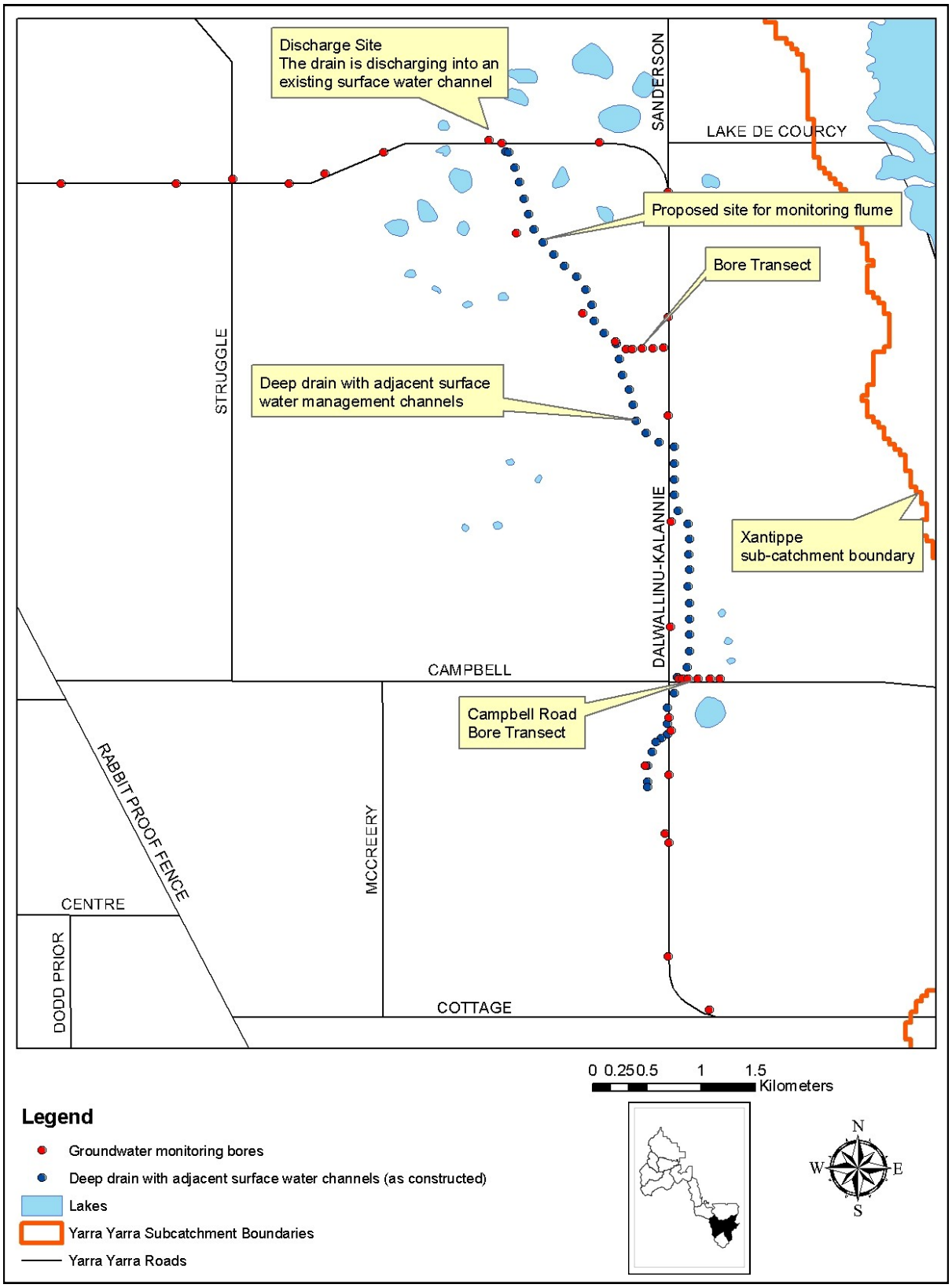


Fig 40: Xantippe

Expenditure, Xantippe

Xantippe - Drain completed 2008

	Length (km)	**Budgeted Cost**	**Actual Cost**	**Under(-)/Over (+) Budget**
Drain Excavation	6.7 km	$109,500.00	$119,300.00	(+) $9,800
	Length (km)	**Budgeted Cost**	**Best estimate at time of writing**	**Under(-)/Over (+) Budget**
Fencing materials	8km	$12,000.00	$16,000.00	(+) $4,000

The cost of fencing has increased by $250/km since budget was written

For the period of construction 1st April 2008 to the 30th April 2008:

Operations

Parts and Repairs
Legal fees
Drilling
Consulting engineer
Monitoring equipment
Design and layout consultancy
Total Cost $3,466

Wages

Coordinator / Manager
Soil Scientist
Project Support officer
IT officer (part time)
Finance manager (daily rate)
Field assistant
Design manager / Surveyor
Total Cost: $38,902

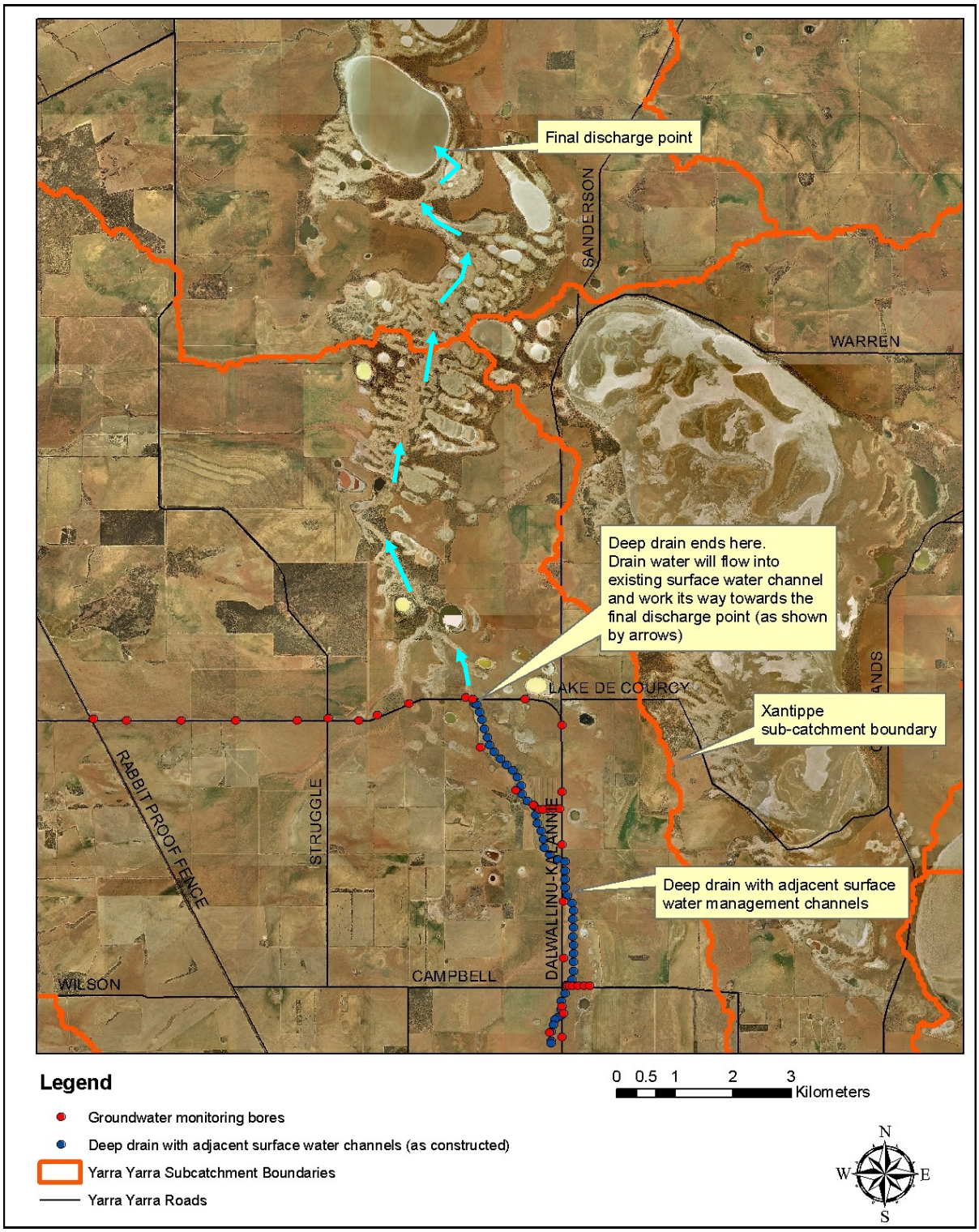


Fig 41: Xantippe drain, flow route

Similar to the Canna Gutha drain (see Fig 33), the Xantippe drain also makes use of existing drains and natural streamlines to deliver the groundwater to the lake system.

The results of carrying out an "As Constructed" (Ascon), following completion of the excavation works

Xantippe 34 Drain As constructed Survey at 150m intervals									
GPS Coord GDA 94'		**Measurement taken**			**Date: April 08**	Drain width	Inside spoil	Outside spoil width	Total width
North	**East**	**Depth of Drain on sloped wall**	**Calculated True depth**	**Depth of Water**	**Photo Point**	**Width 1**	**Width 2**	**Width 3**	**Width 4**
6649849	0505383								
6649840	0505417	1.6	1.39	0.25					
6649702	0505472	1.6	1.39	0.26	586	2.6	5.3	13.1	21.0
6649565	0505513	1.7	1.47	0.4		2.9	5.4	13.3	21.6
6649552	0505552	2.4	2.08	0.4		3.6	9.1	17.7	28.9
6649271	0505600	2.2	1.91	0.4	585	3.2	7.3	17.1	29.5
6649132	0505647	2.35	2.04	0.3		3.3	7.7	17.7	28.9
6649011	0505730	2.5	2.17	0.16		3.7	8.6	19.1	30.5
6648900	0505827	2.8	2.42	0.2	584	3.8	9.4	20.1	31.1
6648794	0505932	2.8	2.42	0.22		3.7	9.4	20.6	31.2
6648693	0506039	2.75	2.38	0.12		3.9	8.7	20	31.1
6648573	0506123	2.8	2.42	0.16	583	4	9.8	20.4	31
6648432	0506185	2.8	2.42	0.24		3.6	7.2	19	31.4
6648285	0506202	2.8	2.42	0.2		3.8	9	20.8	33.5

The data in the table above is an example of the work carried out during an "as constructed" survey. The purpose of the survey is to map the exact location of the drain, after it has been excavated. The data shown is only about a fifth of the data for the Xantippe drain.

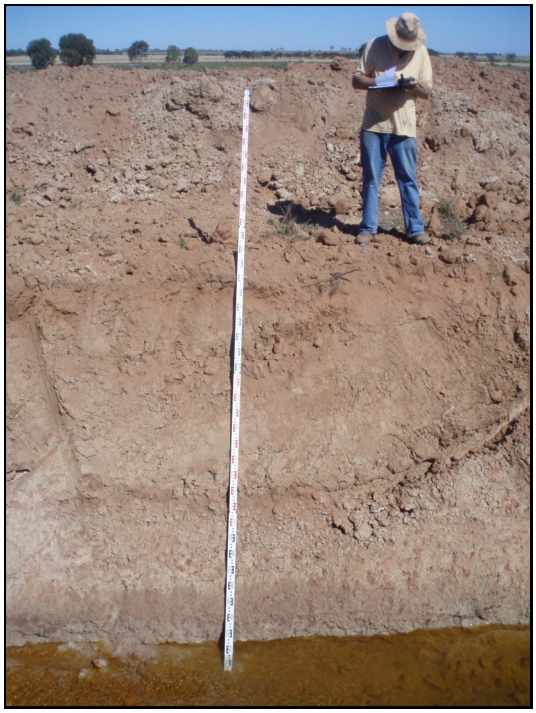


Fig 42: Measuring the depth of the drain on the slope, Xantippe

GPS readings are taken every 150 metres, photos are taken every 450 metres (Fig 42)
The depth of the drain slope is measured, and from this the true depth of the drain can be calculated.
The width of the drain, the inside spoil and the outside spoil are also measured and the total drain width can then be calculated.

These "Ascon" surveys are carried out as soon as possible after the drain has been constructed.

Mongers 16

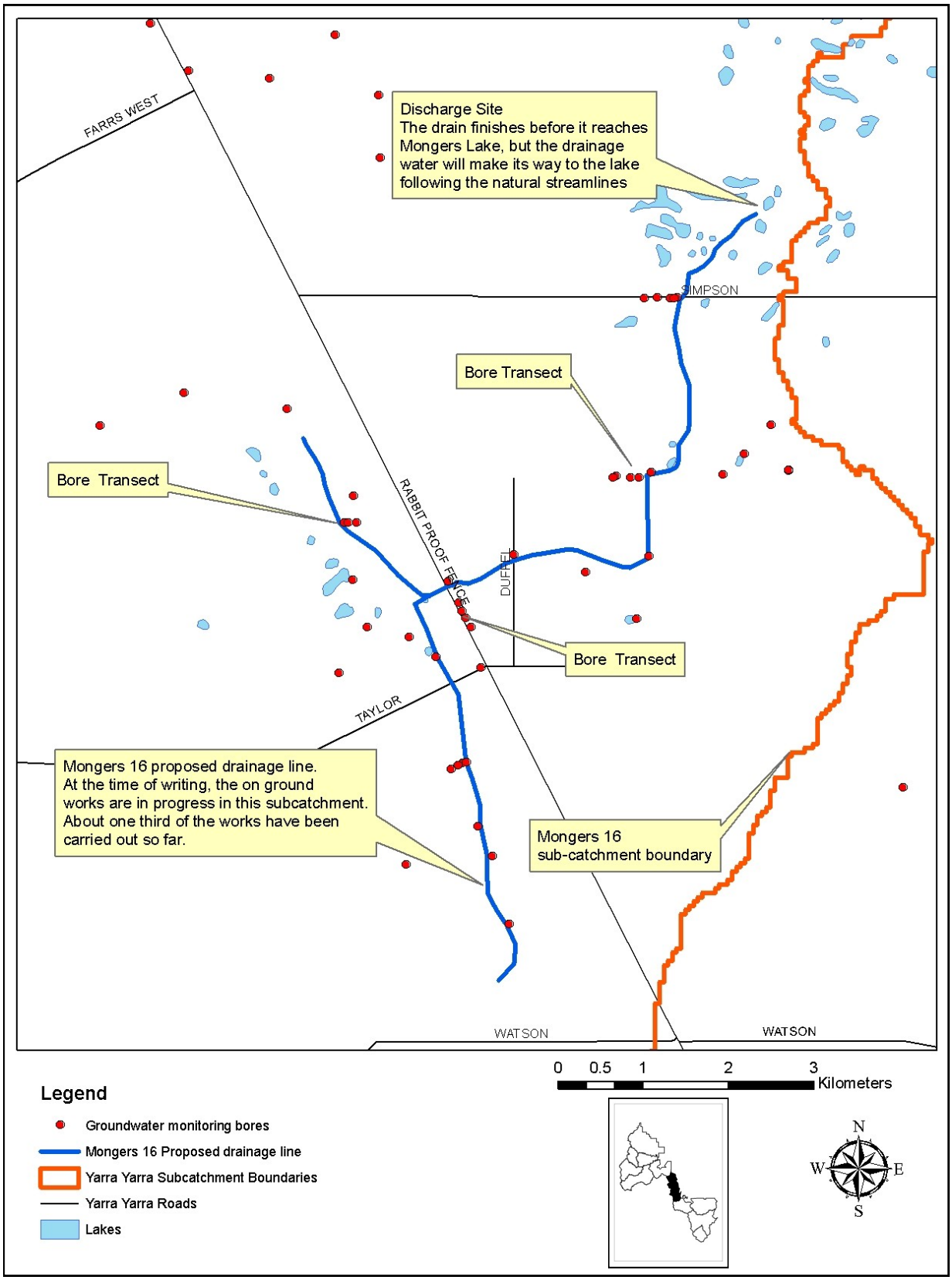


Fig 43: Mongers 16

Expenditure, Mongers 16

Mongers 16 - Drain excavation underway at time of writing, estimated completion date, May 2008

	Length (km) (proposed)	Budgeted Cost	Best estimate at time of writing
Drain Excavation	14.8km	$251,700.00	n/a
Fencing materials	32km	$48,000.00	$56,000.00

As this project is currently unfinished we are unable to give an accurate breakdown of the costs.
We estimate that the drain may cost less than originally budgeted for due to a change in the exact position, and overall it is shorter than initially planned. However there will be additional costs incurred to fulfill the requirements of the clearing permit, such as drain crossings for wildlife, a reptile fence, and strategically positioned ladders in the drains to assist wildlife to get out, if they should get in.

This photo was taken 1st May 2008, Mongers 16 drain.
You can clearly see water in the drain already. This indicates that the groundwater level here is very close to the surface.

Fig 44: Excavation in Mongers 16

This photo was taken 14th May 2008, Mongers 16, Simpson Road culvert (for scale, the culvert diameter is 600mm)
You can see there is a substantial volume of water in the drain. As indicated by the observation bores, the groundwater in this area is less than a metre from the surface in certain places. We hope that this is a good indication of the potential for rehabilitating this land.

Fig 45: Culvert under Simpson Road, Mongers 16

Burakin

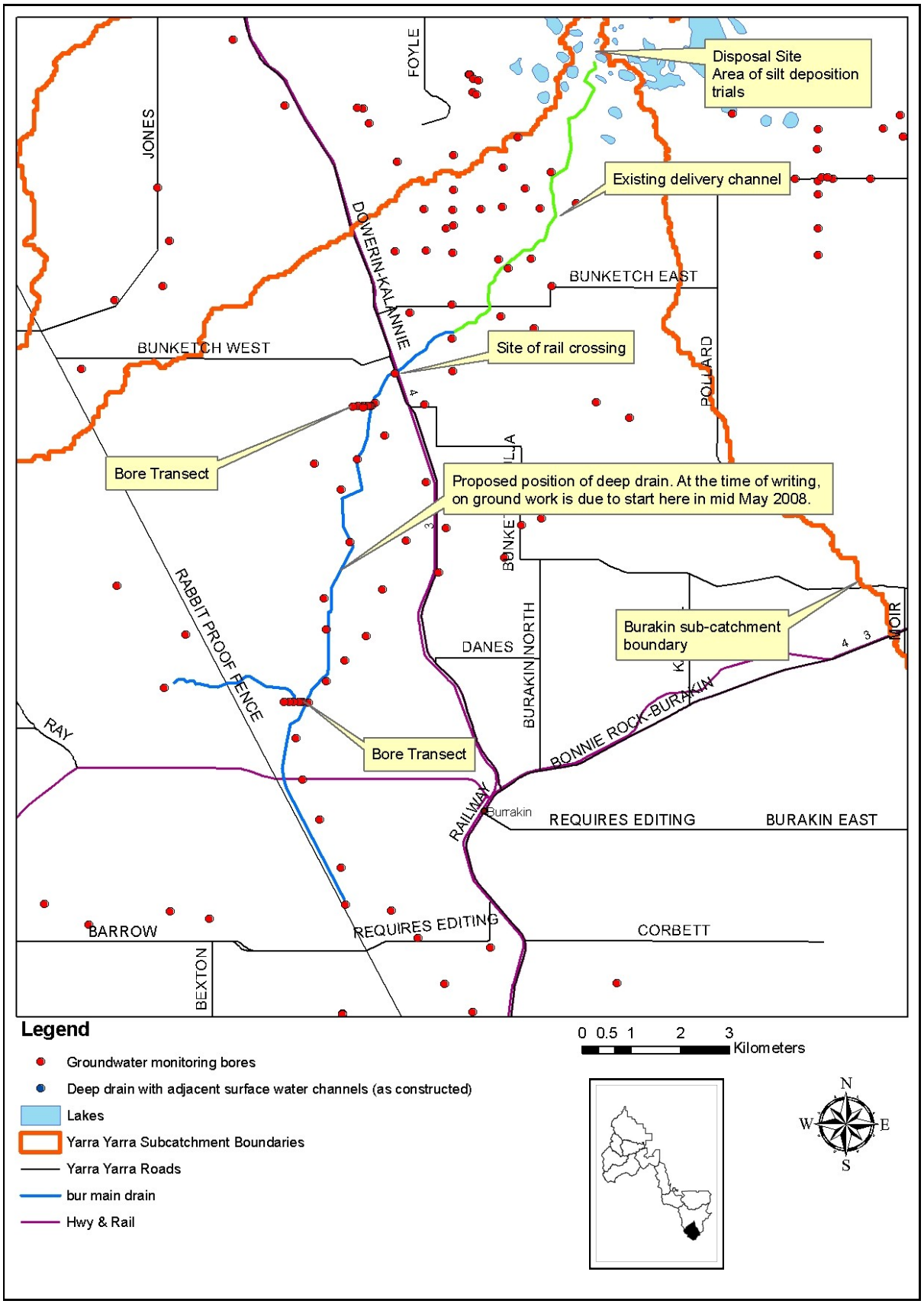


Fig 46: Burakin

Expenditure, Burakin

Burakin - Estimated time of completion for the drain, June 2008

	Length (km) (proposed)	Budgeted Cost	Best estimate at time of writing
Drain Excavation	16.5km	$323,667.00	n/a
Fencing materials	29km	$43,500.00	$50,750.00

As the on ground works have not begun in Burakin we are unable to give an accurate breakdown of the costs. The work here is estimated to start before the end of May 2008, and be completed before the 30th June 2008.

The clearing permit for the drain has recently been approved and now all of the necessary permits are in place. We are currently waiting for Westnet Rail to confirm the starting date for installing the culvert under the railway crossing. The 2.5m deep culvert will take the water from the deep drain. Until this culvert is in place, a pump will be used to move the water from on side of the railway to the other. The drain will pass under the railway at the point indicated on the map opposite. This rail crossing will be a significant cost in Burakin.

Fig 47: The site of the rail crossing, Burakin

Overview of Expenditure

Expenditure as at 20th May 2008

Catchment	Drain Cost	Wages	Operating Costs	Fencing Cost	Length of Drain (km)
Bowgada	$115, 320	$45,766	$13,320	$17,136	10.4
Merkanooka	$147,448	$105,405	$74,642	$18,763	12.8
Canna Gutha	$153,930	$18,346	$2,152	$17,942	10.7
End phase 1					**33.9**
Jibberding	$208,422	$191,345	$42,346	$25,400	11.5
Xantippe	$119,300	$38,902	$3,466	$16,000	6.7
Completed					**52.1**
Mongers 16	$251,700	$25,000	$2,500	$56,000	14.8
Burakin	$323,700	$25,000	$5,000	$50,750	16.5
To be completed					**31.3**
Estimated Total	**$1,319,820**	**$449,764**	**$143,426**	**$201,991**	**83.4**

	Budget	Actual
Grand Total	**$2,161,040**	**$2,115,001**

This leaves a surplus of **$46,039**
If we are able to carry this surplus forward to the end of the project we will make a start on the Goodlands drain which is next on the priority list.
The average cost of deep drainage calculated from the above table combining capital and operating costs is **$17,544 per km.**

Blockers and Drivers

Blockers

Hike in cost of fencing materials
Over the duration of the drain the cost of fencing materials has risen by $250 per km with further price rises imminent. This has increased the pressure on our budget.

Delays
Delays in funding due to the review and subsequent shifting of responsibilities both to the funding body NACC and the proponent YYCMG plus long delays in processing of applications set the project back by 7 months. This equates to close to an extra $170,000 in

wages that has been debited to the project or around $2,000 per km of drain dug.
The major hold-ups were 5 months with no funds received for capital works from 31st July to 31st Dec 2007. This was due to the JSC review and the apparent delays in handing over of funding responsibilities from the State NRM office to NACC.
There was also a two month delay on applications for permits, with one clearing permit taking 13 months to process (which was a permit to clear low scrub, samphire and blue bush on private property).
The stop go effect of project progression due to these delays was most disruptive to the free flow of contracts and also to access permits and quotes for works inside road and rail reserves. This resulted in permits and contracts having to be re-written and some service providers lost interest in the project. One price hike in a quote for a rail culvert was $30,000

Bowgada Drain
The Bowgada drain was the least successful of all the drains excavated. We originally nominated a mean depth of 2.1 metres for a standard deep drain but after observing the output of the Bowgada drain it was decided to increase the mean depth to 2.5 metres. This nominated depth was maintained with success for the rest of the program. However this increased the cost of the drain by $1,500 per km.
During the course of constructing the Bowgada drain, one farmer whose land was midway along the proposed line changed his mind and decided not to participate in the program. This meant that four farmers above him in the landscape were unable to proceed to get their land drained. We are working to resolve this issue as the ground water in the higher reaches of this subcatchment is very close to the surface and a lot of land has been lost with salt encroachment. Pumping the water across the undrained area may be an option.

Jibberding drain
Unfortunately while the project was delayed, the farm at the top end of the Jibberding drain was sold and the new owner did not wish to participate in the project. This resulted in the total drain being shortened by 3 km. There is severe degradation on this property with ground water levels less than 1 metre from the surface, also the homestead is at severe risk and much of the surrounding York Gum woodland has died.

Drivers

Reasonable digging
The digging of the drains to date has been good going with very little rock encountered. This has meant that the rock clause has not been invoked. This has been a big saving.

No price rise to compensate for the fuel hike
Our preferred contractor was New Holstein Pty Ltd who have been most cooperative and helpful with design and supporting us through difficult times with funding. Each drainage line was let out to tender separately and at times we have attracted up to six bidders. New Holstein's tender has remained the same since November 2007 at $8,000 per km for a 2.5m deep drain and $2,000 per km for 3m x 300mm surface drain.

Establishment of the YYCRC
During the period of construction the Yarra Yarra Catchment Regional Council was officially established and the inaugural meeting was held at the Perenjori Council Chambers in June 2007.

Drivers (cont)
The Yarra Yarra Group worked for six years promoting the transformation of catchment management from the YYCMG to the YYCRC. The YYCRC is a statutory body ensuring perpetuity, accountability and compliance to policy.

Farmer support
Out of forty farmers approached to participate in the Yarra Yarra Regional Drainage Program there were only two who declined to participate.

Extra Machines
Because of the delays to the project we have asked the contractor to bring in two extra excavators so that we can maintain our proposed finishing date for the project of the 30th of June 2008. This is still achievable.

Conclusion

Over the next month, we will finish off the excavation works in the last two subcatchments, Mongers 16 and Burakin. There is still a great deal of research and monitoring work to undertake in order to learn as much as we can about the effects of deep drainage on the landscape and to try and fill the gaps in current knowledge. It is still too early to say how successful the drains will be and this highlights the importance of continuing the monitoring and research. As the drains begin to take effect we will be able to implement the large scale revegetation program.
As Stage 1 is now drawing to a close we are looking forward to moving onto Stage 2. For further information on Stage 2, please refer to the document "Stage 2 of the Yarra Yarra Regional Drainage and Research Program" (listed below).

Further Documents

The following documents have been produced during the course of this project

- Deep Drains in The Yarra Catchment: What we've learned to date and our proposal for the future. *Dr Ian Fordyce and Max Hudson, February 2006*
- Canna Gutha Re-vegetation program. *Dr Ian Fordyce, June 2007*
- Samphire in the Yarra Yarra Region, *Dr Ian Fordyce, September 2007*
- The Yarra Yarra Three Stage Drainage Program. *Yarra Yarra Catchment Management Group, September 2007*
- Establishing Priorities for Deep Drainage in the Yarra Yarra Catchment. *Yarra Yarra Catchment Management Group, October 2007*
- Stage 2 of the Yarra Yarra Regional Drainage and Research Program. *Yarra Yarra Catchment Management Group, March 2008*
- Saltlakes in the Yarra Yarra Region, *Dr Ian Fordyce, May 2008*

If you would like copies of any of the above documents please contact Lizzie Butler at the Yarra Yarra Catchment Management Group
Tel: (08) 99731425
Mobile: 0408 934153
Email: yycmg_lizzie@westnet.com.au

Appendix

Stage 1, Phase 1 of the Yarra Yarra Regional Drainage Project, Project Schedule

Project Title:	**Yarra Yarra Drainage Proposal (Joint short term contract) for ongoing drainage proposal**
State ID Number:	**063008**
Commonwealth ID Number:	**n/a**
Sub Regional ID Number:	**n/a**

INVESTMENT DETAILS

Description (supply a brief description of the investment – max 200 words)

This joint contract between the State Natural Resource Management Office and YYCMG (Yarra Yarra Catchment Management Group) will provide funding for management and capital works for a regional drainage program in the Yarra Yarra Catchment Basin. It forms stage one of two projects
1. Yarra Yarra Drainage
2. Yarra Yarra Operations and Coordination Program For Catchment Rehabilitation

Three sub-catchments in the Yarra Yarra Catchment area have been selected to commence the first stage of on-ground works. The sub-catchments are:
Merkanooka - sub catchmet 41
Bowgada - sub catchment 4
Canna/Gutha - sub catchment 42

The YYCMG in consultation with the Department of Water have concluded there is not enough scientific information available on which to base long-term predictions on the effects of regional drainage in the Yarra Yarra Catchment Basin.

YYCMG has carried out scientific studies collecting information from previously established drains, as well as pre-existing and recently established monitoring points. Reports by Nielssen (2002,03,04) and Fordyce (2005) concluded that deep drainage is not an immediate threat to the environment in or adjacent to the Yarra Yarra lake system or to environments further downstream.

Considering this, the YYCMG has resolved to undertake a broad-scale investigation of deep drainage in the Yarra Yarra Catchment Basin. Initially 12 trial sites have been selected at regular intervals in the farmland along the edge of the Yarra Yarra lake system. The three sites selected for this project will constitute the first stage of this regional program

The Yarra Yarra Catchment Regional Council, soon to come into operation, will appoint the YYCMG as a management committee to oversee the project.

The YYCMG have successfully negotiated interim easements over land that will immediately surround the newly established drains so that satisfactory governance facilities can be put in place to protect this large investment of public funds. These easements will become legally binding documents on the formation of the Yarra Yarra Catchment Regional Council.

Funding

Year	Quarter Commencing	Scheduled Payments (GST Excl.)			
		TOTAL	NHT	NAP	NLP
2006-07	On signature	350,000	-	350,000	-
	Payment will not necessarily be made as a lump sum, payment will be made based on justification and receipt of current and agreed documentation for drains 2 & 3. *As at 6 March documentation is in the system with DAFWA – once copies of the paperwork are received and signed off payment will be made to YYCMG*	350,000	-	350,000	-
TOTAL		**700,000**	**-**	**700,000**	**-**

* Drainage construction payments will be made once drainage construction approvals including NOIs, memorandum of understanding letters from landholders and vegetation clearing approvals have been received from Yarra Yarra Catchment Management Group and copies forwarded to NACC for their confirmation and the SNRMO. See project details appendix 1

** The total funding approved by State & Australian Government Ministers for the Yarra Yarra Drain Proposal is **$2,161,040** (2006-07 - $1,327,000 and 2007-08 - $834,040). The current schedule is for $700,000 to enable the YYCMG to start the excavation process for the first three drains (Phase 1). A separate contract will be drawn up for Phase 2 for the period mid April to 30 June 2008 – details to be confirmed but the $'s will be $627,000. The remaining funding $834,040 is to be built back into the NACC IP Program for Drainage and Engineering (05N1-15).

Funding Stream (one only): NAP Project **(part of Regional Investment - National Action Plan)**

Financial Year in which Project to commence: **2006-07**

Project Duration

Project Start Date: 1 November 2006

Project Completion Date: 16 April 2007 for completion of Bowgada and Merkanooka drains and the commencement of the Canna Gutha drain, variation to be requested for ongoing funding subject to agreement with the SNRMO, Australian Government and NACC

Stage 1, Phase 2 of the Yarra Yarra Regional Drainage Project, Project Schedule (Capital Works)

Item 6 Project Schedule

Project Title:	Yarra Yarra Drainage Phase 2 – Drainage Construction and Monitoring
Regional ID Number:	05N115-02
Sub Regional ID Number:	_____

INVESTMENT DETAILS

Description (supply a brief description of the investment – max 200 words)

This project will provide funds for phase 2 of Stage 1 one of the Yarra Yarra Drainage Program. This is construction of the:

1. Jibberding levied deep drains with associated culverts and surface drains (13 kms)
2. Xantippe levied deep drain with associated culverts and surface drains (7 kms)
3. Burakin levied deep drain with associated culverts and surface drains (16.5 kms)
4. Mongers 16 levied deep drain with associated culverts and surface drains (16.3 kms)

and related road and rail culverts for the above four drains.

The project will also fund fencing for the Merkanooka, Canna Gutha, Jibberding, Xantippe, Burakin and Mongers 16 drains, as well as the Merkanooka Drain - Culvert under Mingenew /Morawa road MRD, plus drainage performance monitoring infrastructure and equipment.

Funding

Year	Quarter Commencing	Scheduled Payments (GST Excl.)			
		TOTAL	NHT	NAP	NLP
2007-08	On Signature	$316,825		$316,825	
	Jibberding final payment of 20 % upon drain completion	$42,200		$42,200	
	1 January 2008	$453,956		$453,956	
	Xantippe final payment of 20 % upon drain completion	19,200		19,200	
	1 April 2008	$202,020		$202,020	
	Burakin final payment of 20 % upon drain completion	56,574		56,574	
	Mongers 16 final payment of 20 % upon drain completion	43,680		43,680	
TOTAL		$1,134,455		$1,134,455	

Stage 1, Phase 2 of the Yarra Yarra Regional Drainage Project, Project Schedule (Salaries)

Project Title: Salaries phase 2 Stage 1 Yarra Yarra Regional Drainage

Regional ID Number: _____

Sub Regional ID Number: _____

INVESTMENT DETAILS

Description (supply a brief description of the investment – max 200 words)

The Yarra Yarra Catchment Regional Council have been allocated funds to implement a regional drainage program establishing 100 km of deep drains in the current financial year. They are also developing plans to implement a further 129 kms of deep drains in the year 2008/2009. Furthermore the YY Regional Council will establish a form of governance within a statutory body to efficiently manage these operations.

This application, if successful, will provide funds for the appropriate staff to achieve these ends.

Funding

Year	Quarter Commencing	Scheduled Payments (GST Excl.)			
		TOTAL	NHT	NAP	NLP
2006-07	1 July 2006				
	1 October 2006				
	1 January 2007				
	1 April 2007				
2007-08	1 July 2007				
	1 October 2007	**32,370**		**32,370**	
	1 January 2008	**97,107**		**97,107**	
	1 April 2008	**97,108**		**97,108**	
TOTAL		**226,585**		**226,585**	

Delete years if necessary

Project Duration

Project Start Date: 1st Dec 2007

Project Completion Date: 30th June 2008