DEEP DRAINS
in the Yarra Yarra catchment:

what we've learned to date and

our proposal for the future

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Prepared for NACC by the Yarra Yarra Catchment Management Group

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List of Contents

List of Figures

Tables

SUMMARY

This report describes the experience of the Yarra Yarra Catchment Management Group (YYCMG) with the drain network constructed between May and August 2006 in subcatchment MU55. The local monitoring system is described and results are discussed in terms of expectations and assumptions in earlier reports. YYCMG has previously proposed a number of drains throughout the Yarra Yarra catchment. Further details are provided here of location, design and intent for 12 experimental drains.

Important drainage issues for which predictions are currently unreliable include groundwater draw-down, area of influence, environmental impacts, water quality, required soil amendments, and the best path to recovered productivity. By closely monitoring and documenting the physical and biological environment, costs of construction and maintenance, and the recovery of productive land, our proposed program is intended to reduce that uncertainty. In this sense, it continues the work and spirit of the Engineering Evaluation Initiative.

Overall, the MU55 experience supports the assumption of an average 300 m draw-down, with the proviso that some small parts of the landscape with particularly clayey soils may be slow to respond to drainage and might need soil amendments. Water from the MU55 drain discharges into a small, samphire-fringed saltlake, with overflow continuing to Mongers Lake. Detailed studies of downstream vegetation, water quality, and the geochemistry and mineralogy of sediments in the discharge environment have not detected any deleterious impact of the drain. Monitoring is continuing.

1. INTRODUCTION

Drainage in the Yarra Yarra catchment (Basin 618 in the Southwest Drainage Division) is internal. There are no permanent waterbodies. Intermittent surface runoff makes its way along streamlines in some 60 subcatchments to a chain of ephemeral saltlakes. Some of these lakes, like the 60km-long Mongers Lake, are clear landscape features; in other parts of the chain, such as the 40 km section between Morawa and Three Springs, there is a broad expanse of depressions and saline flats, loosely connected in flood times by poorly defined migrating channels.

The entire lake system extends about 300 km from saline wetlands near Kalannie to Yarra Yarra Lake near Carnamah. The fall along this length is only about 40 m, which gives an average gradient of 0.013%. There is a weak connection downstream with the Moore River system, but this appears to be confined to a deep aquifer in the palaeochannel. No continuous flow of surface water has been reported in historical times.

From a landcare perspective, the problem is that many of the streamlines, which should be conducting water across the landscape, are blocked. Instead of discharging to the saltlake chain, runoff is being ponded along valley floors, and in lower- and mid-slope depressions. Because there is little deep-rooted vegetation to take up and transpire this water, it seeps down through salty horizons in the subsoil, and causes the groundwater table to rise. Wherever this groundwater comes to within a metre or two of the surface, crops and remnant vegetation are severely affected. Only a few specialist plants, such as saltbush and samphire, are able to tolerate this combination of waterlogging and salinity. Many valley floors, which once supported native vegetation or productive farmland, have now been abandoned as samphire flats or salt scalds (Figs 1 and 2).

Fig. 1 Samphire Flat

Fig. 2 Salt Scald

Eventually, if nothing is done to relieve the problem, agriculture will be confined to topographic highs. The only native vegetation to survive, apart from the tolerant communities, will be the upland shublands. Tall eucalypt woodlands might remain at a few mid-slope locations, but they will almost certainly be under intense pressure.

The proposal by the Yarra Yarra Catchment Management Group (YYCMG) is to rehabilitate the major streamlines by excavating deep drains or by de-silting existing channels. The newly excavated banks or levees would be revegetated with herbs and low shrubs. This entire earthworks complex would then become the axis of a bushland corridor – nominally 100 m wide but, after negotiations with the landowner, considerably wider than that on uncropped samphire flats and somewhat narrower across productive paddocks.

Most importantly, a governance system will be established to manage the drains in perpetuity. This will involve a rigorous schedule of monitoring and maintenance.

2. LOCATION

The location of the Yarra Yarra catchment within the Northern Agricultural Region (NAR) is shown in Fig. 3. Figure 4 shows the position of the Mongers 55 drain within the Yarra Yarra region. The location of the drain and bores discussed in this report are shown in Fig. 5. Bore transects and flume positions are shown in Fig. 6.

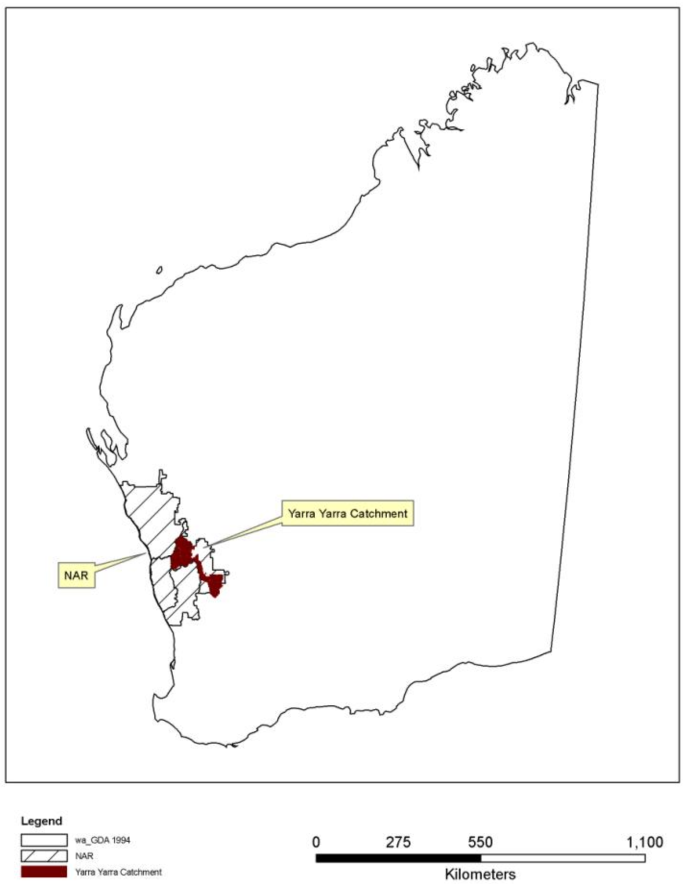


Fig. 3 Location of Yarra Yarra Sub-region within the Northern Agricultural Region.

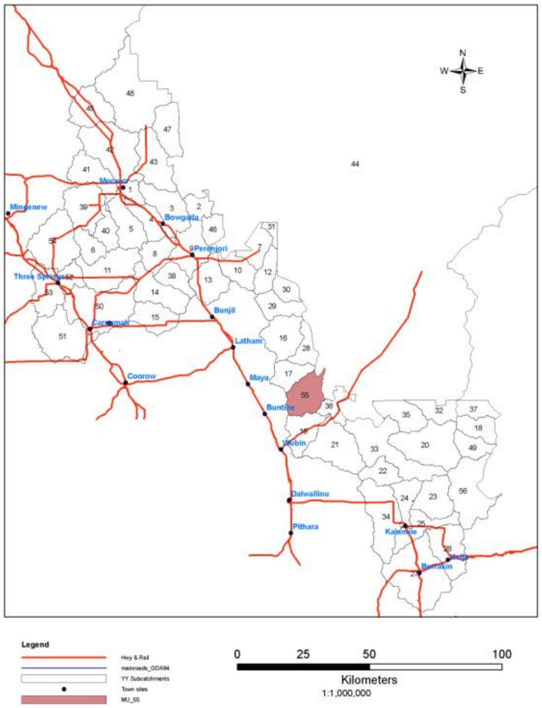


Fig. 4 Location of Sub-catchment MU55 within the Yarra Yarra Catchment.

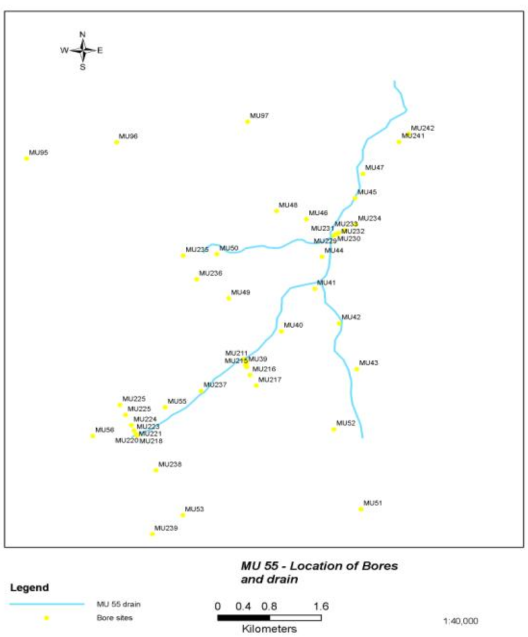


Fig. 5 MU55
Locations of bores and drain

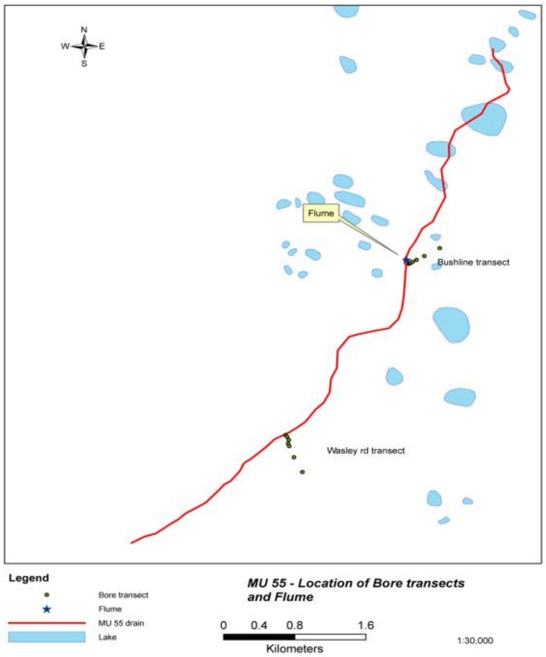


Fig. 6 Location of bore transects and flume

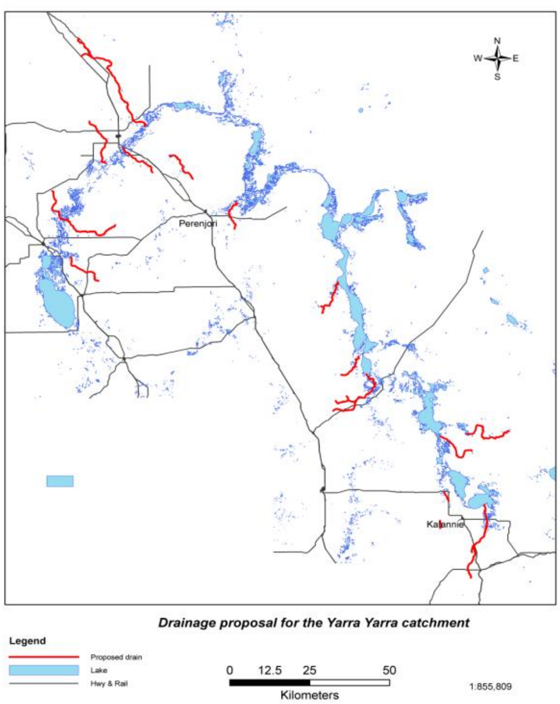


Fig. 7 Location of proposed drains.

3. DESCRIPTION

The YYCMG's design is a double-leveed open drain, flanked by shallow, surface-water drains on either side (see Fig. 8), until the final discharge zone (a saltlake or a clay-bottomed playa). Groundwater is confined to the deep drain itself. It is separated from surface water by the spoil-heap levees and by an intricate system of cross-overs and pipes.

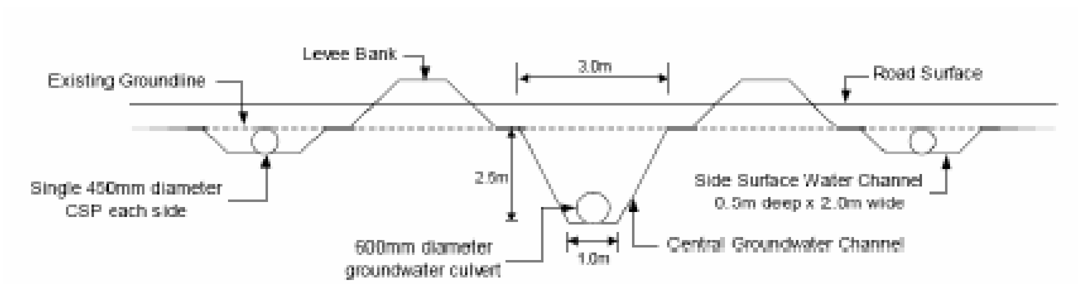


Fig. 8 Drain Cross-section.

Two situations— a road crossing and the junction of two drains— are shown schematically in Figs 9 and 10

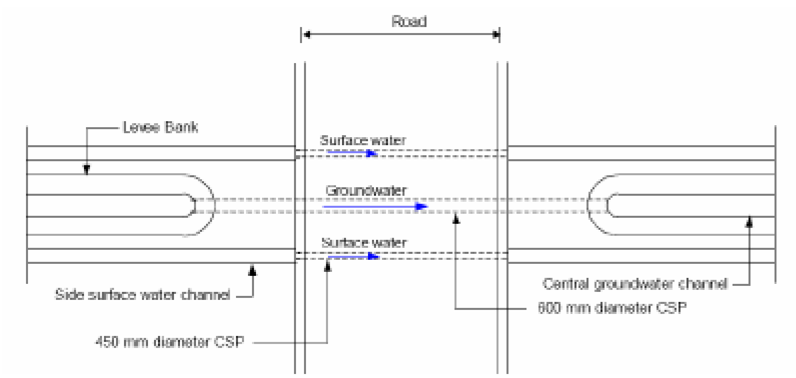


Fig 9 Road Crossing.

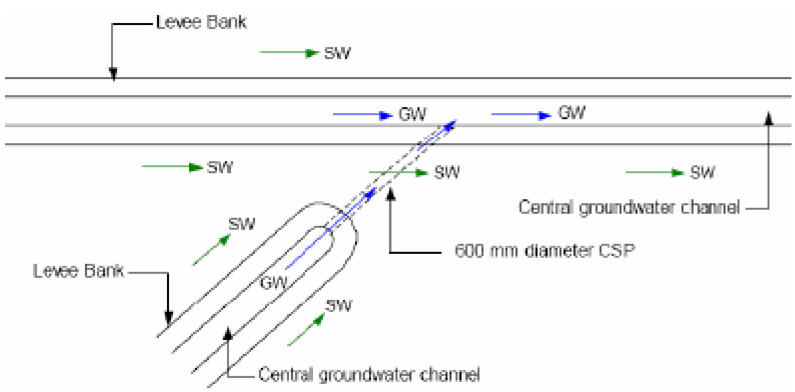


Fig. 10 Drain Junction

This system of separating groundwater form surface water has the following advantages:

• Peak flows after storms are reduced, which means that there is less erosion and decreased maintenance requirements.

• Road crossings, which are an expensive component of drain construction, do not need to be so elaborate.

• Groundwater is likely to be hypersaline and might also become acidic and moderately toxic. If a requirement develops for pre-disposal treatment, then it would be easier to deal with a discrete and steady flow.
• Surface water, which is relatively fresh, can be redirected as required to revegetation plantings on the valley floor.

A further difference from conventional farm drains is that the levees are not simple spoil heaps but are robust structures designed to act as dam walls in flood events. They are compressed with excavator track and wide enough on top to be drivable. In addition, topsoil is draped over the levee so that a stabilising cover of herbs and small shrubs can be established quickly.

4. COST – BENEFIT ANALYSIS

Much of this section has been paraphrased, and some sentences have been lifted whole, from the GHD Draft Final Report to the Department of Water, 'Yarra Yarra Catchment Regional Drainage and Water Management Evaluation', Oct. 2006.

The consulting company ACIL Tasman carried out a comparative benefit-cost analysis (BCA) for salinity-management options in the Yarra Yarra catchment, including YYCMG's deep-drain design used at MU55. Of the six options examined, variants of this design were stand-out winners over groundwater pumping bores and revegetation. Unfortunately, environmental benefits of bush corridors were not assigned an economic value, and were not considered in BCA calculations.

The BCA was based on a number of simplifying assumptions, which were then examined in more detail in a Sensitivity Analysis (Table 1).

Table 1 Key BCA Sensitivity Analysis Variables

Variable	Value
farming system	barley – wheat
	barley – wheat – wheat
gross margins	wheat = $93.49/ha
	barley = $135.17/ha
land recovery	80%
	90%
	100%
draw-down	50 m
	200 m
	300 m
	400 m
	800 m
road and rail maintenance costs	+ 20%
	- 20%
discount rate	5%
	6%
	7%

The variables most sensitive to change are draw-down, land recovery and gross margins. Although changing the value of these variables one at a time changed the calculated BCA figure, the overall ranking of the options remained the same. In other words, the drainage options were still considered economically superior to groundwater pumping or revegetation, even in the most pessimistic scenario (Tables 2 and 3).

Table 2 Optimistic vs Pessimistic Assumptions

Variable	Pessimistic Value	Standard Model	Optimistic Value
draw-down	50 m	300 m	800 m
land recovery	80%	90%	100%
farming system	barley - wheat	barley - wheat	barley – wheat - wheat

Table 3 Optimistic vs Pessimistic Benefit–Cost (B-C) Ratios

Option	Pessimistic B-C Ratio	Standard Model	Optimistic B-C Ratio
Option 1a (deep drain with vegetation corridor)	0.42	1.55	2.27
Option 1b (deep drain without vegetation corridor)	0.50	2.04	3.37

5. GOVERNANCE ISSUES

POINTS TO CONSIDER

As a Sub region we recognize the advantages of working under the umbrella of a coordinating regional body such as NACC. We recognize this as part of the democratic process that leads to grass roots input to policy development.

1. The Yarra Yarra Catchment Group was established in 1997 with associated management Committee and sub committees to manage the lake systems and their surrounds that lie within the established clearing line. We have established an office complex at Perenjori and a branch office at Kalannie.

2. We have conducted a four-year evaluation of the status of the streamlines and the ecology of the system.

3. We have identified the drainage system and its long narrow configuration and the fact that it is virtually land locked.

4. We have found that the natural environment is fair condition. However the ground water build up in the valley floors needs to be released before surface water control in the higher reaches of the catchment can be completely effective.

5. We have identified that the system is made up of a multitude of small catchments which either discharge directly into the lake system or are inter connected to other small catchments that in turn discharge into the lake system. This is a distinct management advantage as the lakes and associated wet lands provide an enormous evaporative area (around 250,000 hectares) greatly minimizing any detrimental downstream effects. Also the average area of run off for each sub catchment is around 18,000 hectares which augurs well for sustainable management as each sub catchment can be assessed and managed at its own level.

We have amalgamated these minor sub catchments into 11 management Zones of a workable size and engage the community at this level. Elected representatives from the Zones make up the basis of the Yarra Yarra Sub Regional management Committee. Two members of the Yarra Yarra committee are elected to represent the sub region on the Regional Northern Agricultural Catchments Council.

The whole of the management and administrative structure revolves around the Zone configuration.

6. During a series of Zone workshops farmers indicated that they are happy with the concept of locally established drainage in the appropriate places for the appropriate reasons and support a large scale regional drainage initiative that will progressively address all drainage problems. Eighty two (82) farmers have expressed their willingness to participate in the regional drainage initiative, nominating 551 km of earthworks to be implemented

7. In support of this the Yarra Yarra have embarked on such a large scale regional drainage initiative that will progressively rehabilitate 600 km of natural water ways which will protect the landscape and assets within each Zone

8. We recognise that all those who live and work in a catchment system should be responsible for the management of that system. It is therefore imperative that all management boundaries should be aligned to catchment boundaries, even at Regional level

9. We also recognise that if the community is to accept the responsibility of management then they need to have ownership of that process and all stakeholders need to be involved.

10. It is essential having established the process that it remains in perpetuity. The establishment of a Regional Organization of Councils is a way of achieving that aim.

The Report on “A Management Framework for Drainage in the Wheatbelt” states that “the preferred option for large scale drainage projects in the wheatbelt is a partnership **Department of Water/ Licensed Local government** model. This begs the question, preferred by who? Certainly not the developers of the Yarra Yarra model.

The imposition of NRM management directly onto Shire Councils is fraught with danger as traditionally Shire Councils have not become directly involved in these activities and do not have the background or expertise to manage catchments. Also Shire Councils are suspicious and consider this an exercise in cost shifting.

For this reason the Yarra Yarra have established a “bottom up” process through Sub Catchments onto Zones onto an LCD committee and then liaising with the Regional Local Government to form policy and establish projects which will be funded in the traditional way.

The activation of other various acts related to drainage legislation through the current local government system is available but not workable because this involves individual Shires making decisions on areas that may not be completely within their boundaries. Local Government boundaries are in no way related to Catchment boundaries, where as the boundaries of a Regional Local Government are established for the specific purpose of Catchment Management and follow catchment boundaries in accordance with the registered deposited map.

Also the establishment of a Sub Regional Land Conservation District (LCD) would be a means of involving Government creating a link through a Commissioners Nominee on the management committee. LCDs can be used to promote a democratic process, which incorporates NRM concepts through close interaction with the stakeholders.

The original development of land conservation districts has set the foundation for the Community involvement and awareness of Natural Resource Management Inadvertently Government agencies promoting hollow promises and the imposition of bureaucratic standards have emasculated and disillusioned the catchment communities resulting in a wide spread break down in the system, The introduction of a local governing body run by Shire Councilors elected from within the catchment will revitalize the connection between the community and Governmental processes. We understand that in the process of establishing best practice that we need to adhere to Government Policy.

11. The LCD boundary will provide a common boundary for the establishment of the Regional Local Government (RLG). The LCD will also provide an avenue to strike a rate to support the administration of the RLG (or drainage board)

During the early part 2003 presentations were delivered to all of the seven shires in the Sub region promoting the creation of a Regional Local Government (RLG) as well as the amalgamation of the LCDs within the boundaries as well as to manage shire land in the Yarra Yarra.

These presentations culminated in a combined meeting of shires in April 2003 that resolved to set up a statutory body for the sole purpose of managing NRM in the Sub Region. It was resolved that a working group should be appointed by the Yarra Yarra to prepare an establishment document.

12. An establishment document has been drafted and submitted to the department of Local Govt. and Regional Development for approval. The working group elected to prepare the establishment document recommends that the RLG or Drainage Board on appointment should be authorized to appoint the Yarra Yarra Catchment Group (or similar democratic group representing the Zones) as the implementation Committee. This committee would develop projects to be submitted to the Board for approval for implementation. It is further recommended that this committee should apply to the Commissioner for Soil and

Land Conservation to assume the status of a Land Conservation District Committee.

We have found that the collection of Geographical and biological information in a digital form is a very effective way of engaging catchment communities at local level. The development of our own “Catchman” Software has provided us with source of income which targets state and national markets as well as providing a tool to develop our own data sets to help in decision making,.

We have established data bases relating to all monitoring done. Monitoring data is also recorded on the Digital Geographical Information System. Data sets are being developed using standardised templates so data collected from the Sub regions using our software will be compatible throughout the region.

6. MONITORING SCHEDULE

The following monitoring is being carried out at MU55. Similar systems are being set up for the first stage of drains at Bowgada, Merkanooka and Canna-Gutha. In addition, aquatic invertebrates and microflora will be surveyed this winter in discharge areas, as well as in undisturbed wetlands in the Yarra Yarra saltlake chain. This has been identified as a major gap in our understanding of the system.

Groundwater flow – stainless-steel flume inserted in drain (near outlet); water level logged hourly to calculate flow rate and discharge volume.

Surface-water flow – surface flow channelled and gauging station installed near discharge point to measure runoff from entire catchment.

Groundwater level – at least three transects of six observation bores (spaced at 10, 20, 50, 100, 200, 400 m); 2-5 control bores; depth measurements for at least three months before drain construction, then at two-day intervals for the initial fortnight after drain construction (or until rate of fall slows), then weekly for about a month, then at two-week intervals for about three months, and finally monthly; at least one bore per transect fitted with gauge and depth logged hourly for entire monitoring period.

Groundwater quality – initial sample set from bores, then from drain (at fixed collection points) at two-monthly intervals; *in situ* pH, EC and Eh; sampling protocol consistent with Acid Groundwater research project; samples analysed at CSIRO Land & Water labs in Adelaide (Dr Rob FitzPatrick).

- Major anions
- Acidity/alkalinity
- ICP-MS suite of metals
- Rare earths
- Radioelements

Weather – daily rainfall from gauge at local farmhouse; pan evaporation from modelled estimate; temperature from nearest official weather station.

Soil salinity – 1:5 extract from shallow auger holes along existing observation-bore transects; sampled before drain and afterwards at six-monthly intervals.

Crop productivity – trial strips/plots, using combination of crop and pasture; normal seeding-growth-harvest cycle.

Gross impacts – at least six photoreference points; photos at six-monthly intervals (spring and autumn).

Downstream impacts – at and near discharge wetland; monitored at six-monthly or yearly intervals (depending on subjective impression of change)

- Chemistry of discharge sediment (as for 'water quality' above)
- Chemistry of discharge water (as above)
- Photoreference points
- Fixed belt-transects for terrestrial vegetation

Drain precipitates – mineralogy and geochemistry; opportunistic sampling; analysis at Uni of SA and UWA.

The Engineering Evaluation Initiative has made available special funding for some of this monitoring work. A substantial part of existing funds is devoted to monitoring work. Additional funding will be sought from other sources for future drains.

7. OBSERVATIONS AT MU55

7.1 Groundwater levels

An important parameter in determining the economic performance of a drain is the groundwater draw-down i.e. the maximum distance from a drain at which he drain influences the height of the watertable. At MU55, the draw-down is uncertain because watertables are still falling in response to the drain, as well as in response to the lack of rain.

The hydrograph for bore MU50, near Russell and Jan MacPhersons homestead, shows a steadily plunging watertable since excavation of the nearest drain. (Fig. 11) The watertable at MU46 is also falling (i.e. becoming deeper), probably more as a reflection of regional groundwater levels than because of the influence of a distant drain (Fig. 12).

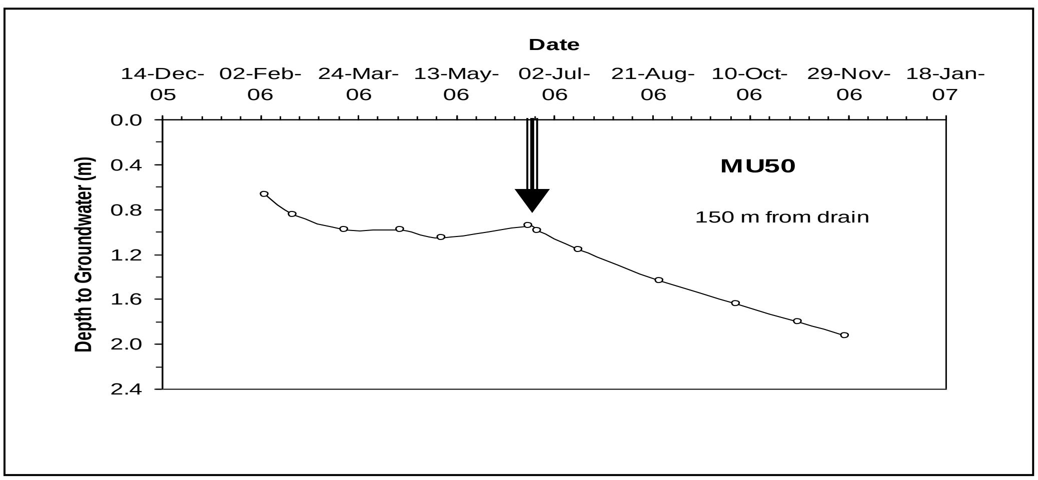


Fig. 11 Hydrograph for observation bore MU50. Arrow indicates the date of drain excavation.

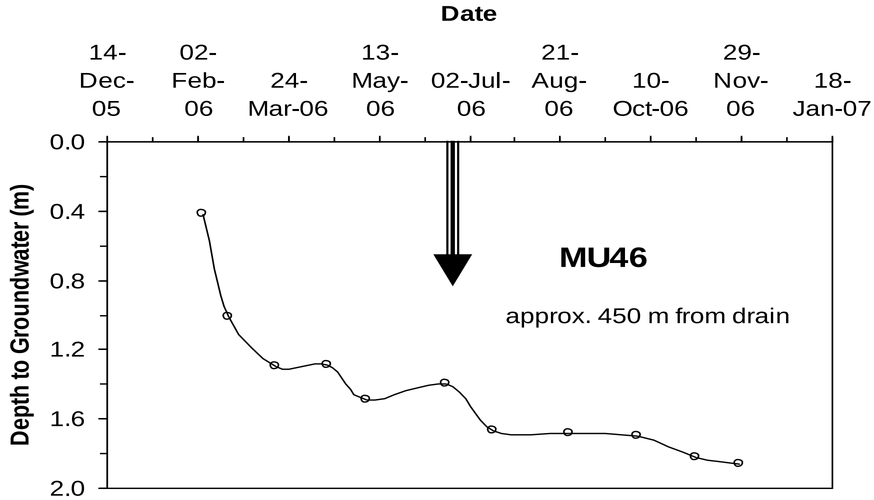


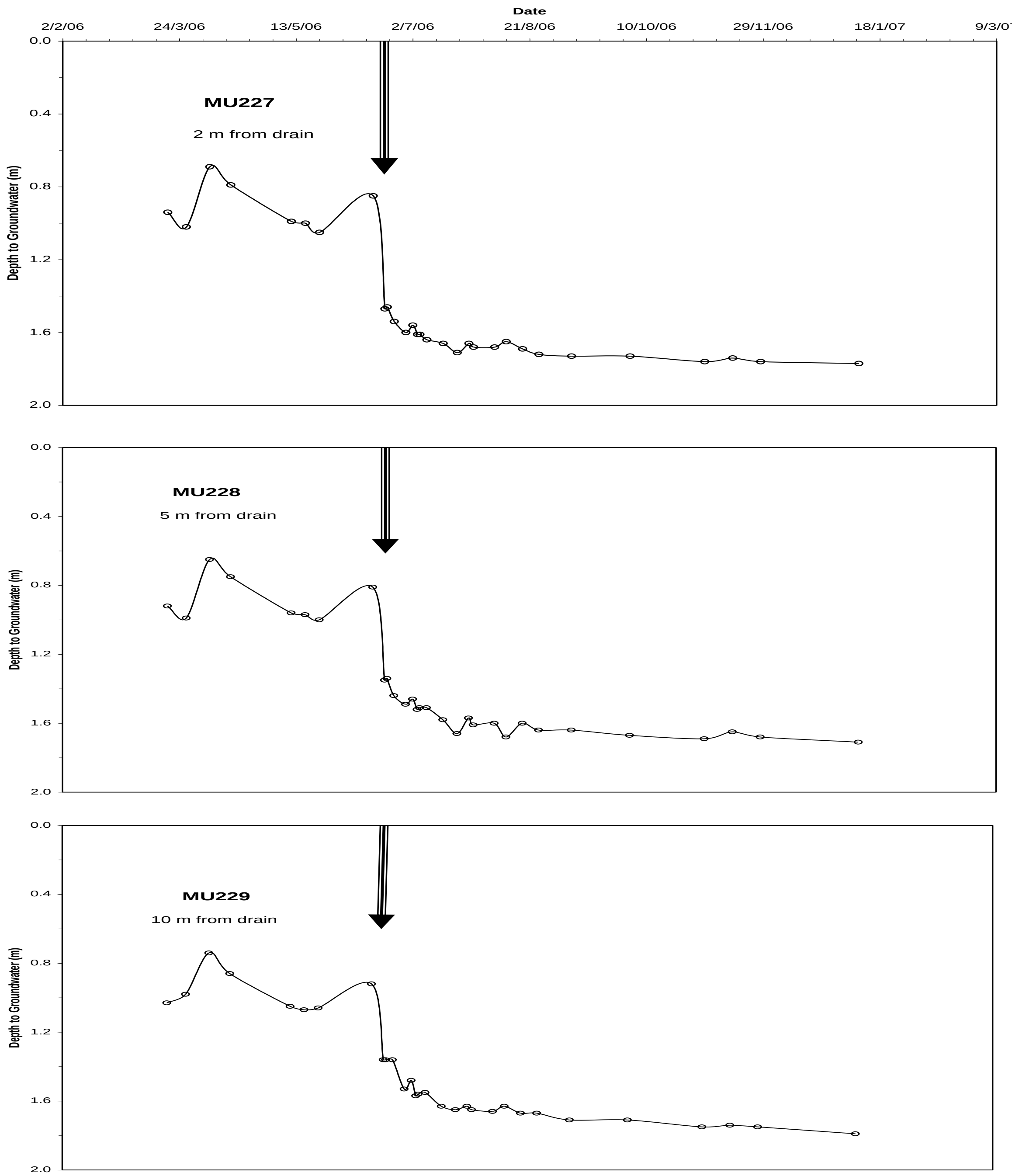
Fig. 12 Hydrograph for observation bore MU46. Arrow indicates the date of excavation.

At the 'Bushline' transect (Fig. 13), bores close to the drain showed an almost immediate response to the drain (Figs 4a-e), then level out after the initial few weeks. Beyond about 100m, however, the hydrographs show a different pattern. There is no immediate response to drain excavation, but the watertable falls consistently and continues to fall (Figs 14g,h). The observation bore MU232, at 100m, shows elements of both patterns (Fig. 14f)

Fig. 13 'Bushline' transect or paired observation bores and piezometers a

b

c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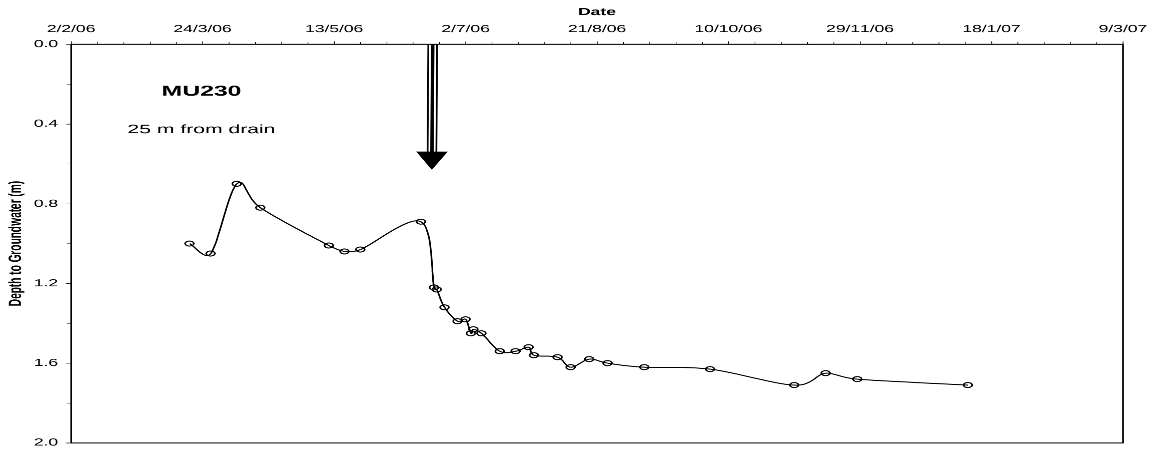
2/2/06
24/3/06
13/5/06
2/7/06
21/8/06
10/10/06
29/11/06
18/1/07
9/3/07
Depth to Groundwater (m)
0.0
0.4
0.8
1.2
1.6
2.0
MU227
2 m from drain
MU228
5 m from drain
MU229
10 m from drain

d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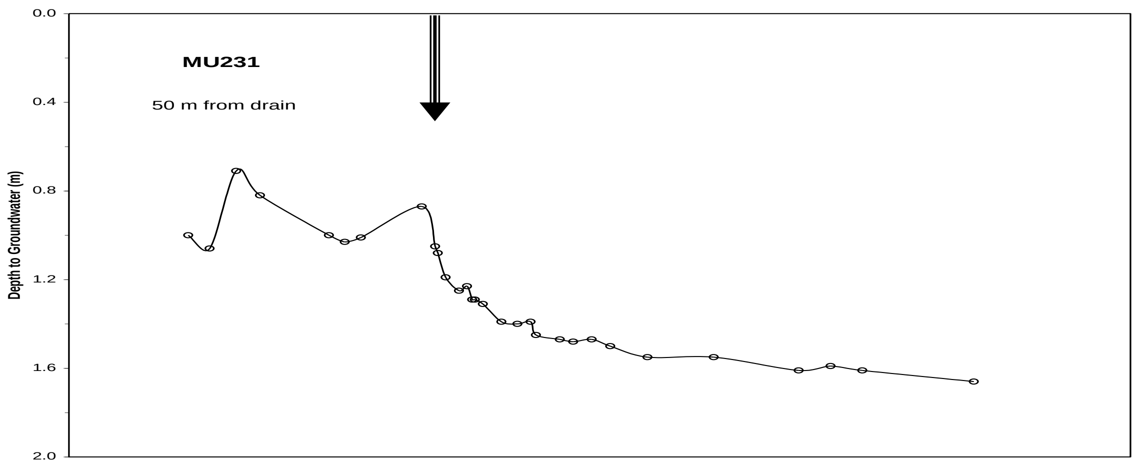
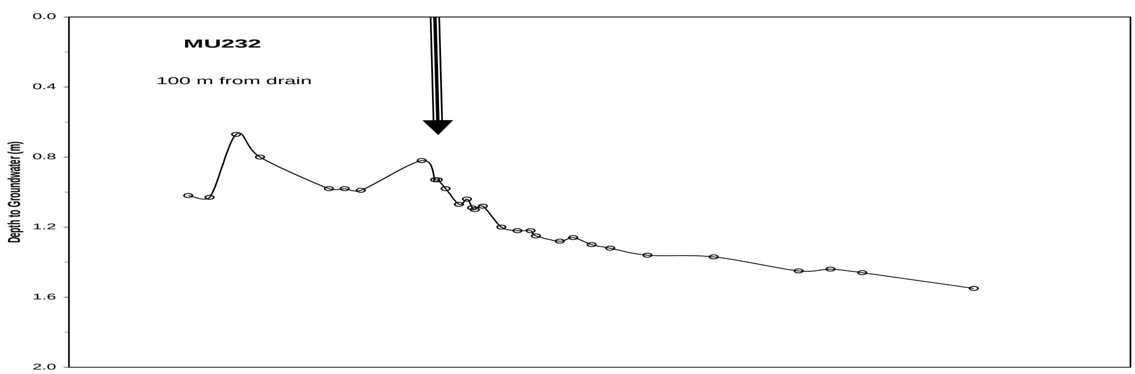
21/8/06
10/10/06
29/11/06
18/1/07
9/3/07
0.0
0.4
0.8
1.2
1.6
2.0
Depth to Groundwater (m)
MU230
25 m from drain

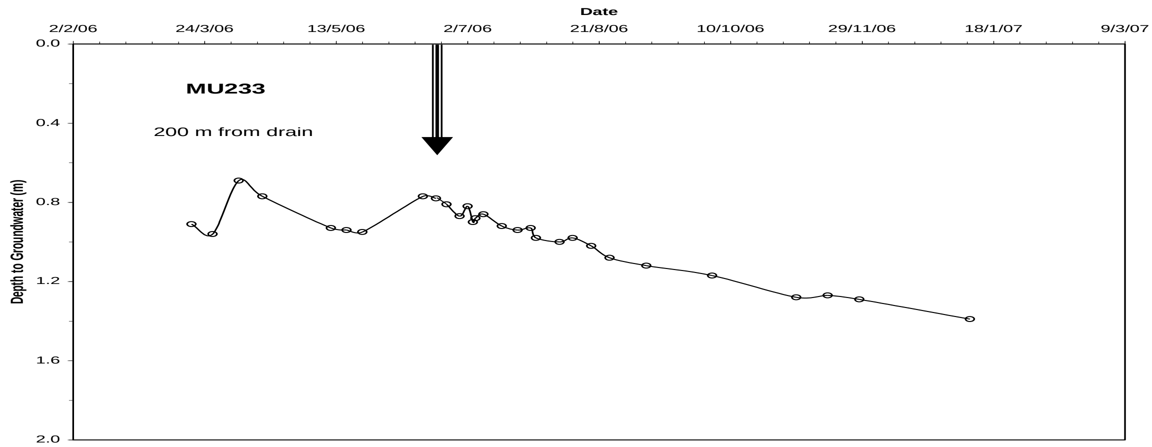
e


0.0
0.4
0.8
1.2
1.6
2.0
Depth to Groundwater (m)
MU231
50 m from drain

f


0.0
0.4
0.8
1.2
1.6
2.0
Depth to Groundwater (m)
MU232
100 m from drain

g



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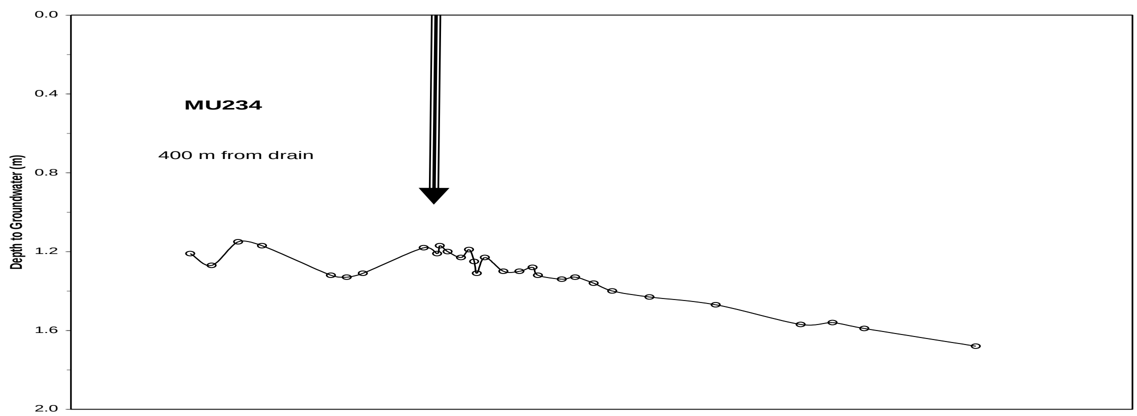


Fig. 14a-h Hydrographs from ‘Bushline’ transect.

So where does the drains influence end? For the ‘Bushline’ transect, there is no clear end because the groundwater table, even out at the eastern end of the transect, has not yet reached an equilibrium level. The arbitrarily cut off situation on January 9th 2007 is shown in Fig 15.

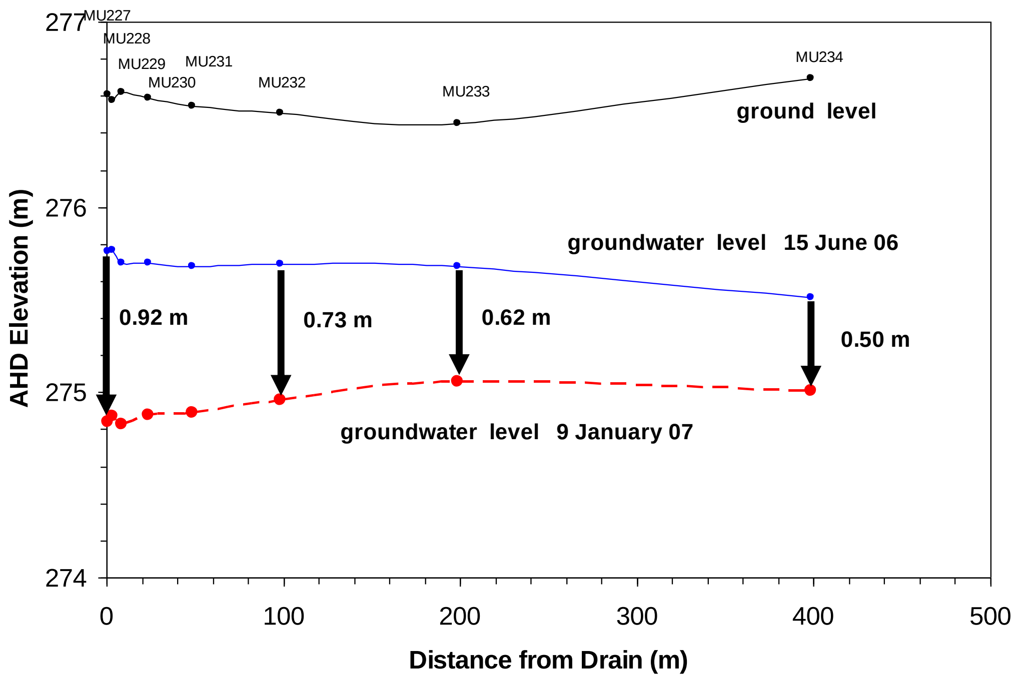
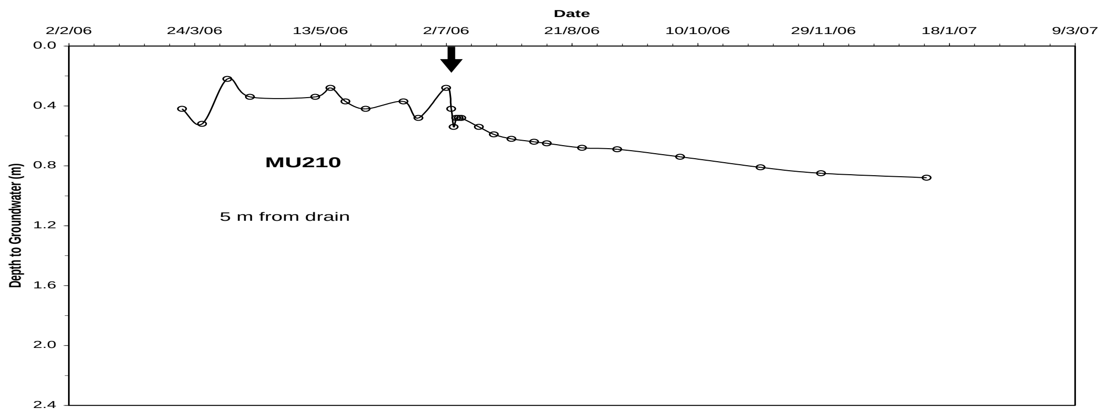


Fig. 15. Cross section of the 'Bushline' transect of monitoring bores showing the fall in groundwater levels since drain excavation. Note vertical exaggeration.

At the 'Wasley Road' transect, there is no clear sign from the hydrographs that the drain is exerting any influence beyond about 30 m (Figs 16a-h). Again there is the problem of no adequate control but, if MU217 is used to represent the regional fall, then there is a suggestion of groundwater levels out to about 150 m falling faster than the regional trend.

The 'Wasley Road' site occupies a plug of particularly clayey soil. Apparently it used to support, before clearing, a stunted melaleuca scrub, and the streamline itself was never cropped. There were none of the wild fluctuations in water level seen in the 'Bushline' hydrographs, in response to summer rain (early 2006, Figs 16a-h), so it is apparent that water movement is very sluggish. There is a case here for deep-ripping and applying gypsum, but the landowner is unwilling to invest in what he regards as unworthy land.

a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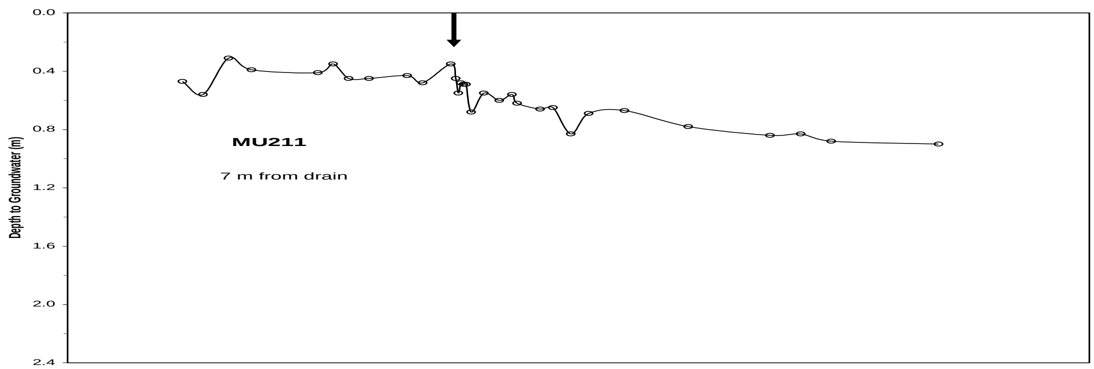
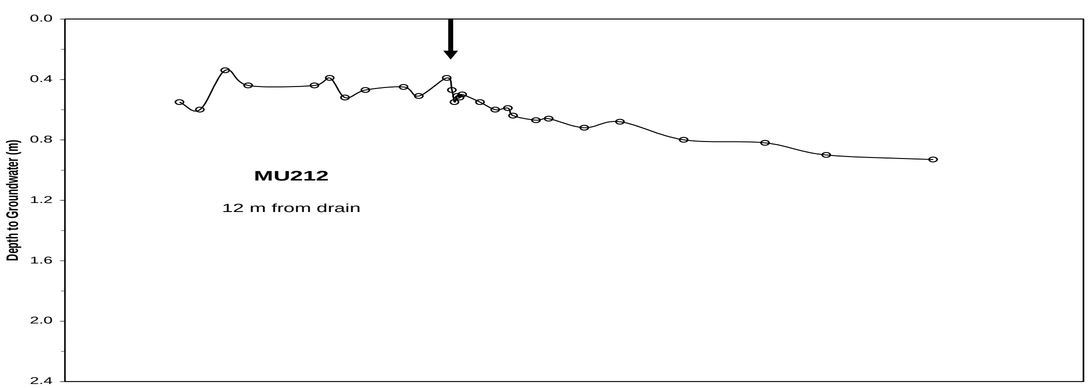
10/10/06
29/11/06
18/1/07
9/3/07
0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU210
5 m from drain

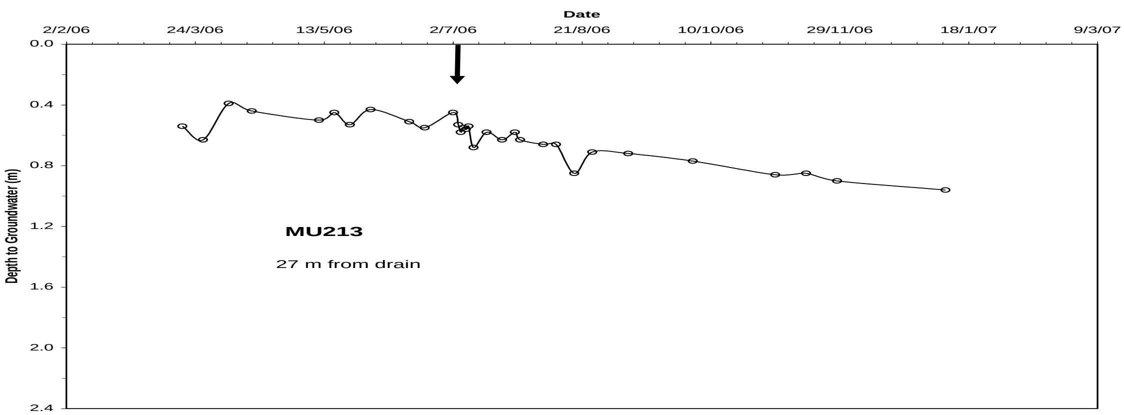
b


0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU211
7 m from drain

c


0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU212
12 m from drain

d


Date
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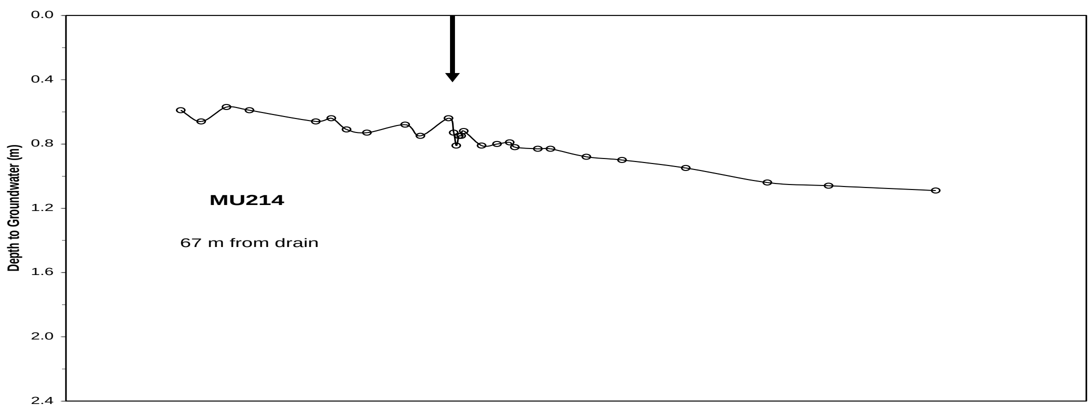
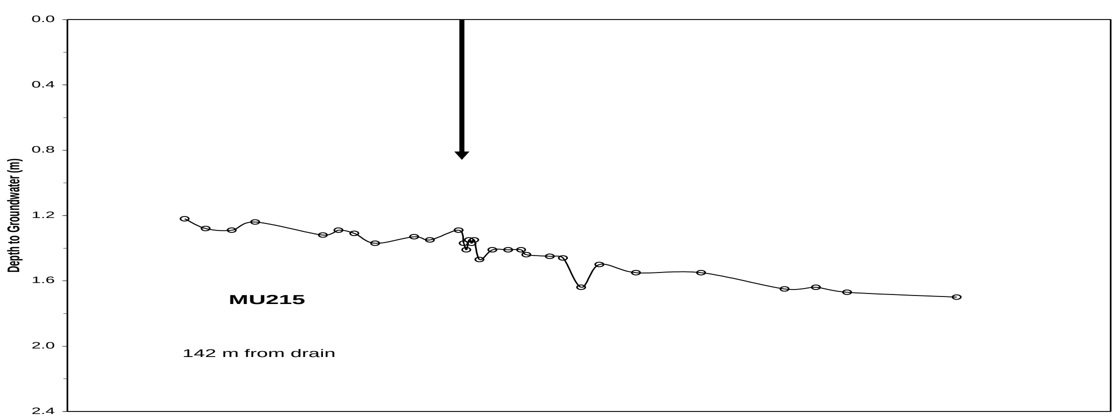
24/3/06
13/5/06
2/7/06
21/8/06
10/10/06
29/11/06
18/1/07
9/3/07
0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU213
27 m from drain

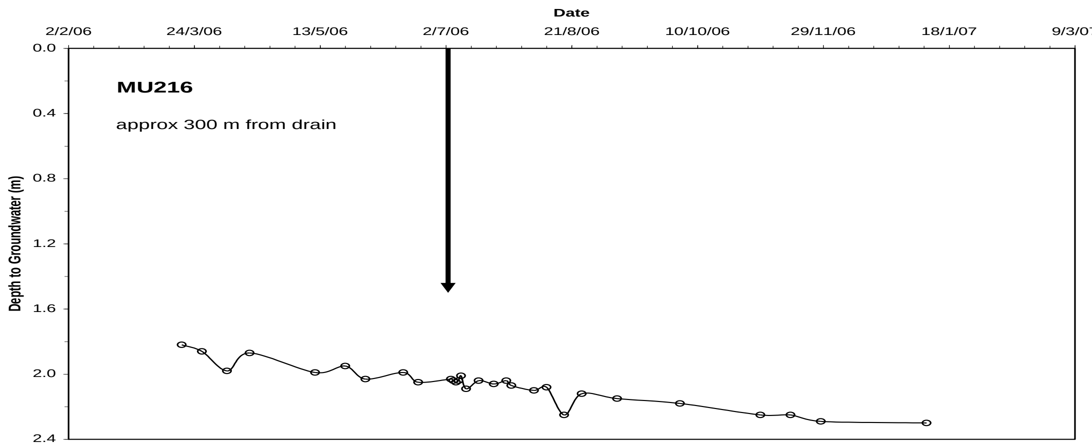
e


0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU214
67 m from drain

f


0.0
0.4
0.8
1.2
1.6
2.0
2.4
Depth to Groundwater (m)
MU215
142 m from drain

g



h

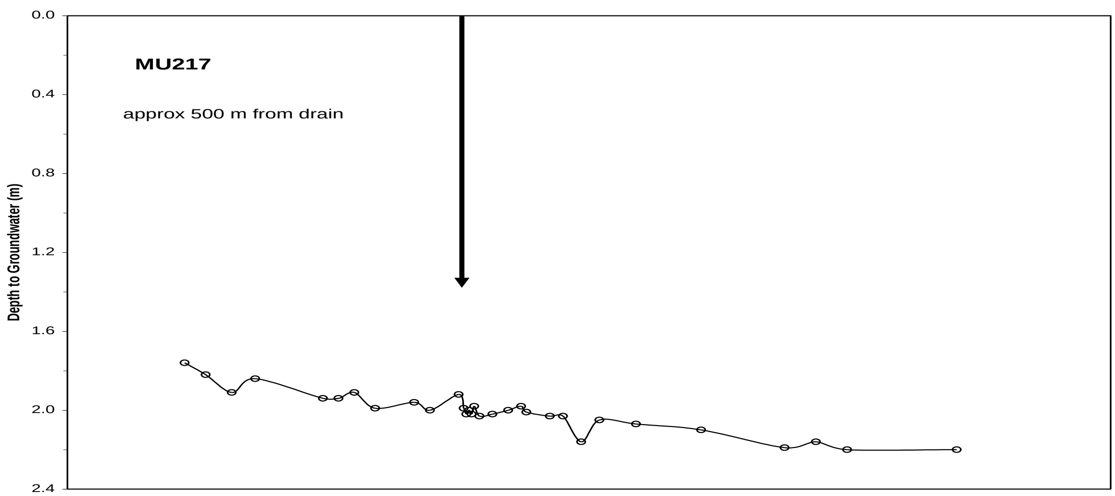


Fig. 16a-h Hydrographs ‘Wasley Road’ transect

7.2 Groundwater Flow Rates

Groundwater flow has been monitored near the outlet of the drain since mid June 2006. The height of the water column across a stainless steel flume is logged at hourly intervals and, since the dimensions of the flume are exactly known, the measurements can be converted to flow rate. The flow monitoring set-up is shown in Fig.17 and an example for the output is shown, for the period June to August, in Fig. 18.

Fig. 17 Flume monitoring set-up

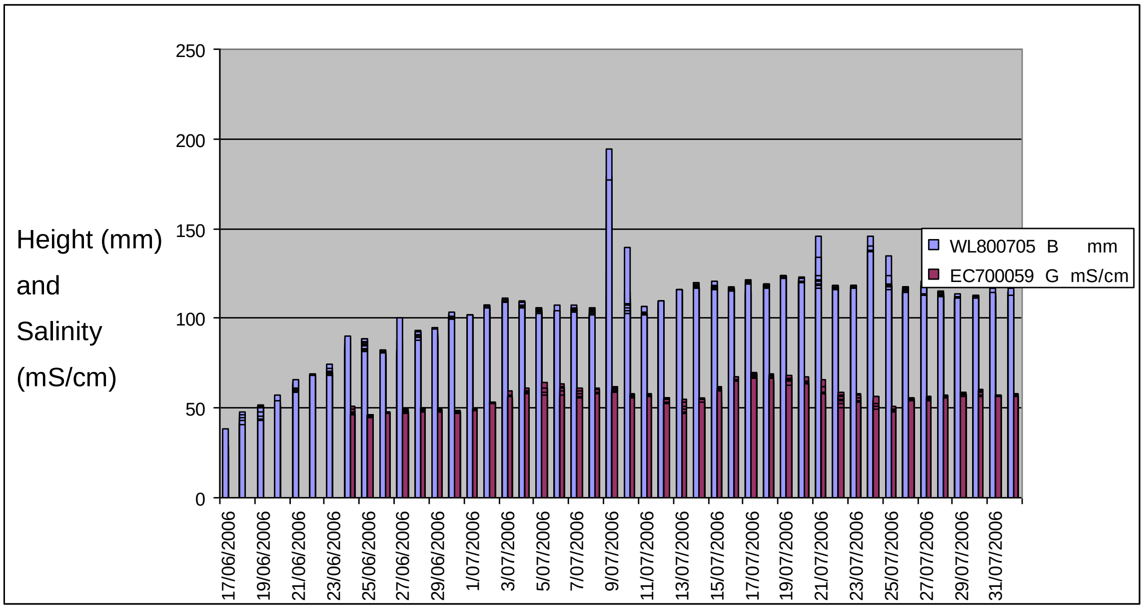


Fig. 18 Flume output June-August 2006

From the start, the MU55 drain produced extraordinarily large volumes of water. Flow rate at the flume peaked at nearly 14 litres/ second, in August/ September 2006, which is one of the highest reported for the WA wheatbelt. Some of the drains on MacPherson's spur were making water as soon as the excavator bucket was lifted. Since November, flow rate has dropped off slightly. Last week groundwater over the flume was flowing at around 7 litres/second.

8. REVEGETATION

Most of the plantings will be broombush (Melaleuca atroviridis in non-saline situations; the slower-growing but more salt-tolerant M. hamata in places currently supporting samphire); tubestock of both species grown from locally collected seed; seedling densities from Greening Australia recommendations

1. Twin rows, 2 m apart, then 4 m gap.
2. Seedlings at 1 m intervals along planting line
3. Effective stocking density = 3400 stems/ha (i.e. approx. 2200 stems/100 m drainlength)

Some areas, unsuitable for broombush plantations, will be dedicated to environmental plantings; varied species – small-medium trees and shrubs, planted 5-8 m apart, not in obvious rows (purely for aesthetic reasons); understorey initially of mixed chenopods (mostly *Atriplex* spp. and *Maireana* spp.), later (as soil becomes less saline and less sodic) replaced by various woody shrubs, planted only 1-3 m apart; all plantings from tubestock, direct seeding of groundstorey species after several years; all from local seed-collections.

Species for environmental plantings selected from the following, according to local soil type, seed availability and the make-up of existing remnants

1. Colluvial flat (red-brown earth)

Eucalyptus loxophleba ssp. supralaevis (York gum)
E. loxophleba ssp. lissophloia
E. myriadena
E. brachycorys
E. spathulata
Casuarina obesa (swamp sheoak)
Melaleuca eleuterostachya
M. lateriflora
M. uncinata complex (broombush)
M. adnata
Acacia obtecta
A. microbotrya (manna gum)
A. jennerae
A. brumalis
A. eremaea
A. hemiteles (tan wattle)
Hakea preissii (needlebush)
Maireana brevifolia (small-leaf bluebush)

2. Colluvial flat (clay)

Eucalyptus loxophleba ssp. supralaevis (York gum)
E. loxophleba ssp. lissophloia
Casuarina obesa (swamp sheoak)
Melaleuca adnata
M. eleuterostachya
M. lateriflora
M. acuminata
M. uncinata complex (broombush)
Callistemon phoeniceus
Acacia hemiteles (tan wattle)
Hakea preissii (needlebush)
Maireana brevifolia (small-leaf bluebush)

3. Alluvial flat (sand over clay)

Eucalyptus loxophleba ssp. supralaevis (York gum)
E. salicola
E. sargentii
Melaleuca halmaturorum
M. uncinata complex (broombush)
M. eleuterostachya
M. lateriflora
M. acuminata
M. thyoides
Acacia eremaea
A. hemiteles (tan wattle)
Pittosporum angustifolium (weeping pittosporum)

9. SOIL AMENDMENTS

Simply lowering the watertable does not necessarily restore the land to productivity. In many, probably most cases, the soil remains saline— a condition which is easily remedied by two or three good wet winters. Less easily remedied however is the problem of sodic soils, which can entirely lose their structure and become loose and powdery. Characteristically the surface takes on a hardset appearance after wetting.

Sodicity is caused by the breakdown of clays in the soil, following prolonged exposure to a high-sodium environment. The condition can be reversed by removing the sodium source (in this case, saline groundwater) and reintroducing high-calcium and/or high-magnesium material. Sodic soils are usually treated by adding gypsum to the profile. There is informal evidence from the region that deep-ripping helps. Where sodic soils are identified, YYCMG will promote trials with the local landowners to determine how best to rehabilitate the land.

Acid sulphate soils (ASS) have not been equivocally identified in the Yarra Yarra region. Based on recent findings in inland South Australia however, such soils could be present in saltlake areas of the Western Australian wheatbelt. Acid sulphate soils are soils containing iron sulphate or sulphide minerals. They only become a problem when drained and exposed to air. Iron sulphide oxidises to produce sulphuric acid, which is potentially released into the environment. Problems that can, in some circumstances, be caused downstream include

- Toxic quantities of aluminium, iron and heavy metals contaminating land and adjacent waterways.
- Impacts on aquatic flora and fauna and on riparian vegetation.
- Reduced plant productivity.
- Soil structure decline, with increased risk of erosion.

Yarra Yarra Catchment Management Group recognises that such scenarios can potentially occur and has the expertise and resources to identify ASS. There are techniques available for rehabilitating ASS-affected landscapes, although most of these have been untested in WA. Regular monitoring of drainwater chemistry and drain precipitates, in association with careful drainage design, will identify problem areas.

10. MANAGEMENT OPTIONS

The nature and chemistry of precipitates (crusts, gels & sediment) drains gives an indication of the chemistry of local soils and groundwater. More importantly, it can indicate how stable the metal load of the drain is and how likely it is to be discharged to the environment. For example, metals sequestered in transient evaporite crusts, such as gypsum, are likely to be flushed down the drain after rain. By contrast, foul-smelling deposits of monosulphidic black ooze (MBO) can also contain high concentrations of iron, aluminium, heavy metals such as copper, calcium, chromium and the rare earth elements lathanum and cerium, all of which can be toxic, in sufficient quantities, to downstream flora and fauna. As long as the MBOs remain anoxic and undisturbed (i.e. they are not allowed to come into contact with air), they are relatively stable and are unlikely to release their freight of metals to the water.

Of the hazards associated with drainage projects, groundwater acidification probably poses the largest environmental risk. In most wheatbelt situations, groundwater which is already naturally acidic is likely to become even more so in a drain. This is because most wheatbelt soils contain large amounts of iron. The oxidation of ferrous to ferric ions releases free hydrogen ions (a process known as ferrolysis), which then combines with sulphate in groundwater to form sulphuric acid. If this new acidity exceeds the buffering capacity of the drain sediments and water, then the drain water becomes more acidic (i.e. its pH decreases). A common observation in the Avon is that pH decreases to 2-3 with several months of drain construction.

At MU55 too, drainwater pH has fallen, but it is still being buffered by sediments in the dispersal lake. Metals released from the catchment soils appear to be concentrating in the mineral akaganeite, which forms a stable orange crust on the floor of both the drain and the lake.

Fig. 19 Akaganeite crust on lake floor

Fig. 20 Iron oxyhydroxides on drain floor..

Management techniques to lower acidity (i.e. to raise pH) are being trialled at the Beacon and Wallatin Creek drains. Treatments include lime-sand-lined drain channel, lime-sand-lined evaporation pond, permeable compost wall, and compost-lined drain. These trials are being carried out by Department of Water, following research by the Co-operative Research Centre for Landscape Evolution and Mineral Exploration, and are being funded through the Avon Catchment Council. Yarra Yarra Catchment Management Group is following the progress with interest.