DEPARTMENT OF
PRIMARY INDUSTRIES




Mandatory Environmental Monitoring

Shepparton Irrigation Region Environmental Monitoring Report For 1995 - 2002

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Office of Regional Manager, DPI: Telephone (03) 5833 5222

Produced By: Greg Day, Environmental Management Program, DPI Tatura, 2003.

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Introduction:

Mandatory Environmental Monitoring has been occurring at 7 sites in the Shepparton Irrigation Region since 1995. The data was supposed to be analysed and reported on annually, however no completed annual reports have been produced to date. This report will analyse all of the data collected between 1995 and 2002 and discuss any findings.

To avoid repetition, a detailed explanation of the Mandatory Environmental Monitoring project's background is included in the accompanying document to this report, entitled 'Shepparton Irrigation Region, Mandatory Environmental Monitoring Manual, 2002'.

Methodology:

Detailed monitoring methodology can be found in the accompanying document 'Shepparton Irrigation Region, Mandatory Environmental Monitoring Manual, 2002".

Results:

Wetland Sites:

Usually, monitoring of nutrient and other physico-chemical concentrations within bodies of water is undertaken to regularly determine where these levels fall in relation to some predetermined concentration or 'trigger value' that is used to assess the risk of adverse effects due to nutrients, biodegradable organic matter or pH. Unfortunately, mainly streams, rivers, large freshwater lakes, estuaries or oceans that have fairly well defined trigger values, and due to the lack of prior monitoring data and knowledge, and to the complexity of wetland environments, there is little information about trigger values for wetlands in south-eastern Australia.

To try to at least get an idea of the significance of the concentrations displayed in these graphs, I have consulted the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines for fresh and marine water quality[1]. These guidelines include a set of default trigger values that have been developed for broad regions across Australia. The preferred method of determining trigger values is on a site by site basis, and should be done using data collected from the particular water body that is being monitored (if the dataset is adequate). This will result in the most accurate and most useful trigger value for each particular site. However, where prior data is not available to determine trigger values (as in the case of these wetlands), the default values from the ANZECC water quality guidelines probably give the best benchmark for comparison to our monitoring data until an adequate dataset can be obtained to derive some more relevant trigger values.

Since no default trigger values yet exist for wetlands in south-eastern Victoria, I will refer to the values for the lowland river category (rivers >150m above sea level), because the rivers in the Shepparton Irrigation Region fall into this category, and the wetlands in question here are in close proximity to lowland river systems.

Another source of criteria for assessing water quality parameters within Victoria can be found in the State of the Environment Report: Victoria's Inland Waters[2]. However, this source does not give any specific guidelines for water quality in wetlands either. Considering that both the ANZECC guidelines and the State of the environment report are both non specific to wetland water quality, I have chosen the ANZECC guidelines to use as a rough guide for water quality parameters since it is the most recent of the two publications.

Gaynors Swamp

Water quality testing has not taken place at Gaynors Swamp since the last time water was present at the two monitoring points in July 1999. The small number of samples that have been taken since 1995 will not be sufficient to give any real indication of any trends, but simply a number of snapshots of the nutrient levels at this wetland since monitoring commenced.

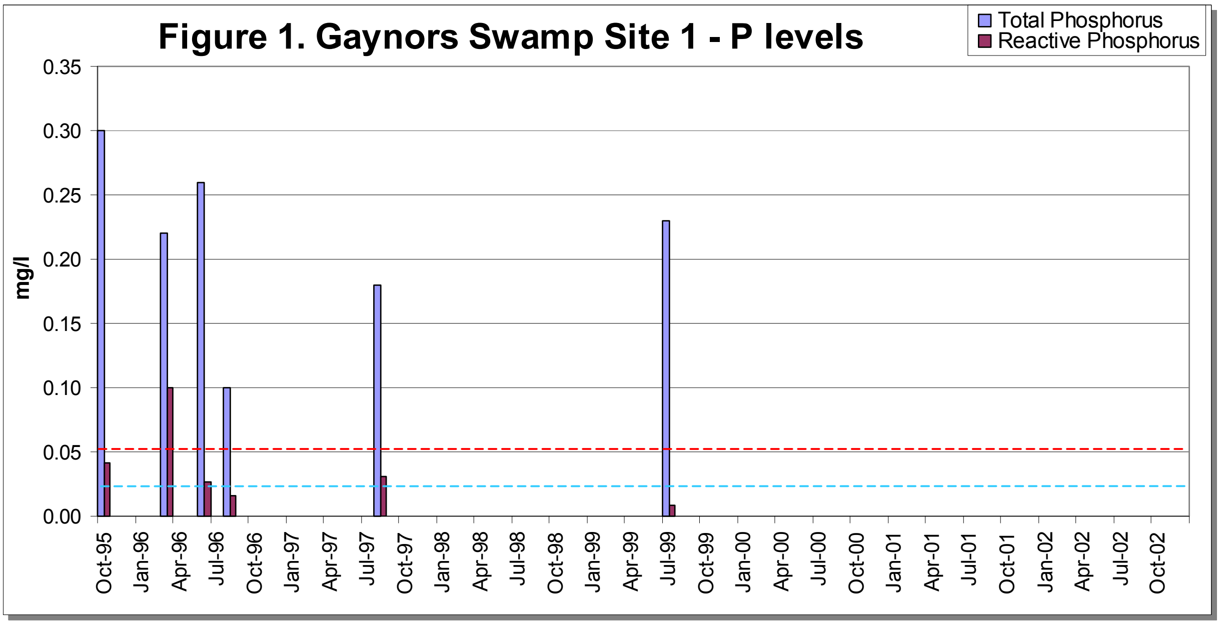


Figure 1. Gaynors Swamp Site 1 - P levels

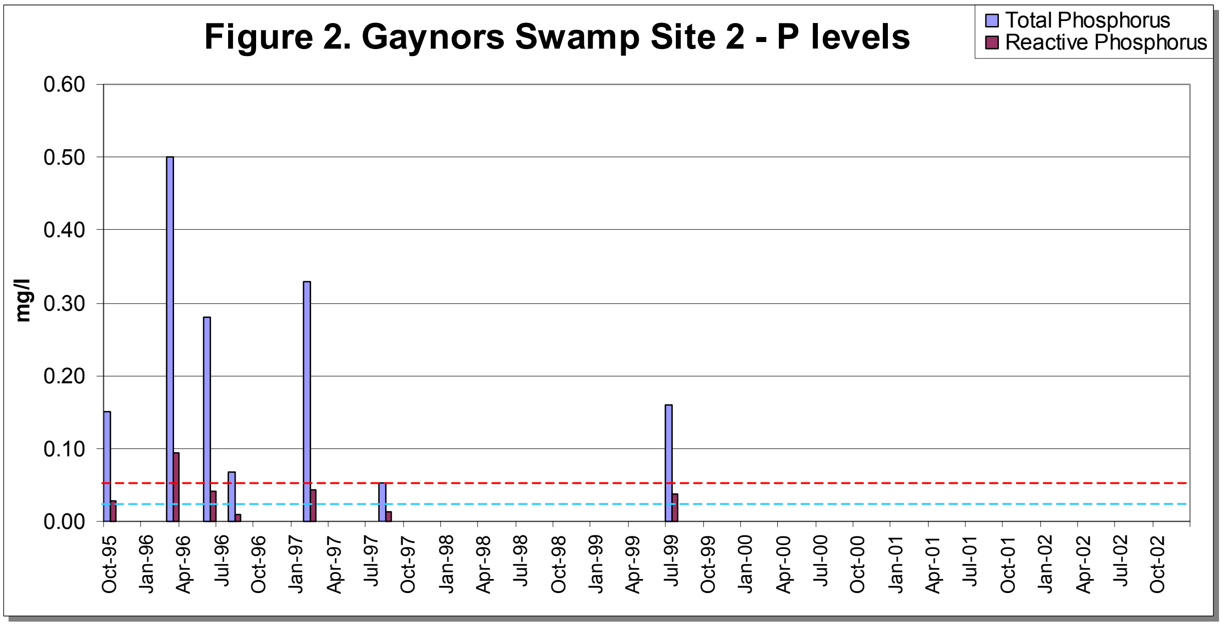


Figure 2. Gaynors Swamp Site 2 - P levels

Figures 1 and 2 display both Total Phosphorus and Reactive Phosphorus concentrations at the two monitoring points for Gaynors Swamp.

The default trigger values given by the ANZECC water quality guidelines are 0.05 mg/L and 0.02 mg/L for Total Phosphorus (---- line) and Reactive Phosphorus (---- line) respectively, keeping in mind that these values are for lowland rivers. Total Phosphorus levels at both monitoring points exceed this trigger point at every reading, and in one instance is actually ten times higher than this trigger point of 0.05 mg/L (See figure 2). Reactive Phosphorus also generally exceeds the default trigger value of 0.02 mg/L, but to a much smaller extent than the Total Phosphorus, and it falls below this level at two separate reading times.

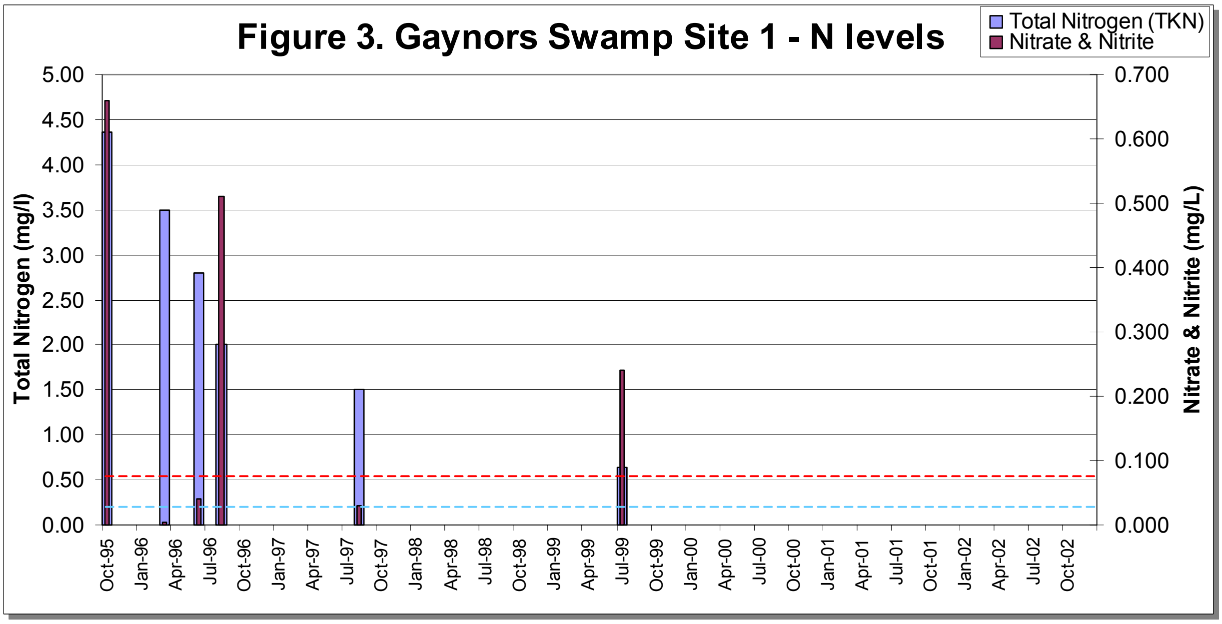


Figure 3. Gaynors Swamp Site 1 - N levels

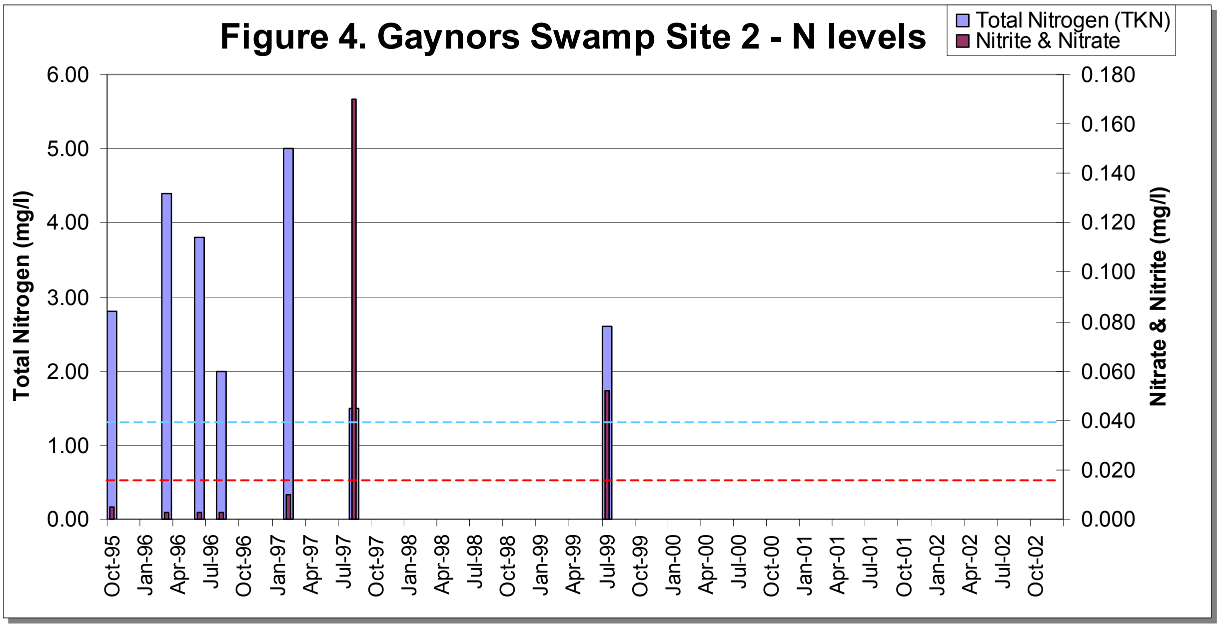


Figure 4. Gaynors Swamp Site 2 - N levels

Figures 3 and 4 display both the Total Kjeldahl Nitrogen and the combined concentration of Nitrate and Nitrite at the two sampling sites at Gaynors Swamp.

The Total Nitrogen concentrations at site 1 seem to show a general decline at each successive sampling from 1995 to 1999 (See figure 3). The first measurements are a long way above the default trigger point value for TKN of 0.5 mg/L (---- line), but each successive measurement falls gradually until the final measurement in mid 1999, which is only slightly higher than this trigger value. It is possible that the frequency of sampling may have missed periods of high nutrient input, so this trend is not necessarily a true representation of changes in nutrient levels over time, however it is encouraging that each measurement has a lower concentration than the previous. Total Nitrogen readings for Site 2 are all well above the default trigger value (Figure 4), and don't show the same distinctive decline over time as for site 1, and instead just seem to fluctuate between 1.5 and 5 mg/L.

Nitrate / Nitrite concentrations at both sites seem to fluctuate far more widely than the Total Nitrogen. It is important to note that the bars on figure 3 & 4 representing Nitrate / Nitrite levels are only higher than the Total Nitrogen bars because there is a secondary Y-axis so that they can both be viewed on the same graph.

Site 1 shows two very high Nitrate / Nitrite readings towards the beginning of monitoring (0.5 and 0.65 mg/L), which are a long way above the default trigger point of 0.04 mg/L (----- line). These two high readings are not reflected at site 2 however, which show very low Nitrate / Nitrate readings at these times, and are far below the 0.04 mg/L trigger value. This also happens in mid 1997, but in reverse with a very high reading being taken at site 2, which is not reflected at site 1.

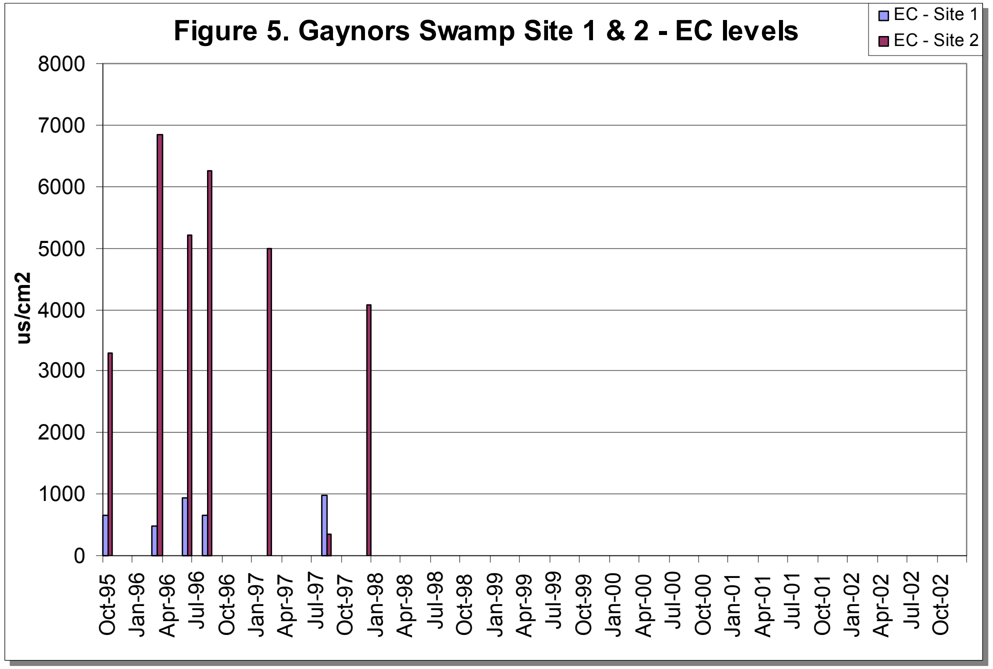


Figure 5. Gaynors Swamp Site 1 & 2 - EC levels
EC - Site 1
EC - Site 2
us/cm2

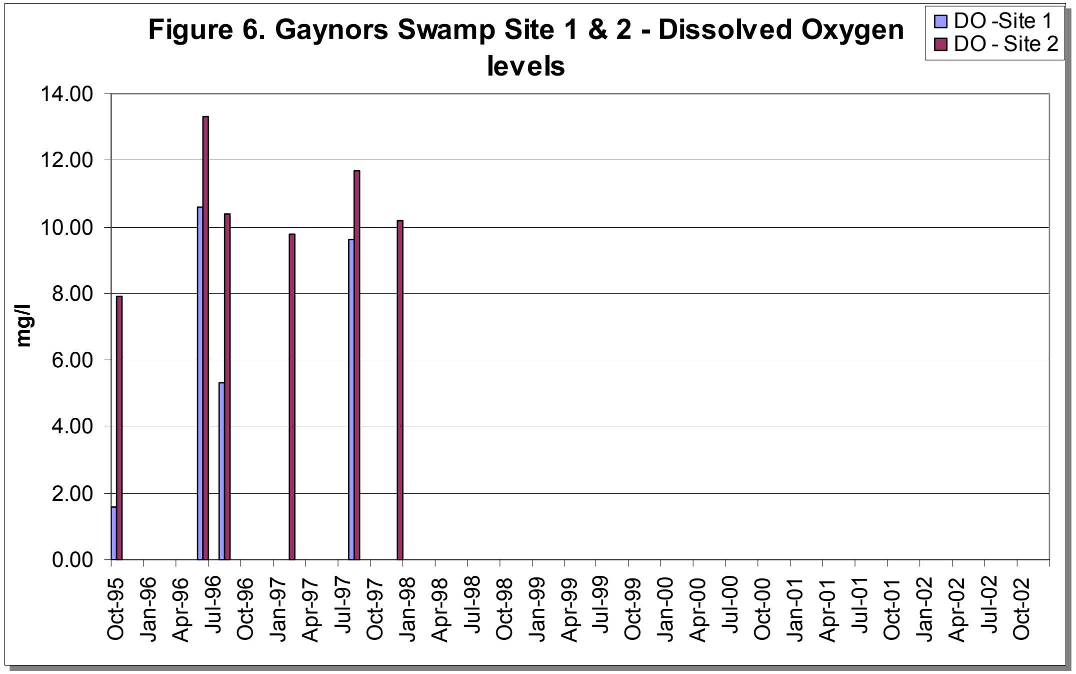


Figure 6. Gaynors Swamp Site 1 & 2 - Dissolved Oxygen levels
DO -Site 1
DO - Site 2
mg/l

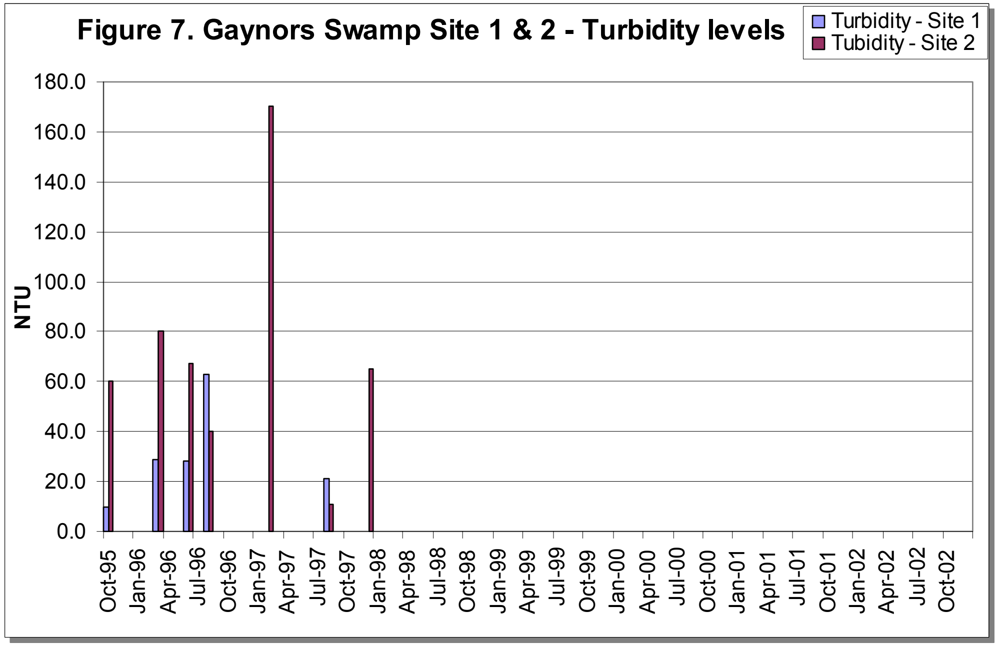


Figure 7. Gaynors Swamp Site 1 & 2 - Turbidity levels
Turbidity - Site 1
Turbidity - Site 2
NTU

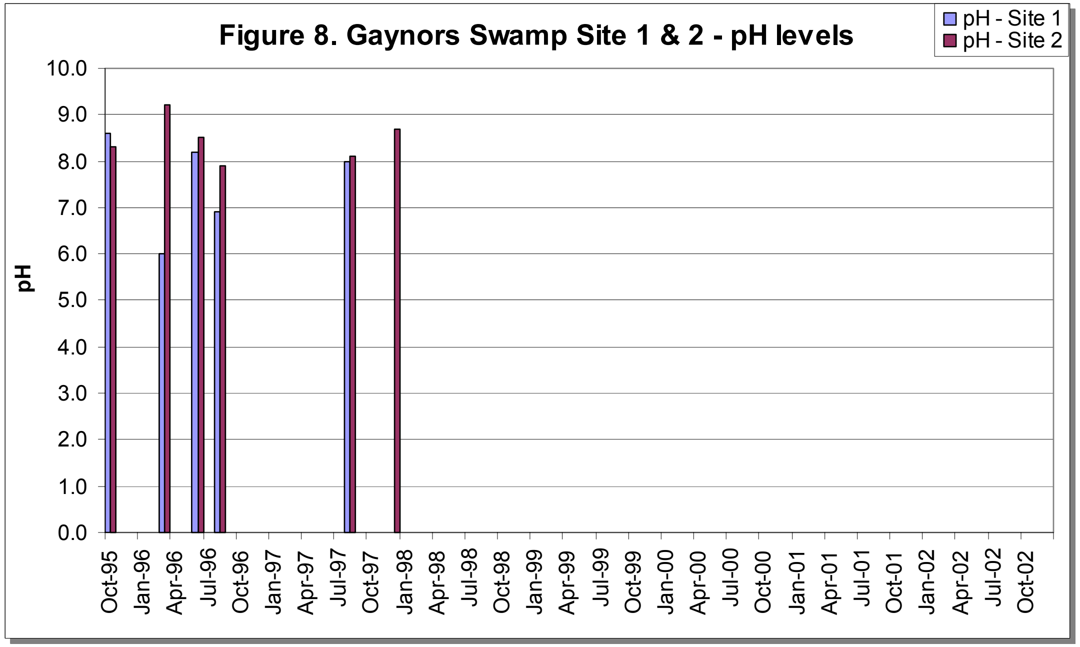


Figure 8. Gaynors Swamp Site 1 & 2 - pH levels
pH - Site 1
pH - Site 2
pH

Salinity levels at the two Gaynors swamp sites differ from each other considerably (See figure 5). Site 2 consistently has much greater EC readings than site 1. Site 1 has EC readings within a range that is considered OK for lowland streams (125 – 2200 EC) defined in the ANZECC guidelines. But site 2 shows EC levels up to nearly 7000 EC, which seem rather high. An explanation for this might come from the hydrograph and EC graphs below (Figures 9 and 10), since the bore is located very close to the water sampling location. The highest EC readings taken at site 2 are between early 1996 and mid 1997. Around the same time, the hydrograph shows that the groundwater levels are extremely close to ground level, and the salinity of this groundwater is also quite high (around 14000 EC). This high groundwater level combined with its high salinity levels would be the most likely explanation for the high readings taken from site 2. The reason why site 1 has much lower EC readings at the same time could only be speculated on, and no bore exists very close to this site to determine what the localised conditions for groundwater level were at this time.

Figure 9. Changes in watertable depth - Bore 4908, Gaynors Swamp

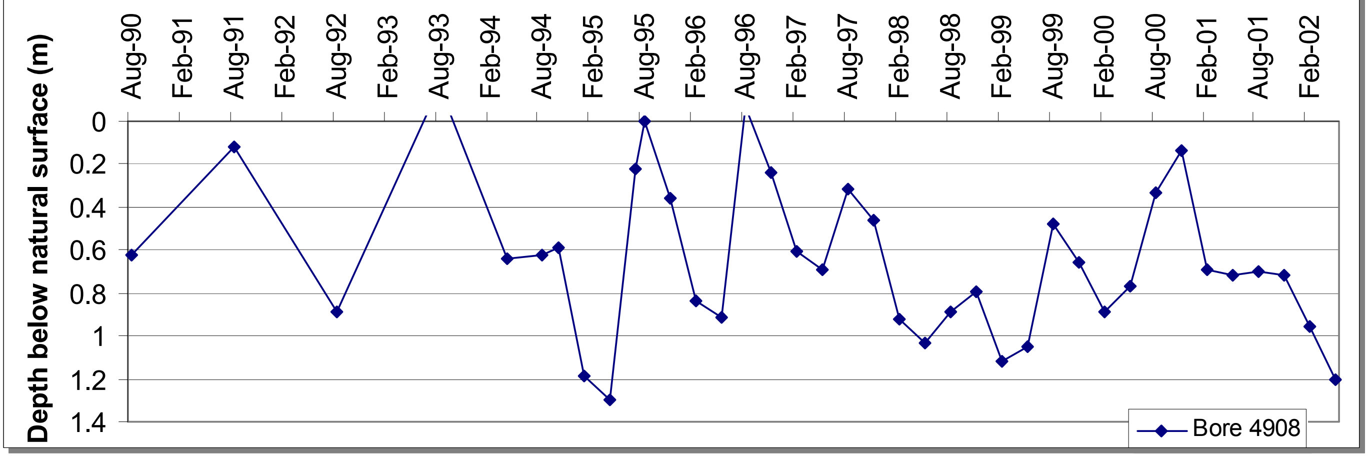
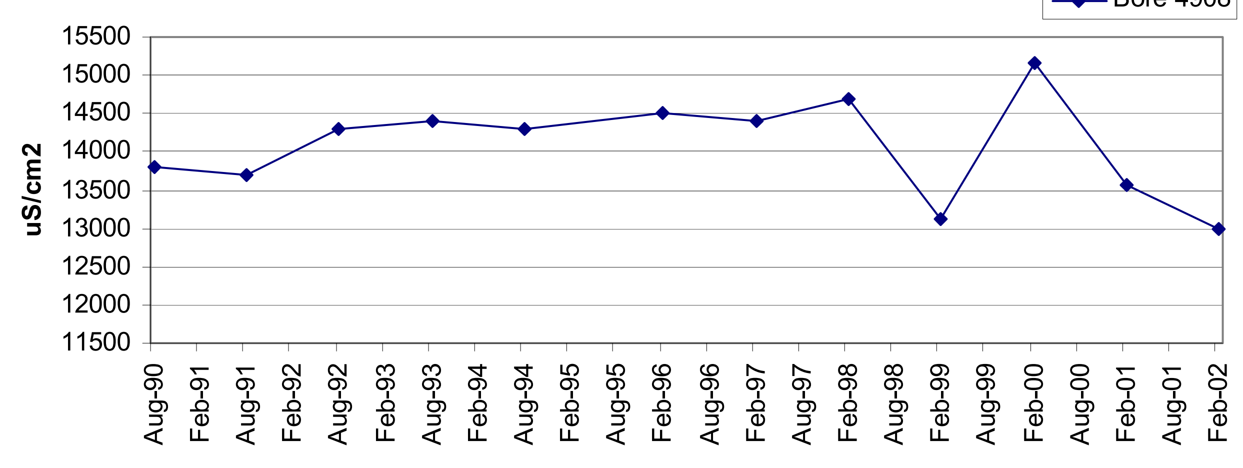


Figure 10. Changes in groundwater salinity levels (EC) - Bore 4908



Dissolved Oxygen

The dissolved oxygen levels shown in figure 6 are given in mg/L, however the ANZECC guidelines give dissolved oxygen levels in percentage saturation. The conversion between mg/L and percentage saturation is not linear, and is affected by the temperature. The ANZECC guidelines define 85% saturation as being the critical dissolved oxygen level where aquatic life in lowland streams may be affected if the level falls below. So using a rough conversion, and considering that water temperature at these wetlands fluctuates between about 15 ˚ C in winter, to around 25 ˚ C in summer, a dissolved oxygen level of less than 8.5 mg/L in winter and around 7 mg/L in summer could be considered to be getting low. But once again these figures should be treated with caution since this is recommended for lowland streams and not wetlands where not enough data is yet available for recommended limits.

So looking at the data in figure 6, the majority of readings are above 7 - 8.5 mg/L, and only in late 1995, and in mid 1996 does the dissolved oxygen reading fall below these levels, with the lowest reading of less than 2 mg/L being at site 1 in late 1995. However the most recent readings have all remained well above 7 - 8.5 mg/L.

Turbidity

Turbidity levels at Gaynors swamp (see figure 7.) have fluctuated quite a lot over time, ranging from between about 10 NTU to over 160 NTU. To get an idea of the significance of these numbers, the ANZECC guidelines recommends a range between 6 – 50 NTU for lowland streams. The levels at Gaynors swamp generally don't exceed 80 NTU, which does not seem to be too much in excess of this recommended range for lowland streams.

pH

The pH levels at Gaynors swamp (see figure 8.) are remaining fairly consistent between about 7 and 9, with one reading being down around the 6 level. The ANZECC guidelines recommend a range of between 6.5 and 8.0 as being acceptable, so looking at our data, the pH readings appear to be a little bit on the alkaline side of this range.

Table 1. Vegetation data for Gaynors Swamp Site 1.

Common name	Botanical name	Nov-97	Dec-98	Apr-99	Jul-99	Oct-99	Dec-99	Apr-00	Jul-00	Oct-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Blown grass	Agrostis avenacea	✓	✓						✓									
Canegrass	Eragrostis australasica	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clover	Trifolium sp.																✓	✓
Fleabane	Conyza bonariensis					✓	✓	✓										
Hawkweed	Picris sp.	✓																
Medic	Medicago sp.	✓																
Milk thistle	Sonchus oleraceus	✓																
Ox tongue	Picris echioides			✓													✓	✓
Prickly lettuce	Lactuca serriola	✓			✓	✓	✓	✓										
Scotch thistle	Onopordum acanthium		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spear thistle	Cirsium vulgare	✓		✓	✓													
	Total Species	7	3	4	3	4	4	4	3	2	2	2	2	2	2	2	4	4
	Salt Indicator Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Vegetation data for Gaynors Swamp Site 2.

Common name	Botanical name	Nov-97	Dec-98	Apr-99	Jul-99	Oct-99	Dec-99	Apr-00	Jul-00	Oct-00	Feb-00	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Ball clover	Trifolium glomeratum										✓	✓						
Bindi eye	Calotis cuneifolia													✓				
Blown grass	Agrostis avenacea	✓	✓								✓							
Brome	Bromus sp.	✓																
Canegrass	Eragrostis australasica	✓		✓		✓	✓	✓	✓	✓					✓			
Clover	Trifolium sp.																✓	✓
Curled Dock	Rumex crispus	✓																
Fireweed groundsel	Senecio linearifolius	✓																
Fungi													✓					
Medic	Medicago sp.	✓	✓															
Milk thistle	Sonchus oleraceus													✓				
Moss													✓				✓	✓
Ox tongue	Picris echioides	✓		✓														
Perrenial rye-grass	Lolium perenne	✓																
Phalaris	Phalaris aquatica	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Poison pratea	Pratia concolor	✓																
River red gum	Eucalyptus camaldulensis					✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
Rush	Juncus												✓		✓	✓		
Rye grass	Lolium sp.		✓								✓			✓	✓			
Scotch thistle	Onopordum acanthium		✓			✓	✓	✓					✓					
Spear thistle	Cirsium vulgare	✓		✓														
Squirrel tail fescue	vulpia bromoides													✓	✓			
Tangled lignum	Muehlenbeckia florulentu	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Valeris				✓														
Wallaby grass	Danthonia sp.		✓			✓	✓	✓	✓		✓	✓	✓					
Wild Oats	Avena sp.		✓								✓				✓	✓		
	Total Species	12	8	5	2	6	6	6	5	4	7	4	8	6	8	5	5	5
	Salt Indicator Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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The vegetation data presented within this report has not been analysed using the suggested approach of looking at changes in relative cover of each species (see monitoring manual for explanation) from quadrat surveys. This was mainly due to the difficulty of recording vegetation survey results digitally for analysis. The database for monitoring data needs a lot of development still, and the recording of quadrat survey data needs the most attention.

So that the survey results were at least recorded in some way digitally, I have entered the results as presence / absence lists by combining the data from all of the quadrats at each site (8 quadrats per transect), for each monitoring run. This should at least assist future vegetation surveys, and ensure the data is recorded in another format other than the original paper recording sheets.

Also, because I have had to enter data collected by other people, there has been no way of checking whether the species identification in these vegetation tables are accurate, especially because common names were often only given. So I suggest that these species lists should be considered with caution when interpreting this data.

Even though I have included a tally for total number of species at the end of each column in the vegetation tables, changes in this number may be greatly affected by changes in staff undertaking the surveys. I noticed that the early data seemed to be quite detailed, and appeared to have been undertaken by a very experienced person, but the latter surveys were a bit more haphazard, especially in terms of the recording of data. So this data also needs to be analysed with care.

The first quadrat site at Gaynors swamp (see table 1) is dominated by cane grass and scotch thistle. The species composition here has barely altered since the monitoring began here. Even though this is one of the saltier sites being monitored, it is interesting that no salt indicator species are present here.

The second vegetation survey site at Gaynors swamp has a more diverse flora composition than the first. The dominant species being tangled lignum and phalaris. There were no salt indicator species recorded here either.

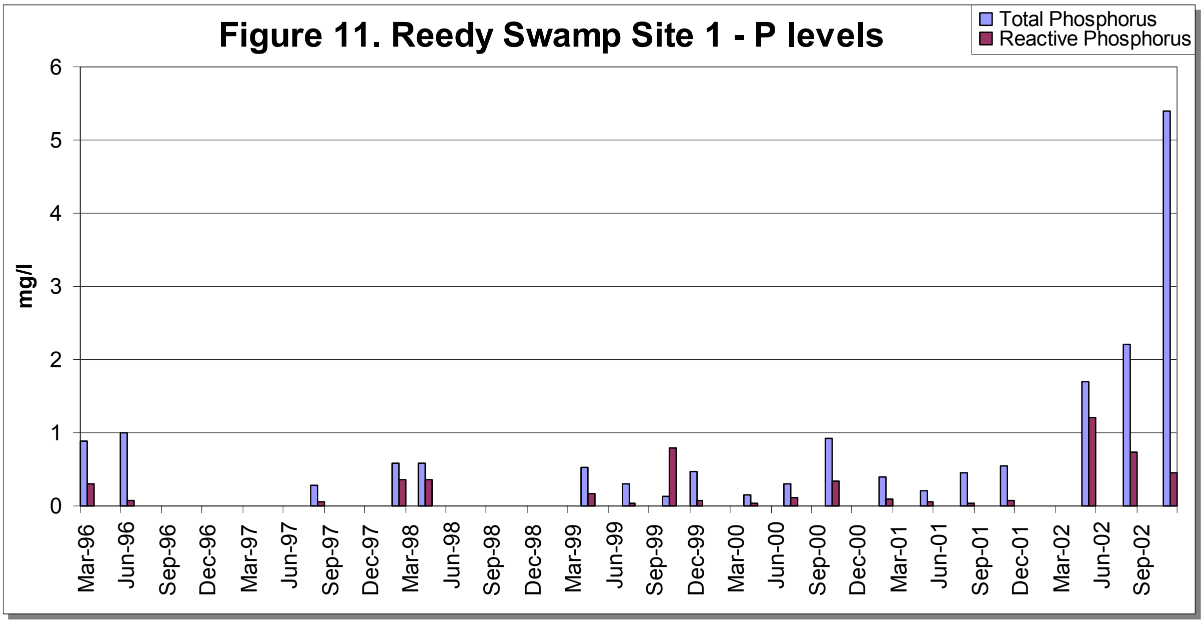
Macroinvertebrates

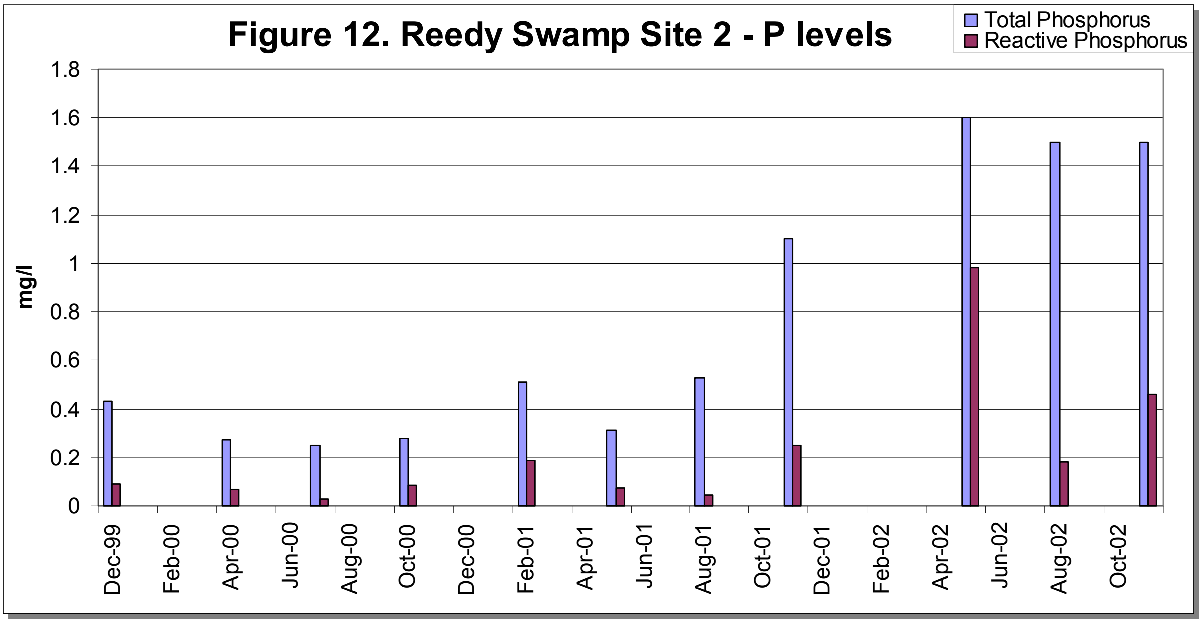
Because macro-invertebrate sampling was begun at a later stage than all of the above parameters, Gaynors swamp has not yet been sampled because it has been dry for the entire period that macro-invertebrate monitoring has been undertaken.

Reedy Swamp

Reedy Swamp is the only wetland out of the three being monitored that has had water in it almost all of the time since monitoring began. Even during the recent dry period, this wetland has had environmental water inputs to keep it relatively full. Water quality measurements have continued on a regular 3 monthly basis, except for dissolved oxygen and pH readings, which were unfortunately omitted for a long period of time. The wetland has also been recently dried out over the summer period to try and reinstate a more natural wetting and drying regime.

Phosphorus

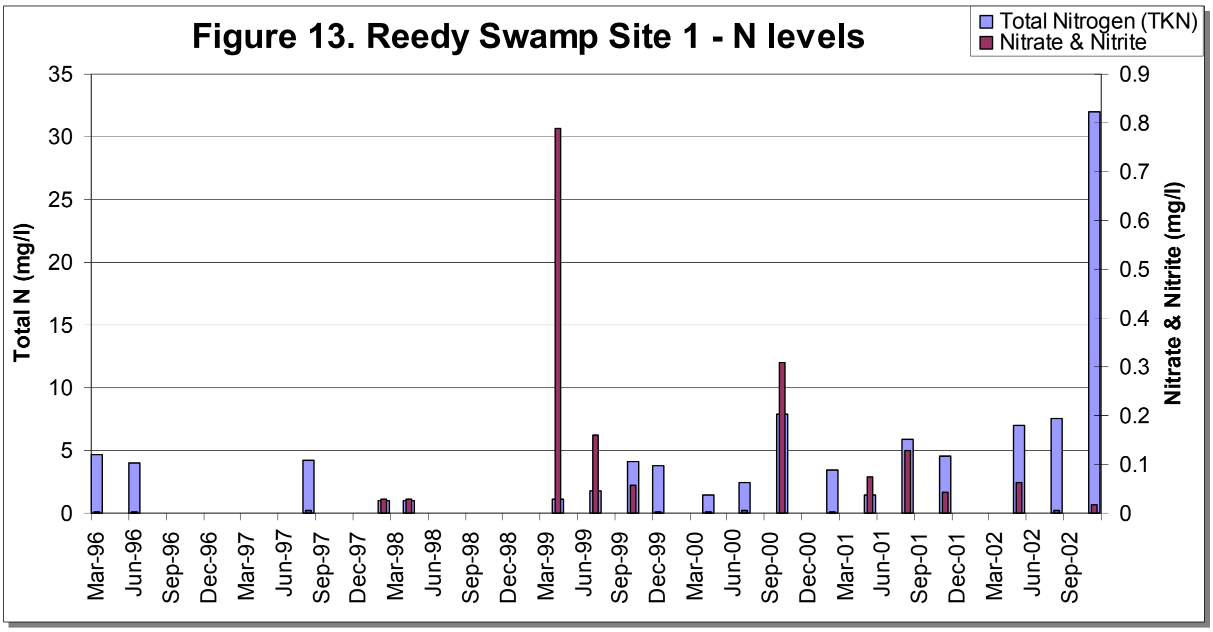


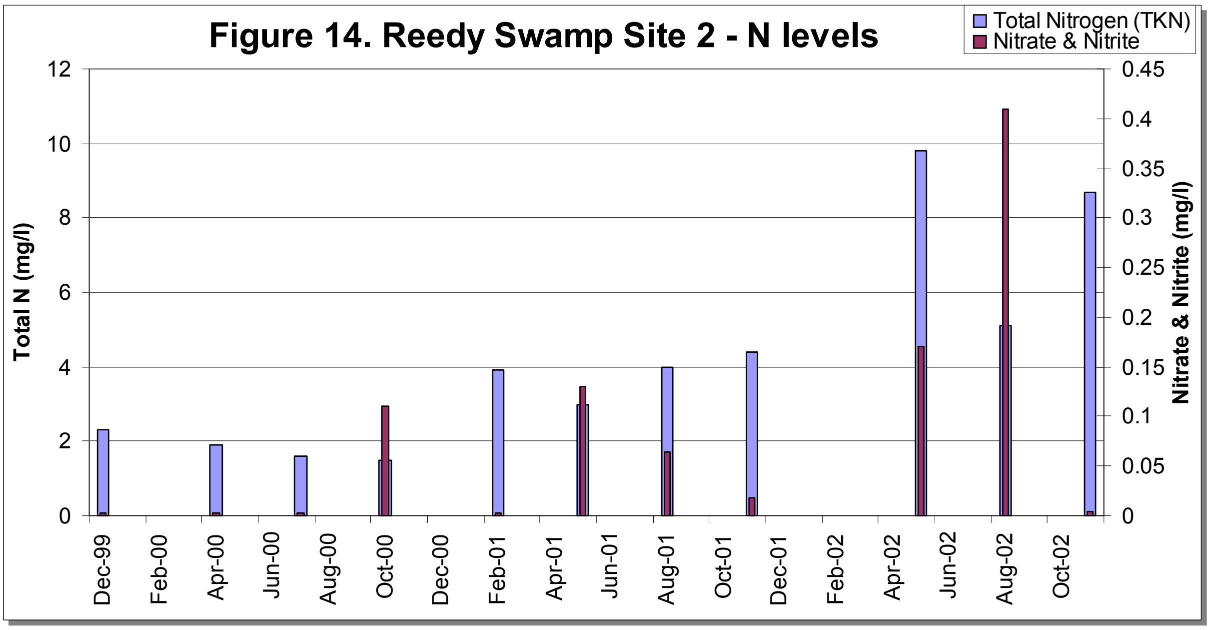


In terms of nutrient levels, the Reedy Swamp data is beginning to show a gradual increasing trend for both Total Nitrogen and Total Phosphorus at both sampling locations. This wetland site is beginning to get a reasonably long data set for water quality parameters. And although the level of sampling frequency and rigour is extremely low compared to what is usually required for water quality monitoring, this is the probably one of the best water quality data sets of any of the wetlands in this area. So at this stage there appears to be a sustained increase in concentration of nutrients within the water body at Reedy Swamp. This does not necessarily mean that there is an increasing amount of nutrients flowing into the wetland because we have not sampled the quality of water that is flowing into the wetland from the channel. So the origin of these increased nutrient levels could be something for further investigation. It is interesting that the greatest increase in nutrients is after summer 2002, which is when the wetland was dried out, and then refilled. It is important to note that as a response to being dried out, there was a large amount of macrophyte growth, which subsequently died and decayed when the wetland was refilled, possibly releasing a large amount of nutrients into the waterbody. The eastern side of the wetland had a lot more macrophyte growth than the western side, which could also be the reason for the large differences in nutrient reading between site 1 and 2 during the last sampling. It is possible that the nutrient levels will return to a lower concentration in future. Further water quality monitoring should hopefully detect this.

The total Phosphorus levels at both sampling sites (see figure 11 & 12), for Reedy Swamp at the last three samplings are both very high, and the most recent sampling at site 1 indicates an alarmingly high Phosphorus level, about 100 times greater than the default trigger value for a lowland stream. I have omitted the dashed lines in the graphs showing the default trigger values that were included for Gaynors Swamp because for this wetland site they seem completely irrelevant considering the nutrient levels are so much higher than the trigger values.

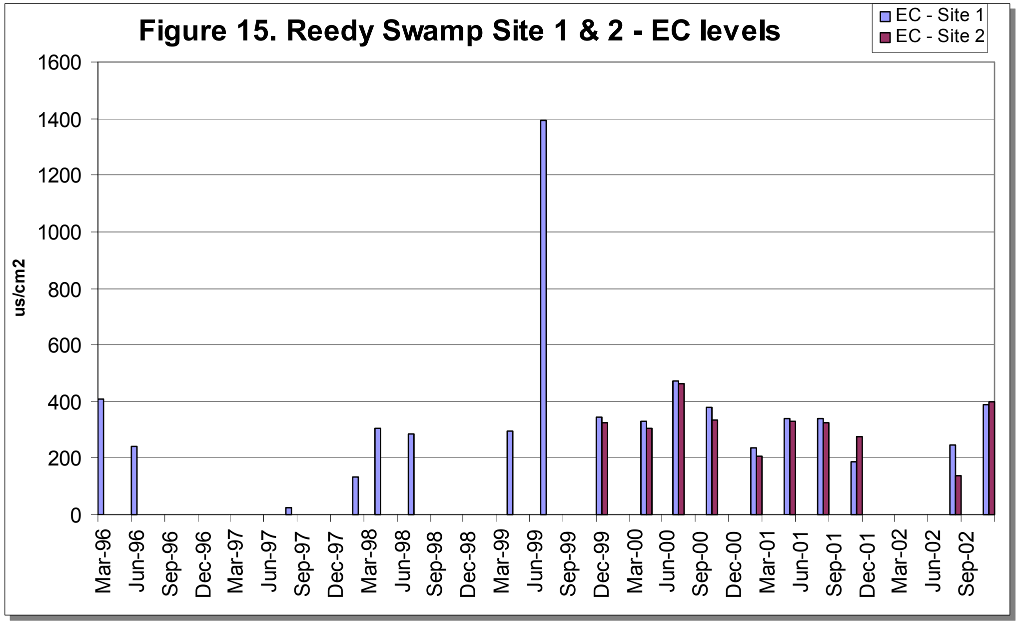
There is also a noticeable increase in Reactive Phosphorus levels in recent samplings at both site 1 and 2 compared to the comparatively lower levels recorded prior to Spring 2001. One interesting point on the graph of site 1 Phosphorus levels is that the initial jump in Reactive Phosphorus levels just after the wetland was refilled in early 2002 is followed by a decrease, which is the exact opposite to the Total Phosphorus's large increasing trend. The Reactive Phosphorus levels seem to be returning to their normal levels much sooner than the Total Phosphorus levels.

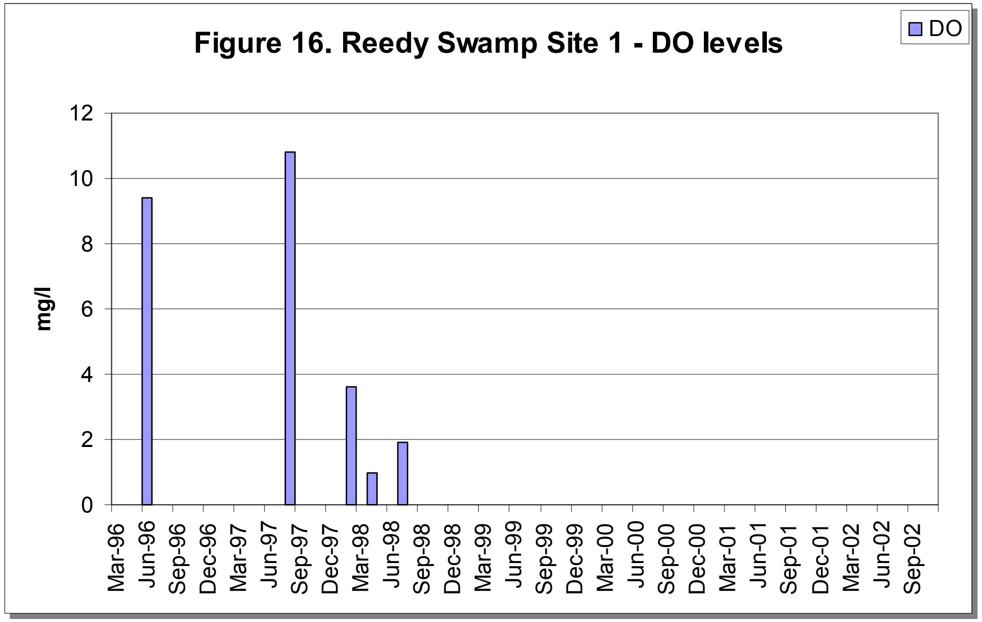


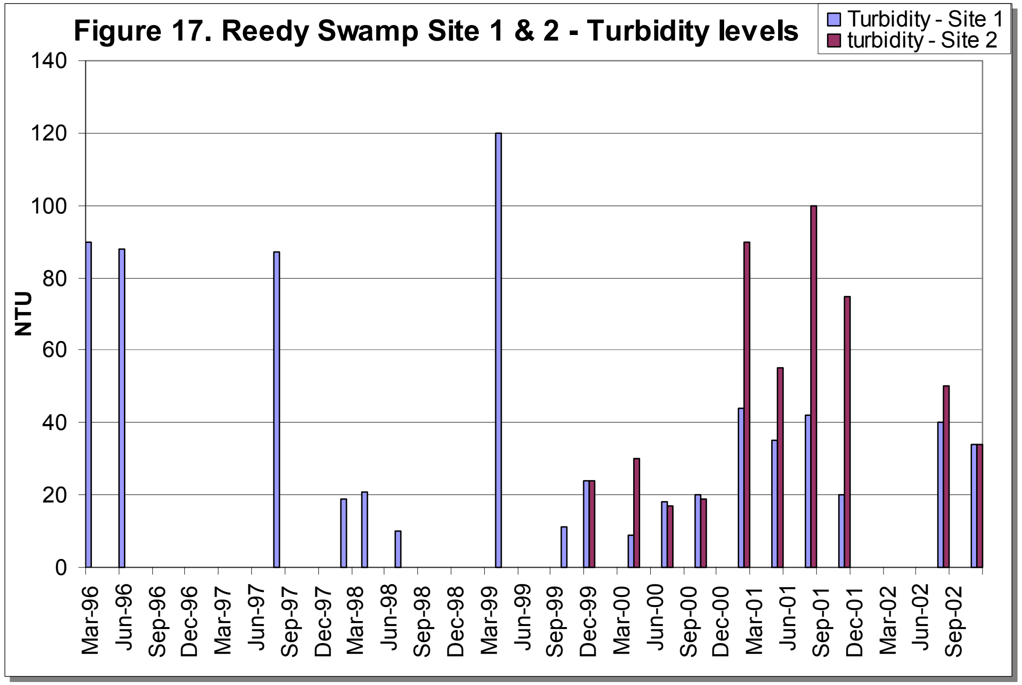


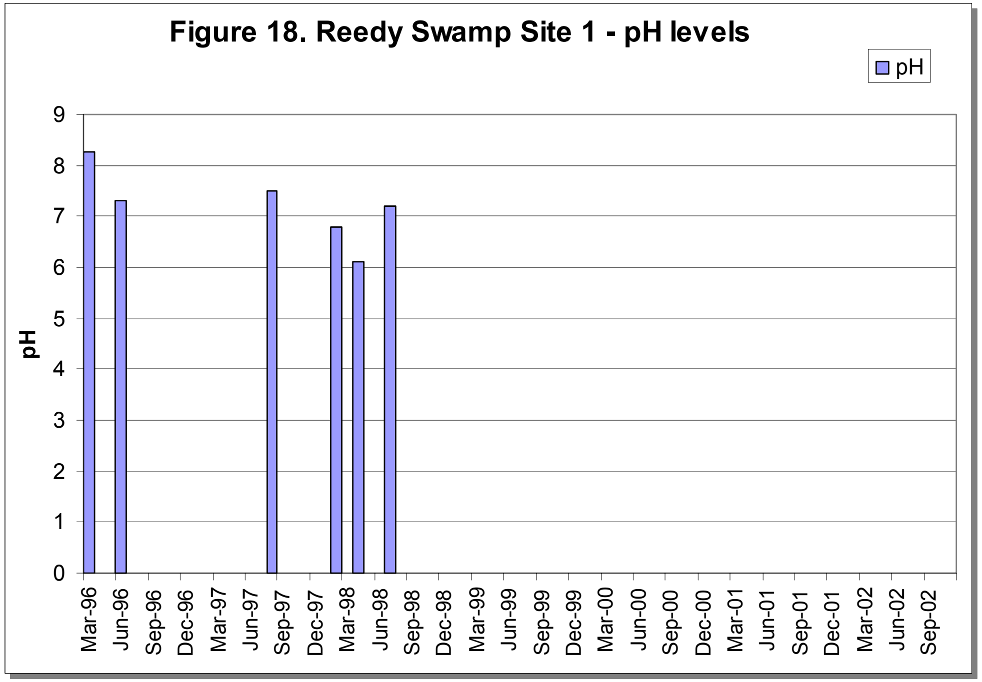
Total Nitrogen levels follow much the same pattern as the Total Phosphorus levels, and are similarly quite high. The most recent reading at Site 1 also shows an alarmingly high reading of 32 mg/L, which is over 60 times greater than the trigger point for lowland streams (see figure 13). But once again this high Nitrogen reading at site 1 is where there was a large amount of decaying macrophytes. The elevation in Total Nitrogen levels for the last 3 samples at site 2 is not as pronounced as at site 1, which is again consistent with the Phosphorus data. There is a dip on total Nitrogen at the August sampling for site 2, followed by an increase again at the November sampling, but interestingly there is a sharp peak in Nitrate / Nitrite levels at the same time (see Figure 14).

At site 1, the Nitrate / Nitrite levels for the past 3 samples are relatively low compared to most of the other previous samples, which is contrary to what is happening with Total Nitrogen levels. At site 2 however, the Nitrate / Nitrite levels seem to be increasing along with the increase in Total Nitrogen, except for the most recent sample which has a very low Nitrate / Nitrite level.









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Salinity

Salinity levels at Reedy Swamp have generally fluctuated between 200 – 400 EC (µS/cm), with the exception of one relatively high reading of 1400 EC in winter 1999, which quickly returned to normal levels. These salinity levels are within an acceptable range, and the salinity levels appear to be very stable at this stage. The higher reading in winter 1999 seems a bit out of place with the rest of the data, and looking back through the photopoint photos, there does not seem to be any major inflow events at this time that could import this amount of salt. Nor is there any rapid drying occurring during this winter period that might concentrate salt at the sampling location. There is a relatively high Turbidity reading taken a few months prior to this high salinity reading (see figure 17). This suggests that there has been either a disturbance at the site, or there has been an inflow of water creating more turbid conditions, but other than this there is no good evidence of the cause for this elevated salinity reading. Measurement error cannot be ruled out either.

Dissolved Oxygen

Dissolved Oxygen measurements have not been taken very frequently at Reedy Swamp, and ceased sometime in mid 1998, which is unfortunate. From the limited number of samples shown in figure 16, the first two are above the acceptable limit of 7 – 8.5 mg/L, and the last 3 show a steep decline in dissolved oxygen levels to below 4 mg/L, and in one case to a very concerning level of around 1 mg/L in about may 1998. No samples have been taken since to see whether dissolved oxygen levels increased again to higher levels.

Turbidity

Turbidity levels at Reedy Swamp have fluctuated between about 10 and 120 NTU, with a period of very low turbidity between September 1999 and December 2000. There are quite a few occasions when the Turbidity level gets quite a bit higher than the upper limit of 50 suggested by the ANZECC guidelines, especially during 2001 at site 2 where the readings seem to be consistently higher than for site 1, and are up around the 80 – 100 NTU mark. The last 2 readings at both sample sites have come back to acceptable levels of around 35 – 50 NTU.

pH

The pH levels at Reedy Swamp have not been measured very frequently also, and ceased in mid 1998. The readings that have been taken are quite stable, and vary between about 6 and just above 8, which is a quite acceptable level for pH as specified by the ANZECC guidelines.

Table 3. Vegetation data for Reedy Swamp Site 1.

Common name	Botanical name	Nov-97	Dec-98	Apr-99	Jul-99	Oct-99	Dec-99	Apr-00	Jul-00	Oct-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Algae											✓							
Aster weed	Aster subulatus	✓														✓	✓	
Azolla	Azolla filiculoides	✓	✓	✓	✓	✓		✓	✓	✓	✓						✓	✓
Blackberry night shade	Solanum nigrum	✓																
Brown beetle grass	Diplachne fusca																	✓
Celery buttercup	Ranunculus sceleratus	✓												✓				✓
Clove strip	Ludwigia peploides	✓																
Common rush	Juncus usitatus																	✓
Creeping knotweed	Polygonum plebeium	✓																
Curled Dock	Rumex bidins															✓		✓
Drain flat sedge	Cyperus eragrostis	✓																
Duckweed	Lemna sp.		✓	✓	✓	✓	✓	✓	✓	✓								
Garden dandelion	Taraxacum sp.																	
Giant rush	Juncus ingens	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓
Lesser Joyweed	Altemanthera denticulata	✓													✓			✓
Milk thistle	Sonchus oleraceus	✓																
Pale knotweed	Polygonum lapathifolium															✓		
Prickly lettuce	Lactuca serriola	✓																
Prickly sowthistle	Sonchis asper	✓																
River red gum	Eucalyptus camaldulensis					✓		✓	✓	✓	✓	✓	✓	✓	✓			
Rush	Juncus sp.	✓																
Slender knotweed	Persicaria decipiens	✓															✓	✓
Small spike rush / sedge	Eleocharis pusilla																	
Spear thistle	Cirsium vulgare	✓																
Tall spike rush	Eleochris sphacelata					✓												
Two-row bitter-cress	Rorippa sp.	✓																
Umbrella sedge	Cyperus eragrostis																	
Water couch	Paspalum paspalodes	✓	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓	✓	✓
Water pepper	Polygonum hydropiper			✓											✓		✓	
Water primrose	Ludwigia peploides ssp. Montevidensis		✓												✓			✓
	Total Species	17	5	5	4	6	3	5	4	4	5	2	2	2	6	4	6	10
	Salt Indicator Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Victoria The Place To Be

Table 4. Vegetation data for Reedy Swamp site 2

Common name	Botanical name	Oct-99	Apr-00	Jul-00	Nov-00	Feb-02	May-02	Aug-02	Nov-02
Algae									
Aster weed	Aster subulatus								
Azolla	Azolla filiculoides	✓	✓	✓					✓
Brown beetle grass	Diplachne fusca								
Celery buttercup	Ranunculus sceleratus	✓			✓				
Common rush	Juncus usitatus							✓	✓
Curled Dock	Rumex bidins						✓	✓	
Duckweed	Lemna sp.	✓	✓	✓					
Giant rush	Juncus ingens								
Lesser Joyweed	Alternanthera denticulata					✓	✓		✓
Milk thistle	Sonchus oleraceus						✓		
Onion grass							✓		
Pale knotweed	Polygonum lapathifolium							✓	
River red gum	Eucalyptus camaldulensis						✓	✓	✓
Slender knotweed	Persicaria decipiens						✓		
Small spike rush / sedge	Eleocharis pusilla								
Tall spike rush	Eleochris sphacelata								
Umbrella sedge	Cyperus eragrostis						✓		
Water button (si)	Cotula coronopifolia						✓		
Water couch	Paspalum paspalodes	✓				✓	✓		✓
Water pepper	Polygonum hydropiper	✓				✓		✓	
Water primrose	Ludwigia peploides ssp. Montevidensis					✓	✓	✓	✓
	Total Species	5	2	2	1	4	10	6	6
	Salt Indicator Species	0	0	0	0	0	1	0	0

The vegetation surveys at Reedy Swamp have been running for much longer at site 1 than at site 2. Site 1 is also more heavily vegetated than site 2, which has a lot more open water.

The main changes in vegetation at this wetland site would not really be with respect to the species composition, but how the various riparian species spread and then recede during the wetting and drying cycle of this wetland. Tables 3 and 4 only show which species are found within the quadrats at each monitoring run, but do not give us an indication of how the vegetation has reacted to wetting and drying. The photos taken from the photopoints give a fairly good indication of how the vegetation responds to this process.

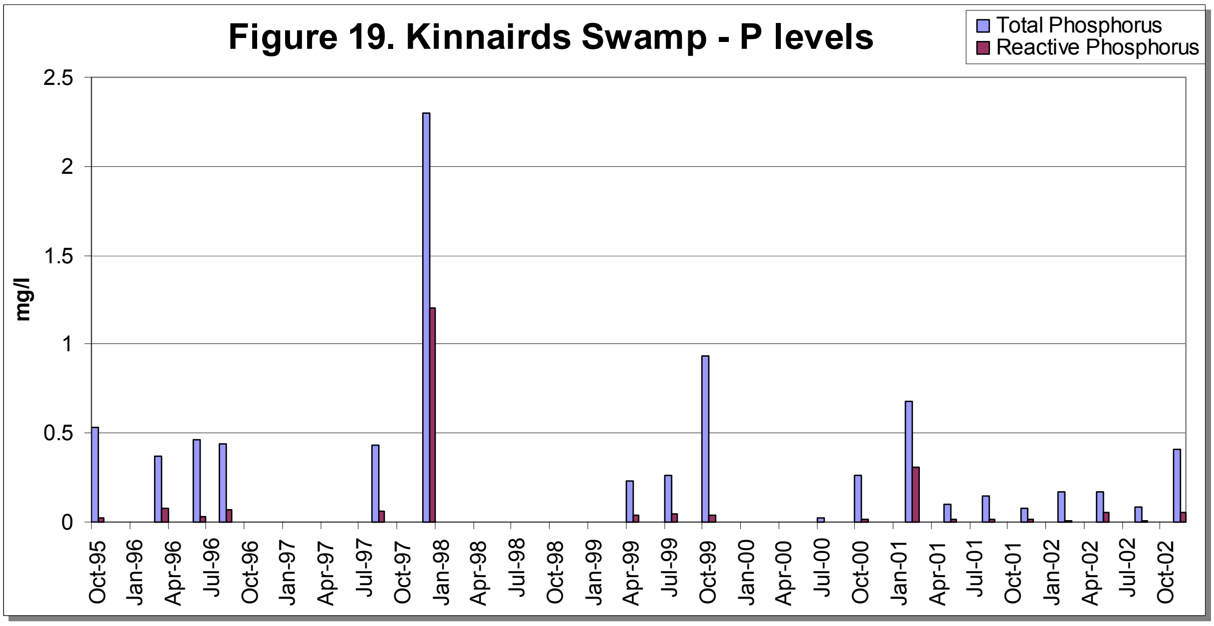
Macroinvertebrates

The macro-invertebrate report for 2002 is the fourth report that has been completed for Reedy swamp. These reports are included as a separate addition to this report since Arthur Rylah Institute completed them for us and there is no real need to duplicate the information they have given us within this report. The results for the 2002 monitoring also discuss what the macro-invertebrate communities are indicating in relation to the changes in nutrient levels at this site, and also compare the most recent results with previous reports.

It is important to note that the macro-invertebrate sampling in 2002 had the number of sampling locations increased from 2 to 5 (to try and cover a variety of different sites around the wetland), and was the first year we decided to identify the macro-invertebrates down to the lowest practical taxonomic level. This was to try and produce a more rigorous sampling, and hopefully lead to some more robust results. By identifying down to a finer level, the latest report has been successful in identifying particular macro-invertebrates that are reflecting changes seen in the water quality at this site.

Kinnairds Swamp

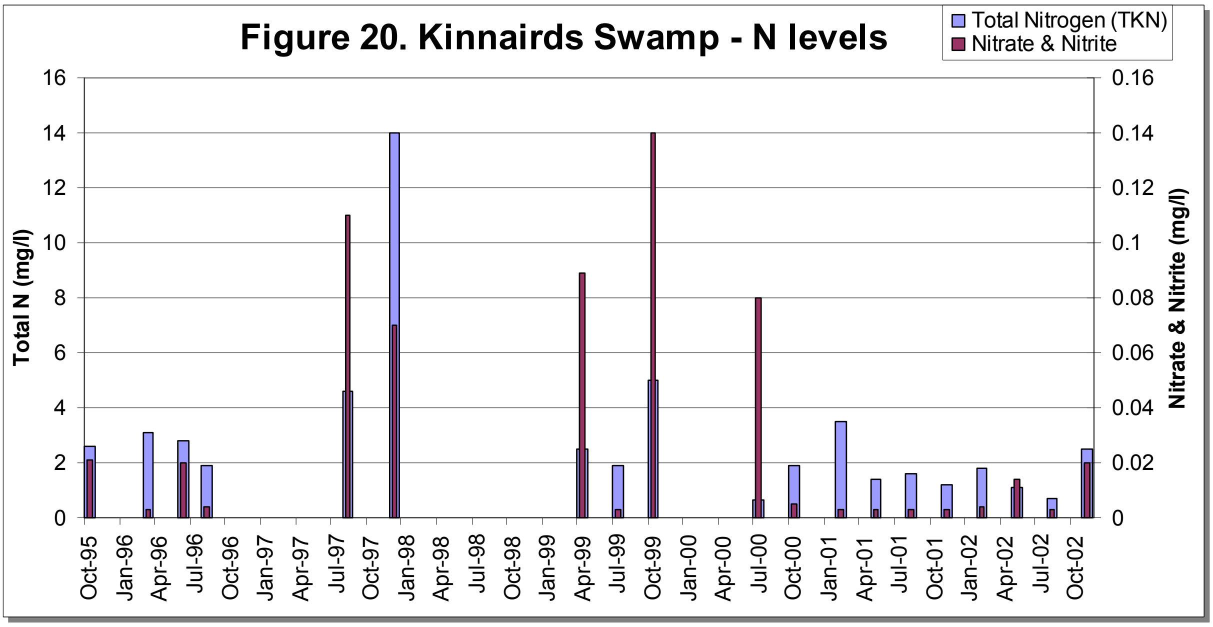
The monitoring site at Kinnairds Swamp has not been inundated with water since winter 1996. Water quality samples and measurements since this time have been taken from the constructed part of the wetland, which is influenced by irrigation water from the surrounding area, and has generally been kept full during the recent dry period with inflows from the irrigation system.



Kinnairds Swamp only has one sampling location for water quality parameters. And due to the flow of water that has continued through the recent dry period, sampling of water quality parameters has continued over a substantial period of time at this site.

Total Phosphorus levels have tended to fluctuate between about 0.1 mg/L and 0.9 mg/L, which are reasonable levels, especially when compared to the Phosphorus levels at Reedy Swamp. There is only one spike that stands out in Figure 19, which is in early 1998 where the Total Phosphurs and Reactive Phosphorus levels jumped substantially. After this point, there is a period of over a year where no data was collected. Phosphorus levels then return to a normal level when sampling resumes in April 1999.

Reactive Phosphorus levels follow the same pattern as the Total Phosphorus levels consistently since measurements began. Both Total and Reactive Phosphorus have remained at relatively low levels over the past year and a half, which is encouraging.



In contrast to the Phosphorus data, the Nitrogen data seems to fluctuate quite a bit more wildly. The Total Nitrogen levels are still a little bit high (between 4 to 8 times greater than default trigger value), but are still lower than the Nitrogen levels at Reedy Swamp. The peak in early 1998 is also consistent with the peak in Total Phosphorus levels at this same time, so there must have been an event just prior to this that elevated the nutrient levels at this site. Total Nitrogen returns to a much lower level again between April 1999 and present.

Up until late 2000, the Nitrate / Nitrite levels at Kinnairds Swamp fluctuated quite dramatically, but have generally remained less than 4 times higher than the level of the default trigger point of 0.04 mg/L. From late 2000 until present, the Nitrate / Nitrate levels seem to have stabilised at a quite low level, with very little fluctuation in readings.

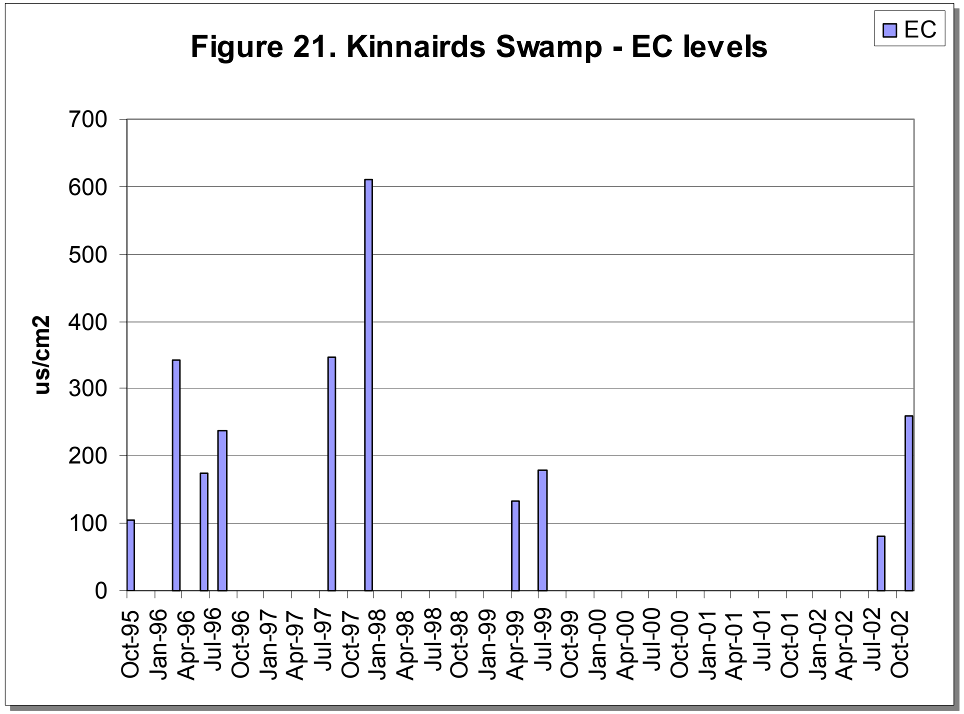


Figure 21. Kinnairds Swamp - EC levels
EC
us/cm2
700
600
500
400
300
200
100
0
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
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Jan-02
Apr-02
Jul-02
Oct-02

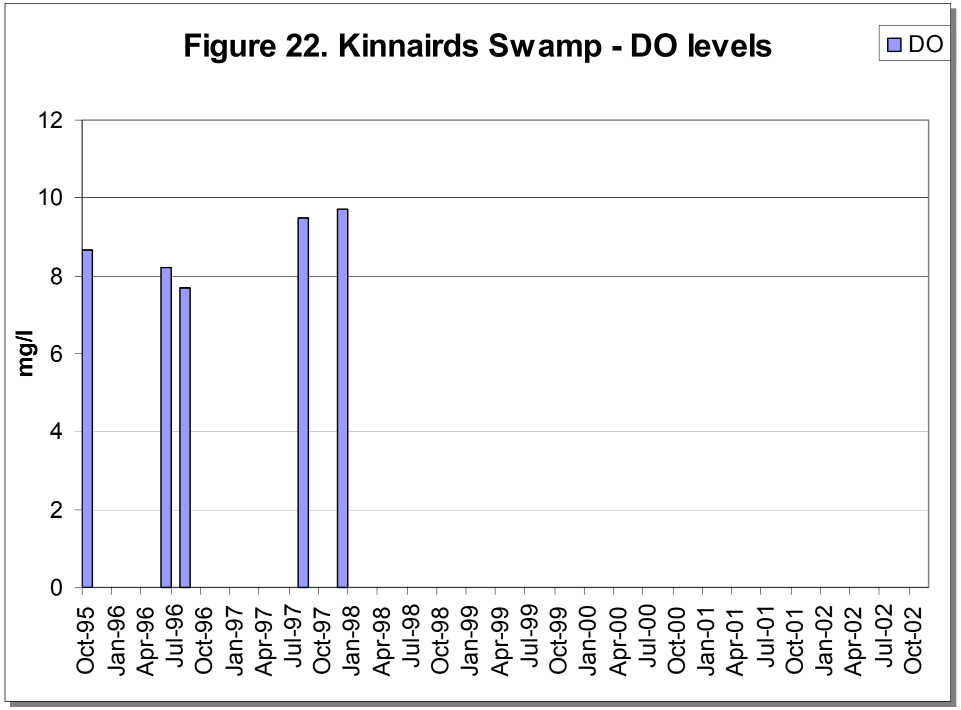
Figure 22. Kinnairds Swamp - DO levels
DO
mg/l
12
10
8
6
4
2
0
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
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Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02

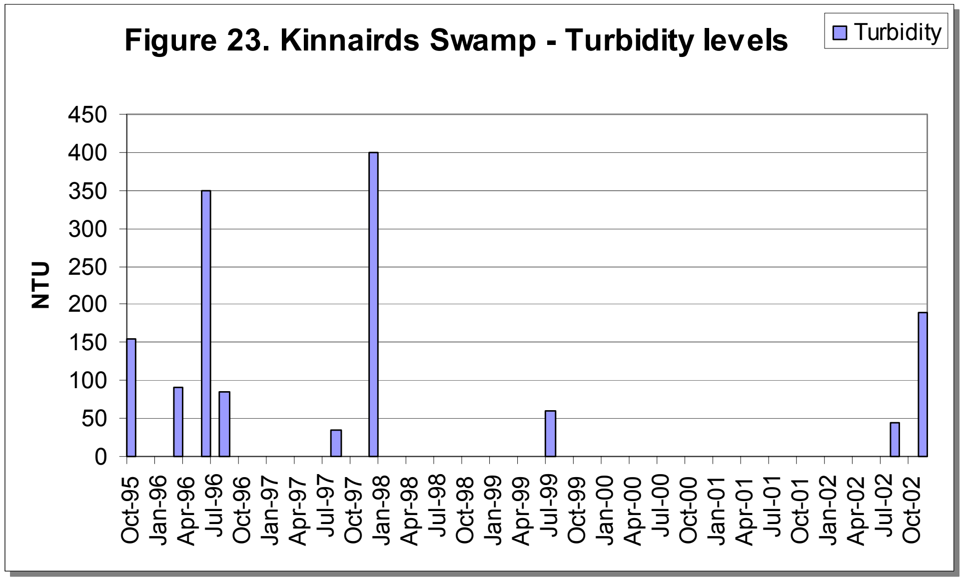
Figure 23. Kinnairds Swamp - Turbidity levels
Turbidity
NTU
450
400
350
300
250
200
150
100
50
0
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
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Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02

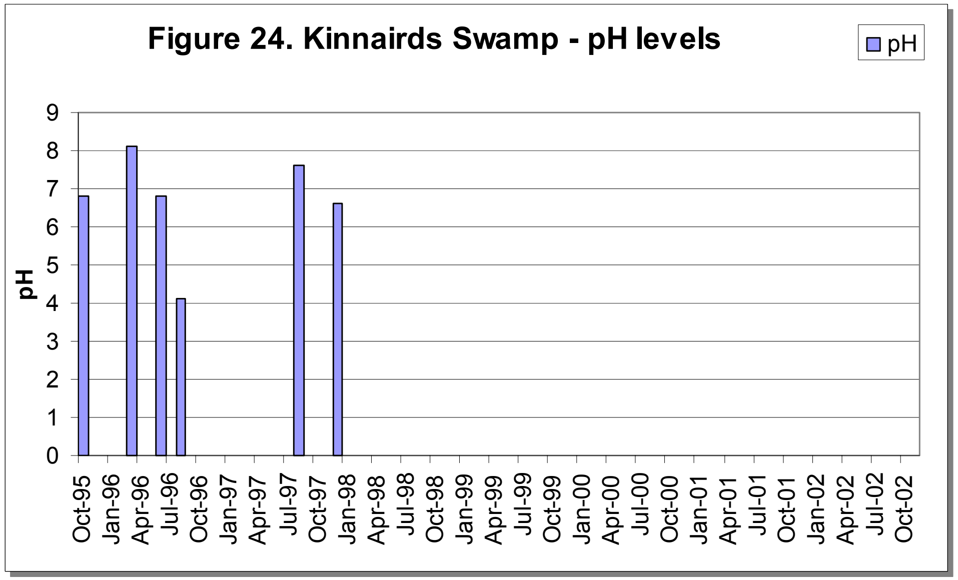


Figure 24. Kinnairds Swamp - pH levels
pH
pH
9
8
7
6
5
4
3
2
1
0
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02

Salinity

EC levels at Kinnairds swamp are well within acceptable limits, and remain below 350 µS/cm, except for a once off reading of around 600 µS/cm in January 1998, which is still within acceptable limits, but is almost a doubling of other EC readings taken here.

Dissolved Oxygen

All Dissolved oxygen readings at Kinnairds swamp are above the acceptable limit of about 7 mg/L. Dissolved oxygen readings have unfortunately once again been ceased quite a long time ago, and there is a large gap between the time of cessation and present.

Turbidity

Turbidity levels are probably the parameter of most concern at Kinnairds swamp. Almost all readings are well above the upper limit of around 50 NTU, and even go as high as 400 NTU. There is a long gap in data between 1999 and 2002, but the last reading taken in 2002 shows that the turbidity levels are still fairly high.

pH

The pH levels at Kinnairds swamp generally fluctuate around the neutral level of 7, and remain within acceptable limits (6.5 – 8). Only one reading falls outside this range (reading of about 4), taken in August 1996.

Vegetation

Table 5. Vegetation data for Kinnairds Swamp

Common name	Botanical name	Nov-97	Dec-98	Apr-99	Jul-99	Oct-99	Dec-99	Apr-00	Jul-00	Oct-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Aster weed	Aster subulatus	✓		✓														
Azolla	Azolla sp.	✓	✓															
Blown grass	Agrostis avenacea	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓					
Capeweed	Arctotheca calendula																✓	✓
Cats ear / Flatweed	Hypochoeris radicata										✓							
Celery buttercup	Ranunculus sceleratus	✓																
Chickweed	Stellaria media	✓																
Clove strip	Ludwigia peploides	✓																
Clover	Trifolium sp.	✓												✓				
Common rush	Juncus usitatus		✓	✓	✓													
Common sneezeweed	Centipeda cunninghamii	✓																
Common spike sedge	Eleocharis acuta	✓																
Common tussock grass	Poa labillardiera	✓																
Corkscrew grass	Stipa setacea		✓															
Couch grass (si)	Cynodon dactylon			✓		✓							✓			✓		
Curled Dock	Rumex bidins			✓		✓		✓	✓	✓	✓	✓		✓				
Drain flat sedge	Cyperus eragrostis	✓																
Fleabane	Conyza bonariensis				✓	✓	✓											
Foxtail	Alopecurus sp.	✓	✓															
Garden dandelion	Taraxacum sp.		✓															
Hares foot clover	Trifolium arvense																	
Hogweed	Zaleya sp.										✓							
Hyssop Loosestrife	Lythrum hyssopifolia	✓																
Jersey cudweed	Gnaphalium luteo-album	✓																
Marigold	Calendula sp.	✓																
Medic	Medicago sp.	✓	✓															
Milk thistle	Sonchus oleraceus		✓		✓	✓	✓							✓	✓			
Moss													✓					
Mud dock	Rumex bidens		✓															
Lesser Joyweed	Alternanthera denticulata	✓																
Nardoo	Marsilea drummondii			✓			✓				✓		✓	✓	✓	✓		
Onion Grass	Romulea rosea								✓	✓						✓		
Ox tongue	Picris echioides	✓									✓							
Paspalum	Paspalum dilatatum		✓								✓							
Peppercress	Lepidium sp.															✓		
Poison pratea	Pratia concolor																✓	✓
Prostrate knotweed	Polygonum aviculare	✓																
Prickly lettuce	Lactuca serriola	✓			✓	✓					✓		✓					
Prickly sowthistle	Sonchis asper	✓																
River buttercup	Ranunculus inundatus																	
River red gum	Eucalyptus camaldulensis					✓												
Robust milfoil	Myriophyllum papillosum	✓																
Rough spear grass	Stipa scabra			✓			✓				✓							
Rye grass	Lolium sp.					✓	✓				✓	✓	✓	✓	✓	✓		
Scotch thistle	Onopordum acanthium		✓			✓							✓			✓		
Sea barley grass (si)	Critesion marinum								✓	✓								
Slender knotweed	Persicaria decipiens	✓																
Small spike rush / sedge	Eleocharis pusilla					✓												
Spear thistle	Cirsium vulgare	✓	✓	✓					✓	✓				✓				
Squirrel tail fescue	vulpia bromoides										✓			✓	✓	✓		
Star fruit	Damasonium minus	✓																
Swamp isotome	Isotoma fluviatilis													✓				
Swamp wallaby grass	Amphibromus neesii	✓																
Tangled lignum	Muehlenbeckia florulenta	✓																
Toad rush	Juncus bufonius	✓																
Tumble weed	Amaranthus albus		✓															
Twining toad flax	Kickxia sieberi												✓					
Upright Milfoil	Myriophyllum crispatum	✓	✓															
Wallaby grass	Danthonia sp.			✓		✓							✓	✓				
Water couch	Paspalum paspalodes	✓																
Water lily	Nymphaea alba		✓															
Wild Oats	Avena sp.											✓	✓				✓	✓
Willow herb	Epilobium sp.	✓																
	Total Species	31	14	9	5	10	6	2	5	5	11	4	10	9	4	7	3	3
	Salt Indicator Species	0	0	1	0	1	0	0	1	1	0	0	1	0	0	1	0	0

The only noticeable changes to the vegetation at this quadrat location are that a few of the species that usually grow in wetter areas such as celery buttercup, common rush, water lily, water couch, upright milfoil, slender knotweed, lesser joyweed, plus others, are only present at the beginning of surveys in late 1997 – early 1998. These species then disappear and haven't been recorded since within the quadrats. Next time this site floods, it would be interesting to see if these species return. The past 2 surveys show a very low number of species present, but this can be directly attributed to the dry conditions.

Kinnairds swamp has also been drier for longer than the macro-invertebrate sampling has been running. Even though the water quality parameters have still been taken from the constructed part of the wetland, macro-invertebrates have not been sampled from this part, but should be sampled if a flood was to fill the greater wetland area.

Remnant Vegetation Sites:

The groundwater data presented in this report is limited only to the bores that are positioned the closest to each of the vegetation quadrat sites. This means that data from only 1 or 2 bores is used to see what is happening with groundwater trends at the vegetation quadrat site. Due to the often complex way groundwater interacts with the surrounding geology of the landscape, and the possibility of large localised variations in groundwater depth (which might not be detected due to small number of bores), the data presented here can only be used as an approximate guide as to what is happening with groundwater at each of the vegetation monitoring sites.

The groundwater contour maps produced by the Tatura GIS team for the Shepparton Irrigation Region are also quite useful for looking at broader groundwater trends around the monitoring sites, and seem to match quite well with the hydrographs presented in this report. These maps are available as GIS layers, and can be added to the monitoring arcview project (see monitoring manual for details), for a good visual representation of broader hydrographical trends. To keep this report more specific, I have omitted this information and concentrated only on the mandatory monitoring bores.

Timmering

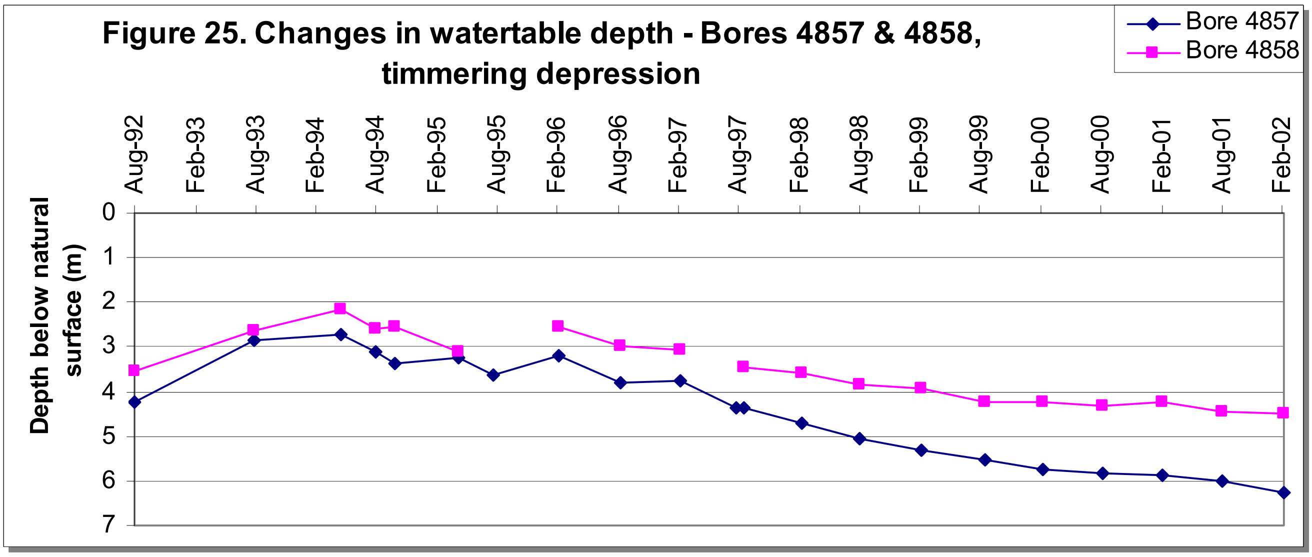


Figure 25. Changes in watertable depth - Bores 4857 & 4858, timmering depression

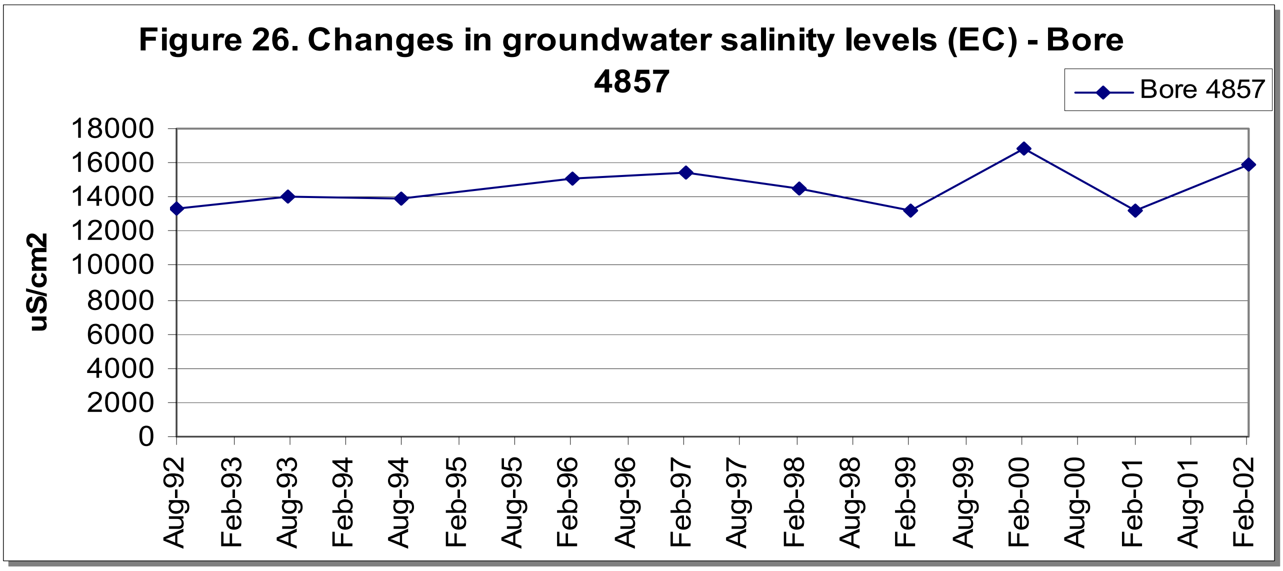


Figure 26. Changes in groundwater salinity levels (EC) - Bore 4857

The two bores that are monitored at Timmering depression (4857 & 4858) are located fairly close to each other (see diagram in monitoring manual), with the vegetation quadrats located midway between the two bores. We assume that the groundwater depth at the vegetation quadrat sites is fairly close to the depth at the bore locations.

Figure 25 shows an encouraging trend for groundwater at this site. There is a steady fall in groundwater depth since early 1996. The depth has fallen from around 2.5 – 3 metres below the surface, to about 4.5 – 6 metres below, and in early 2002 still appears to be falling (data for the rest of 2002 still needs to be obtained from Sinclair Knight Mertz).

The EC levels have also remained at a fairly constant level over the past 10 years, and seem to be fluctuating between about 13000 and 16500 EC.

Table 6. Vegetation data for Timmering Site 1.

Common name	Botanical name	Nov-97	Dec-98	Unknown date	Jul-99	Nov-99	Dec-99	Apr-00	Oct-00	Feb-01	May-01	Jun-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Annual beard grass (si)	Polypogon monspeliensis					✓											
Ball clover	Trifolium glomeratum					✓	✓	✓	✓						✓		
Barrel clover						✓											
Bears ear	Cymbonotus lawsonianus						✓										
Blown grass	Agrostis avenacea			✓		✓	✓	✓	✓								
Blue bell	Wahlenbergia sp.			✓										✓			
Buttercup	Ranunculus sp.					✓											
Canegrass	Eragrostis australasica		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓
Capeweed	Arctotheca calendula																
Cats ear / Flatweed	Hypochoeris radicata			✓			✓			✓	✓	✓	✓	✓	✓	✓	✓
Clover	Trifolium sp.			✓							✓	✓	✓	✓		✓	
Common rush	Juncus usitatus		✓	✓	✓						✓					✓	✓
Couch grass (si)	Cynodon dactylon							✓		✓	✓	✓		✓			
Curled Dock	Rumex bidins							✓		✓				✓		✓	✓
Flat weed					✓	✓		✓	✓								
Garden dandelion	Taraxacum sp.	✓				✓											
Great brome	Bromus diandrus	✓				✓											
Hares foot clover	Trifolium arvense					✓											
Hyssop Loosestrife	Lythrum hyssopifolia					✓							✓				
Iris	Gynandriris sp.					✓											
Kidney weed	Dichondra repens												✓				
Lovegrass	Eragrostis sp.									✓	✓	✓					
Milk thistle	Sonchus oleraceus	✓	✓			✓											✓
Moss											✓	✓	✓		✓	✓	
Nardoo	Marsilea drummondii	✓	✓	✓													
Narrow leaf clover	Trifolium angostifolium												✓				
Onion Grass	Romulea rosea			✓			✓					✓			✓		✓
Ox tongue	Picris echioides	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Oxalis	Oxalis sp.													✓			
Pale rush	Juncus pallidus		✓														
Pennisetum grass	Pennisetum sp.	✓															
Perrenial rye-grass	Lolium perenne	✓															
Poison pratea	Pratia concolor	✓														✓	
Prickly lettuce	Lactuca serriola	✓		✓	✓										✓		
River red gum	Eucalyptus camaldulensis		✓	✓							✓						
Rough spear grass	Stipa scabra						✓	✓	✓						✓		
Rush	Juncus sp.	✓															
Rye grass	Lolium sp.					✓	✓			✓	✓	✓	✓				✓
Scotch thistle	Onopordum acanthium		✓			✓	✓			✓	✓	✓	✓				✓
Sea barley grass (si)	Critesion marinum			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
Sedge	Cyperus sp.			✓													
Silky brome	Bromus molliformis											✓	✓			✓	
Small spike rush / sedge	Eleocharis pusilla					✓											
Soft brome	Bromus hordeaceus					✓											
Sower thistle						✓											
Spear / Perennial thistle	Cirsium vulgare	✓		✓	✓			✓	✓					✓			
Spider grass	Enteropgon acicularis																
Squirrel tail fescue	vulpia bromoides					✓				✓	✓		✓	✓			
Sub clover	Trifolium subterraneum																
Swamp isotome	Isotoma fluviatilis					✓					✓	✓	✓				
Swamp wallaby grass	Amphibromus neesii	✓				✓											
Tube sedge	Carex tereticaulis	✓															
Variegated thistle	Silybum marianum									✓							
Wallaby grass	Danthonia sp.									✓	✓	✓	✓	✓			✓
Water button (si)	Cotula coronopifolia					✓											
Water couch	Paspalum paspalodes			✓	✓												
Wild Oats	Avena sp.	✓		✓		✓				✓	✓	✓	✓	✓	✓	✓	✓
Yellow wood sorrel	Oxalis corniculata			✓													
	Total Species	14	7	17	7	25	11	10	8	13	16	15	14	10	10	9	11
	Salt Indicator Species	0	0	1	0	3	1	2	1	2	2	2	1	1	1	0	1

Table 7. Vegetation data for Timmering Site 2

Common name	Botanical name	Nov-97	Dec-98	Dec-99	Apr-00	Oct-00	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Blown grass	Agrostis avenacea		✓	✓								
Blue bell	Wahlenbergia sp.									✓		
Canegrass	Eragrostis australasica		✓									
Cats ear / Flatweed	Hypochoeris radicata				✓	✓	✓					
Clover	Trifolium sp.	✓	✓									
Common rush	Juncus usitatus		✓									
Common spike sedge	Eleocharis acuta	✓										
Couch grass (si)	Cynodon dactylon						✓					
Hares foot clover	Trifolium arvense	✓										
Prickly lettuce	Lactuca serriola	✓										
Milk thistle	Sonchus oleraceus	✓										
Moss							✓	✓		✓	✓	✓
Nardoo	Marsilea drummondii						✓	✓	✓	✓	✓	✓
Ox tongue	Picris echioides	✓										
Pennisetum grass	Pennisetum sp.	✓										
Perennial thistle									✓			
Poison pratea	Pratia concolor	✓									✓	✓
River red gum	Eucalyptus camaldulensis	✓	✓						✓			
Rush	Juncus sp.	✓										
Rye grass	Lolium sp.							✓				
Scotch thistle	Onopordum acanthium		✓								✓	✓
Pale rush	Juncus pallidus		✓									
Spear / Perennial thistle	Cirsium vulgare	✓										
Swamp isotome	Isotoma fluviatilis						✓	✓				
Swamp wallaby grass	Amphibromus neesii	✓										
Upright Milfoil	Myriophyllum crispatum	✓										
Wallaby grass	Danathonia sp.						✓	✓				
	Total Species	13	7	1	1	1	6	5	3	3	4	4
	Salt Indicator Species	0	0	0	0	0	1	0	0	0	0	0

The vegetation data for the remnant vegetation sites is unfortunately, quite difficult to analyse for changes to the vegetation quality and composition at the quadrat sites using the current techniques. The quadrats almost completely fail to include any of the overstorey vegetation at the sites, because the scale that the surveys are conducted at is simply too small to take into account the larger scale surrounding overstorey vegetation. The photographs are the only data collection method that takes the overstorey into consideration, and some changes to overstorey condition may be detected in the photographs. The species lists at least provide some quite good baseline information about what species are present at each site, but are not yet a good analysis tool for environmental change.

Timmering site 1 has a relatively high number of species compared to most of the other vegetation monitoring sites. There are often a number of different thistles present at this location, plus quite a few different native and introduced grasses. The vegetation composition here does not seem to have changed dramatically since monitoring began. There have been 4 species recorded here that are commonly found at mildly salty sites, but none of them appear to be dominating the area. Plus the presence of salt sensitive clover species suggests that salinity is not a problem at this site.

Site 2 has far fewer species than site 1, which is probably due mainly to the greater tree canopy cover here. Many of the quadrats here end up being bare and heavily covered by red gum litter. Mainly thistles push through this litter layer, plus a few grasses, but not much else.

Mosquito

Figure 27. Changes in groundwater depth - Bore 3382, Mosquito depression

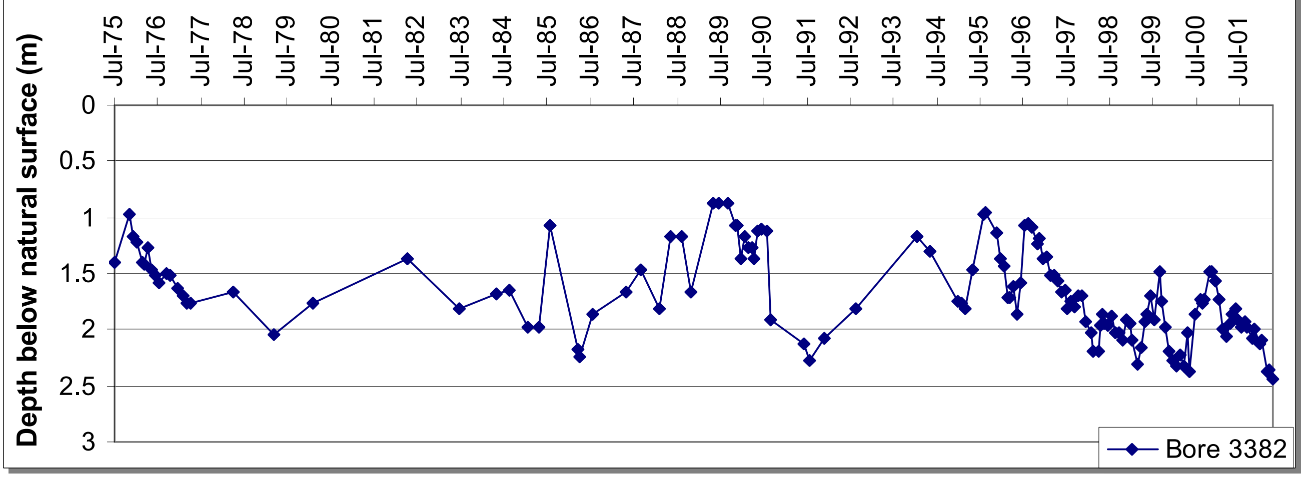
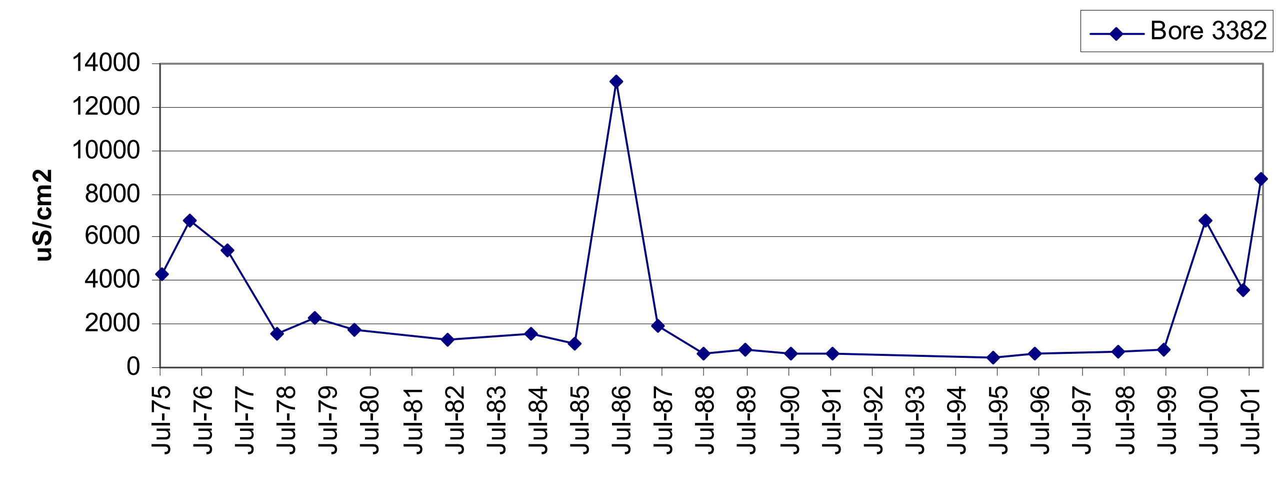


Figure 28. Changes in groundwater salinity levels (EC) - Bore 3382



The bore at Mosquito depression has been monitored for a long time, and I have decided to include all of the data in this report to get an idea of what the groundwater has been doing over a longer stretch of time. Groundwater depth at this location fluctuates quite a lot, which might be explained by the proximity of the bore to irrigated pastures for dairying. Between 1975 and mid 1996, the depth below natural surface fluctuates between about 90cm and 2.3m. After mid 1996, there does appear to be a falling trend, and the most recent reading included here indicates that the groundwater depth here has almost hit the 2.5 metre mark for the first time since the data begins in 1975.

EC levels have also remained quite constant since 1975, except for 3 periods where the salinity levels have become elevated. These are quite clearly seen on Figure 28. The peak at around July 1986 reach about 13000 EC, which is a very large jump from the more usual levels of less than 2000 EC. There also appears to be an increasing trend over the last 2-3 years as the groundwater depth is gradually falling.

Vegetation

Table 8. Vegetation data for Mosquito depression

Common name	Botanical name	Nov-97	Apr-99	Jul-99	Nov-99	Apr-00	Jul-00	Oct-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Blackberry	Rubus fruticosus		√		√											
Blackberry night shade	Solanum nigrum		√													
Canegrass	Eragrostis australasica		√													
Capeweed	Arctotheca calendula		√	√	√	√	√	√				√			√	
Cats ear / Flatweed	Hypochoeris radicata		√	√	√	√			√	√	√	√	√	√	√	√
Caustic weed	Euphorbia drummondii												√	√		√
Clover	Trifolium sp.	√	√	√	√		√	√	√	√	√	√	√	√	√	√
Common Everlasting	Helichrysum apiculatum								√	√	√					
Common rush	Juncus usitatus		√													
Couch grass (si)	Cynodon dactylon		√			√	√	√							√	
Crowfoot	Erodium sp.		√		√										√	
Curled Dock	Rumex bidins	√	√		√				√		√	√	√		√	
Drain flat sedge	Cyperus eragrostis		√													
Field cress			√													
Geranium / Cranesbill	Geranium sp.		√						√	√		√	√	√		
Great brome	Bromus diandrus	√														
Heliotrope	Heliotropium sp.		√													
Hogweed	Zaleya sp.		√						√	√						
Marsh mellow	Malva parviflora	√	√							√						
Medic	Medicago sp.		√													
Milk thistle	Sonchus oleraceus	√										√				
Moss										√					√	√
Nardoo	Marsilea drummondii		√													
Onion Grass	Romulea rosea	√		√	√		√	√	√	√	√	√	√	√	√	
Ox tongue	Picris echioides				√	√	√	√	√	√	√	√	√	√	√	
Oxalis	Oxalis sp.	√							√							
Paddy mellon	Cucumis myriocarpus		√													
Paspalum	Paspalum dilatatum	√	√	√	√				√	√	√	√	√	√		√
Perennial rye-grass	Lolium perenne	√														
Phalaris	Phalaris aquatica		√													
Prostrate knotweed	Polygonum aviculare	√														
Prickly lettuce	Lactuca serriola	√	√													
River red gum	Eucalyptus camaldulensis		√													
Rough spear grass	Stipa scabra												√			
Rye grass	Lolium sp.				√							√		√	√	√
Santa clause										√						
Scotch thistle	Onopordum acanthium				√					√				√		
Sea barley grass (si)	Critesion marinum		√		√			√	√	√	√	√	√	√		√
Silky brome	Bromus molliformis											√				
Soft brome	Bromus hordeaceus	√			√											
Sower thistle			√													
Spear thistle	Cirsium vulgare		√			√	√									
Spider grass	Enteropgon acicularis												√			
Squirrel tail fescue	vulpia bromoides				√	√										
Sub clover	Trifolium subterraneum				√											
Sweat Briar	Rosa rubiginosa															√
Wallaby grass	Danthonia sp.	√	√		√				√	√	√	√	√	√		√
Wild Oats	Avena sp.													√	√	
Windmill grass (si)	Chloris truncata											√		√		√
Yellow box	Eucalyptus melliodora		√													
Yellow wood sorrel	Oxalis corniculata				√											√
	Total Species	13	28	5	17	6	6	6	12	14	9	14	12	13	11	11
	Salt Indicator Species	0	2	0	1	1	1	2	1	1	1	2	1	2	1	2

The vegetation at this site is often heavily grazed by stock. The number of species recorded here is still quite high, and remains fairly consistent throughout the monitoring period. One or two salt tolerant species are usually present here, but there is no indication that salinity is having an impact on the vegetation within the quadrats. But looking at the photographs of the overstorey vegetation at this location, the bulokes are showing quite a bit of dieback towards the lower lying parts of the remnant. It is difficult to tell from the photographs if this dieback has been getting worse over the past few years, and the precise cause of this dieback is not possible to deduce from this monitoring data.

Minchins

The groundwater bores at the Minchins vegetation-monitoring site were installed at the beginning of the mandatory monitoring project, and are not a part of the bore network monitored by Sinclair Knight Mertz and entered into the statewide database. The bore data presented below has been collected by environmental monitoring officers since monitorng began, and has not been subjected to the same data collection protocols or quality control that the other bores have.

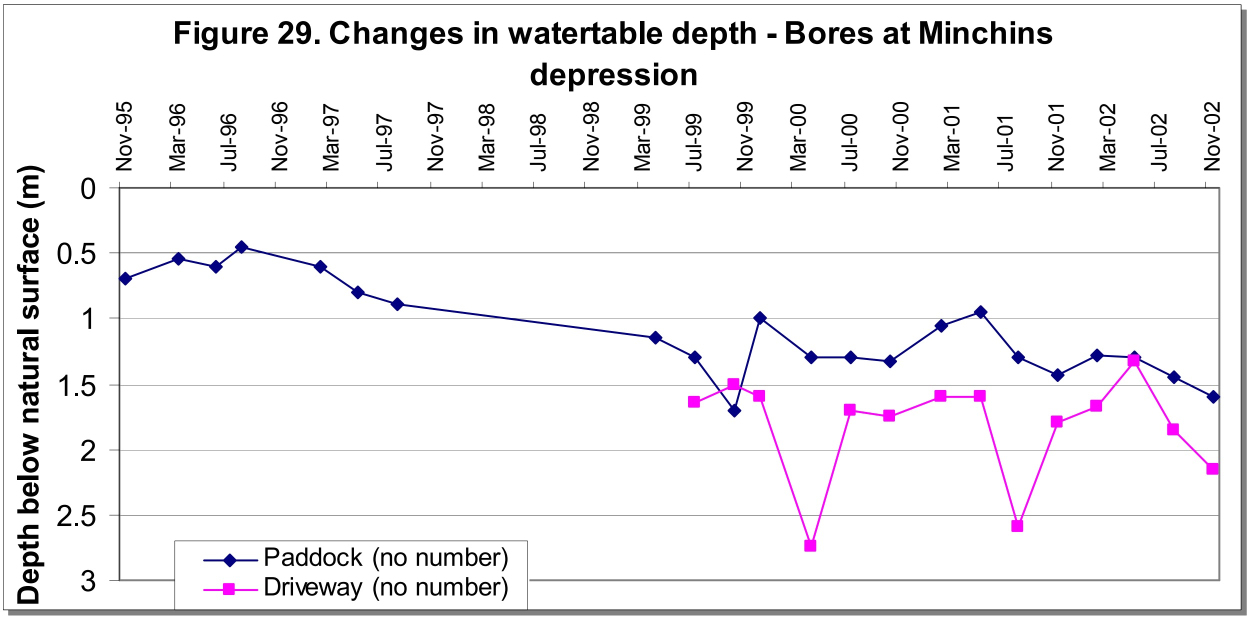


Figure 29. Changes in watertable depth - Bores at Minchins depression

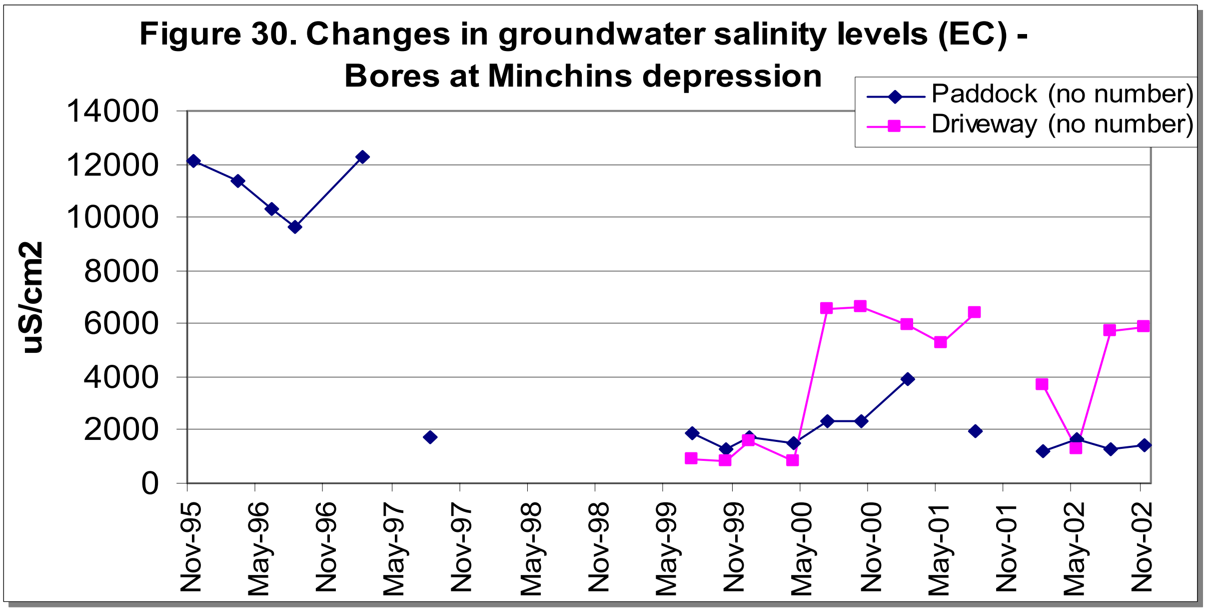


Figure 30. Changes in groundwater salinity levels (EC) - Bores at Minchins depression

The bore labelled 'paddock' in figure 29, is located right near the vegetation quadrat (see diagram in monitoring manual), and has the longest data set for this monitoring site. The bore labelled 'driveway' has a much shorter data set, and is located further away from the vegetation quadrat.

Victoria The Place To Be

At the commencement of monitoring, the depth below natural surface is between 1m and 0.5m, but after July 1996, a constant fall in groundwater depth begins, and continues until mid 1999 to about 1.7 metres. Groundwater then holds steady at approximately 1.3 metres below natural surface for about 2.5 years (until mid 2002), and it appears to be falling again for the second half of 2002.

The driveway bore shows two sharp falls (over a metre in a very short period of time) in groundwater depth, which then return to almost the same level as before in an equally short period. In general, the depth below natural surface has remained fairly constant, and the latter half of 2002 shows a gradual fall (which is consistent with the bore located in the paddock).

The EC readings at the paddock bore start at a quite high level of between 10000 – 12000 µS/cm in 1995 – 96, and the next reading in 1997 shows the EC levels have fallen dramatically to less than 2000 µS/cm. From this point on, the EC levels at this bore generally remain around the 2000 µS/cm level.

Table 9. Vegetation data for Minchins depression

Common name	Botanical name	Nov-97	Nov-98	Jul-99	Oct-99	Dec-99	Apr-00	Jul-00	Oct-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Annual beard grass (si)	Polypogon monspeliensis		✓														
Blackberry night shade	Solanum nigrum									✓	✓						
Capeweed	Arctotheca calendula			✓	✓	✓		✓	✓		✓					✓	
Clover	Trifolium sp.		✓							✓		✓	✓	✓			
Couch grass (si)	Cynodon dactylon	✓	✓			✓	✓					✓		✓	✓	✓	
Creeping saltbush (si)	Atriplex semibaccata																✓
Curled Dock	Rumex bidins									✓		✓		✓			
Fat hen	Chenopodium album	✓															
Hogweed	Zaleya sp.									✓	✓	✓		✓	✓		
Hyssop Loosestrife	Lythrum hyssopifolia		✓														
Knotweed	Polygonum sp.			✓													
Lucerne	Medicargo sativa												✓				
Marsh mellow	Malva parviflora											✓		✓		✓	✓
Milk thistle	Sonchus oleraceus				✓	✓											
Nettle-leaf Goosefoot	Chenopodium murale														✓		
Paspalum	Paspalum dilatatum			✓						✓	✓						
Perrenial rye-grass	Lolium perenne	✓	✓														
Prostrate knotweed	Polygonum aviculare	✓	✓														
Rye grass	Lolium sp.												✓		✓		✓
Saltbush (si)	Atriplex sp.		✓														
Sea barley grass (si)	Critesion marinum			✓	✓	✓		✓	✓	✓			✓		✓		✓
Shepherds purse	Capsella bursa-pastoris												✓				
Skeleton weed	Chondrilla juncea			✓			✓										
Spear thistle	Cirsium vulgare			✓	✓	✓											
Spider grass	Enteropgon acicularis												✓				
Strawberry clover (si)	Trifolium fragiferum																✓
Wall barley grass	Critesion murinum ssp. Leporinum	✓	✓														
Wild Oats	Avena sp.												✓				
Windmill grass (si)	Chloris truncata											✓		✓			✓
	Total Species	5	8	6	4	5	2	2	2	6	4	6	7	6	5	3	6
	Salt Indicator Species	1	3	1	1	2	1	1	1	1	0	2	1	2	2	1	4

Muckatah

I have once again included bore data from before mandatory monitoring commenced, to see how the groundwater has risen over a long period of time at this site, and then stopped at around the two metre depth mark for about the past 10 years.

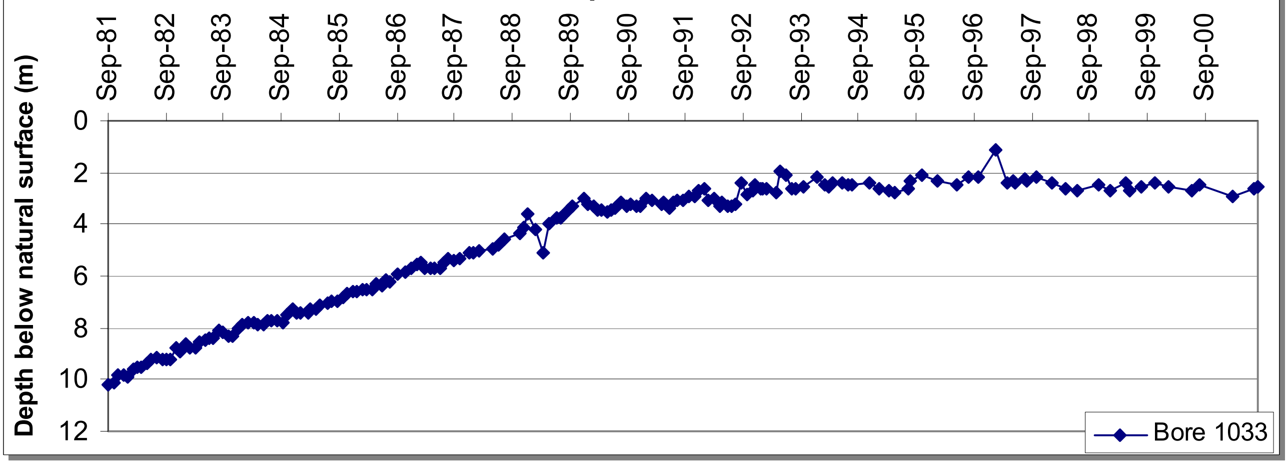


Figure 31. Changes in groundwater depth - Bore 1033, Muckatah depression

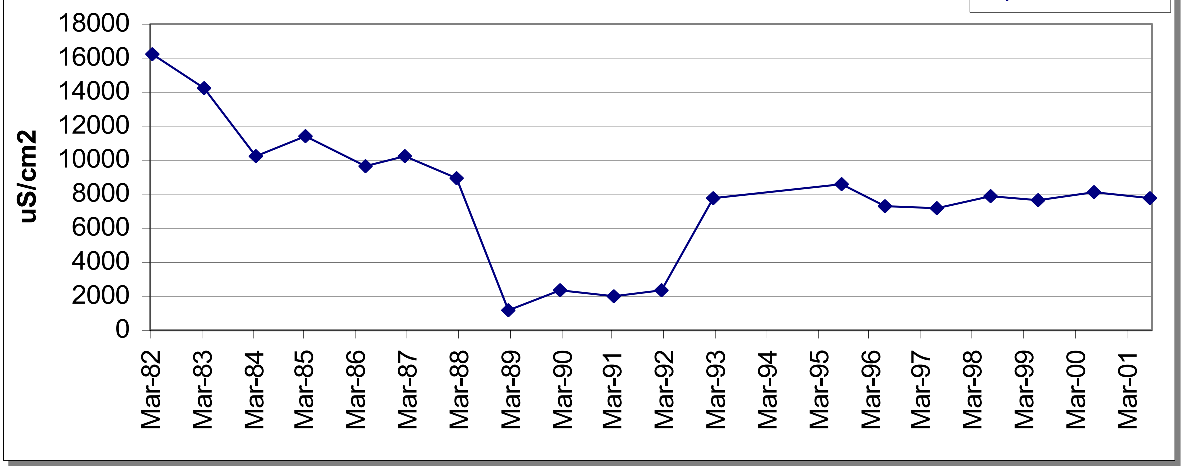


Figure 32. Changes in groundwater salinity levels (EC) - Bore 1033

After the groundwater stabilisation at around 2 metres depth for about the 4 years leading up to 1996 (where the shallowest depth occurred), the groundwater seems to be very gradually declining again. However, considering the current extremely dry conditions, it is a little bit concerning that the groundwater at this site is not falling as markedly as the other monitoring sites.

The salinity levels at Muckatah have varied quite dramatically over the past 20 years. The most noticeable feature of these changes (see figure 32) is the dip in EC levels to reasonably low levels from about 1989 to 1992. Prior to this the EC levels fell around 14000 EC, quite a dramatic change. After 1992, they increase again to about 8000 EC where they have stabilised until present.

Table 10. Vegetation data for Muckatah site 1.

Common name	Botanical name	Nov-97	Nov-98	Unknown date	Jul-99	Nov-99	Dec-99	Apr-00	Jul-00	Feb-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Ader						✓												
Ball clover	Trifolium glomeratum					✓												
Bindweed	Convululus erubescens					✓										✓		
Blackberry night shade	Solanum nigrum			✓														
Blown grass	Agrostis avenacea			✓														
Buloke	Casuarina leuhmannii			✓							✓	✓	✓	✓	✓	✓	✓	✓
Capeweed	Arctotheca calendula																✓	
Cats ear / Flatweed	Hypochoeris radicata					✓												
Clover	Trifolium sp.												✓	✓			✓	
Common rush	Juncus usitatus	✓		✓														
Corkscrew grass	Stipa setacea		✓															
Corrigated / Variable sida	Sida corrugata													✓	✓	✓	✓	
Couch grass (si)	Cynodon dactylon								✓	✓			✓	✓	✓			
Crowfoot	Erodium sp.			✓													✓	
Cumbungi	Typha domingensis or orientalis			✓														
Curled Dock	Rumex bidins			✓	✓	✓			✓						✓	✓		✓
Field cress				✓														
Geranium / Cranesbill	Geranium sp.												✓					
Grassland wood sorrel	Oxalis sp.											✓	✓					
Grassy bird weed											✓							
Grey box	Eucalyptus microcarpa	✓		✓							✓							
Hares foot clover	Trifolium arvense					✓												
Heliotrope	Heliotropium sp.		✓															
Hogweed	Zaleya sp.														✓			
Horehound	Marrubium vulgare	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
Iris	Gynandriris sp.					✓												
Lichen						✓												
Lucerne	Medicargo sativa													✓				
Medic	Medicago sp.		✓															
Milk thistle	Sonchus oleraceus					✓												
Moss					✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Nardoo	Marsilea drummondii			✓														
Nodding saltbush (si)	Rhagodia nutans								✓									
Onion Grass	Romulea rosea	✓		✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓
Oxalis	Oxalis sp.	✓			✓													
Peppercress	Lepidium sp.					✓										✓		
Perrenial rye-grass	Lolium perenne	✓																
Phalaris	Phalaris aquatica			✓	✓						✓							
Prickly lettuce	Lactuca serriola			✓														
Rough spear grass	Stipa scabra	✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rush	Juncus sp.		✓															
Rye grass	Lolium sp.			✓		✓	✓							✓		✓		✓
Sea barley grass (si)	Critesion marinum			✓		✓	✓											
Short wallaby grass	Danthonia carphoides							✓		✓								
Sida	Sida sp.	✓				✓												✓
Skeleton weed	Chondrilla juncea									✓								
Small spike rush / sedge	Eleocharis pusilla			✓														
Soft brome	Bromus hordeaceus	✓				✓												
Spear thistle	Cirsium vulgare			✓														
Spider grass	Enteropgon acicularis													✓				
Squirrel tail fescue	vulpia bromoides					✓	✓									✓		
Stinging nettle	Urtica urens			✓					✓				✓			✓		
Turnip weed	Rapistrum rugosum												✓					
Wall barley grass	Critesion murinum ssp. Leporinum	✓																
Wallaby grass	Danthonia sp.	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
Water couch	Paspalum paspalodes			✓	✓													
Wild Oats	Avena sp.			✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓
Windmill grass (si)	Chloris truncata		✓				✓	✓		✓	✓					✓		✓
Wingless bluebush	Maireana enchylaenoides			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow wood sorrel	Oxalis corniculata			✓		✓	✓							✓	✓	✓	✓	✓
	Total Species	11	5	25	8	23	10	6	10	8	12	9	13	15	12	16	12	13
	Salt Indicator Species	0	1	1	0	1	2	1	2	2	1	0	1	1	1	1	0	1

This site is dominated by grasses, especially rough spear grass, wallaby grass and onion grass. There is also a lot of horehound around this site. The vegetation data for this site does not suggest any increasing salinity influence, and the overstorey condition shown in the photographs remains very good here. There is also a reasonable amount of grey box regeneration where the site 1 quadrats are located, and the development of these trees is clear within the photographs.

Table 11. Vegetation data for Muckatah site 2.

Common name	Botanical name	Nov-97	Nov-98	Jul-99	Feb-00	Apr-00	Jul-00	Feb-01	May-01	Aug-01	Nov-01	Feb-02	May-02	Aug-02	Nov-02
Canegrass	Eragrostis australasica											✓			
Capeweed	Arctotheca calendula			✓						✓				✓	
Cats ear / Flatweed	Hypochoeris radicata							✓	✓	✓	✓		✓	✓	✓
Caustic weed	Euphorbia drummondii										✓	✓			
Clover	Trifolium sp.		✓												
Common rush	Juncus usitatus	✓	✓							✓					
Corkscrew grass	Stipa setacea		✓												
Corrigated / Variable sida	Sida corrugata										✓	✓	✓	✓	✓
Couch grass (si)	Cynodon dactylon					✓	✓	✓	✓	✓	✓	✓			
Crowfoot	Erodium sp.												✓	✓	
Curled Dock	Rumex bidins						✓						✓	✓	
Geranium / Cranesbill	Geranium sp.	✓													
Heliotrope	Heliotropium sp.		✓												
Hogweed	Zaleya sp.											✓	✓	✓	
Horehound	Marrubium vulgare		✓		✓	✓	✓	✓	✓		✓				
Hyssop Loosestrife	Lythrum hyssopifolia												✓		
Knotweed	Polygonum sp.			✓											
Marsh mellow	Malva parviflora									✓	✓			✓	✓
Milk thistle	Sonchus oleraceus	✓					✓								
Moss					✓		✓	✓	✓	✓				✓	✓
Nodding saltbush (si)	Rhagodia nutans						✓								
Onion Grass	Romulea rosea	✓		✓			✓	✓	✓	✓	✓		✓	✓	✓
Oxalis	Oxalis sp.	✓									✓				
Paspalum	Paspalum dilatatum								✓					✓	
Perrenial rye-grass	Lolium perenne	✓													
Phalaris	Phalaris aquatica			✓											
Rough spear grass	Stipa scabra	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rush	Juncus sp.		✓												
Rye grass	Lolium sp.							✓	✓		✓				✓
Scotch thistle	Onopordum acanthium							✓	✓	✓					
Sea barley grass (si)	Critesion marinum							✓	✓		✓	✓	✓		✓
Shepherds purse	Capsella bursa-pastoris										✓				
Short wallaby grass	Danthonia carphoides				✓	✓									
Sida	Sida sp.	✓													✓
Skeleton weed	Chondrilla juncea					✓									
Soft brome	Bromus hordeaceus	✓												✓	
Spear thistle	Cirsium vulgare	✓		✓											
Spider grass	Enteropgon acicularis	✓								✓	✓				
Squirrel tail fescue	vulpia bromoides								✓		✓	✓			
Stinging nettle	Urtica urens						✓								
Spear grass	Stipa sp.	✓													
Turnip weed	Rapistrum rugosum									✓					
Wall barley grass	Critesion murinum ssp. Leporinum	✓													
Wallaby grass	Danthonia sp.	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
Water couch	Paspalum paspalodes			✓											
Wild Oats	Avena sp.	✓	✓	✓				✓			✓	✓	✓		✓
Windmill grass (si)	Chloris truncata				✓	✓	✓						✓	✓	✓
Wingless bluebush	Maireana enchylaenoides			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow wood sorrel	Oxalis corniculata						✓		✓	✓		✓	✓	✓	✓
	Total Species	15	7	8	6	8	12	12	14	14	17	12	14	16	14
	Salt Indicator Species	0	0	0	1	2	3	2	2	1	2	2	2	1	2

The vegetation seen at this site is very similar to site 1, which is expected considering the proximity of the two sites. The quadrats are again dominated by grasses, and the species composition has not changed much during the monitoring period. Although grazing is generally absent from this site, there have been occasional disturbances by the landholder to remove woody debris and weeds from around the area, but tree regeneration and the mature trees have not been harmed.

Conclusions / Recommendations:

One of the main aims of this monitoring project was to try and gauge how well environmentally valuable yet vulnerable areas were coping with salinity. From the data collected so far from the 7 mandatory monitoring sites, it is very difficult to differentiate the impacts of one form of potential environmental degradation (ie salinity), from a number of other potential causes that may be present (ie the effect of a severe drought, or intensive agricultural practices).

The salinity levels at each monitoring site do not appear to be getting any higher, but keeping in mind the dry conditions that have prevailed over recent years, continued monitoring of salinity levels at these sites needs to continue, especially to see what the return of wetter seasons will do to salinity levels. No conclusions can be drawn regarding the effect of salt on these remnant vegetation or wetland sites.

Nutrient levels for the wetland sites were the biggest surprise within the monitoring data. The elevated nutrient levels at Reedy swamp to levels far greater than would cause concern in a lowland stream, do not seem to be causing any adverse environmental effects here at this site. A high priority should be put on continued monitoring of water quality to see where the nutrient source is coming from, and if nutrient levels again fall back to more normal levels, or to monitor for adverse impacts if they don't. These results perhaps also highlight how little is know about the significance of different levels of water quality parameters for wetlands in this part of Australia. Future investigating into different thresholds for water quality in these particular wetlands would be helpful to try and gauge when any of the water quality parameters is reaching a concerning level.

The elevated nutrient levels at Reedy swamp in the recent past should be something to keep in mind if water from this wetland is released into the Goulburn river. Monitoring of water quality at the outlet would be wise if water was released from the wetland.

Some recommendations are also included at the end of the macro-invertebrate reports that accompany this report. I would also strongly recommend that macro-invertebrate monitoring be continued, at least at Reedy swamp, since this site may potentially be affected by the high nutrient loadings, and it is important to see how these loadings are affecting the biota of this wetland.

One very important bit of information that has not been collected adequately is the depth of the wetland at the time of monitoring both water quality and macro-invertebrates. Depth gauges that are set to the Australian Height Datum (AHD), would provide extremely valuable information that could help to describe some of the trends in water quality at the wetland sites. The water quality parameters that were omitted for a few years should also be resumed.

This report also highlights the need for consistency when collecting monitoring data. The manual accompanying the report will not ensure consistency of data collection, but until this is achieved, the robustness of the data will never be adequate.

The vegetation survey data collection, storage, and analysis really needs to be looked at. It is not going to serve its aims with the present approach.

<u>References</u>:

1. Australia and New Zealand Environment and Conservation Council (2000): Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines (Chapters 1-7).

2. Office of the Commissioner for the Environment (1998): State of the Environment report 1988, Victoria's Inland Waters.