

**Corangamite Catchment Management Authority**

**Treatment Options for Discharge Management**

**March 2008**



**RMCG**

ABN: 35 154 629 943

Consultants for Business, Communities & Environment

**Bendigo Office:**

135 Mollison Street, Bendigo  
PO Box 2410 Mail Centre, Bendigo, Victoria 3554  
T (03) 5441 4821 F (03) 5441 2788

**Melbourne Office:**

Suite 1, 357 Camberwell Road, Camberwell 3124  
T (03) 9882 2670 F (03) 9882 0996

E [rm@rmcg.com.au](mailto:rm@rmcg.com.au) W [www.rmcg.com.au](http://www.rmcg.com.au)

**Contact Details:**

Name: J. McRobert  
 Title: Senior Consultant  
 Address: Box 2410, Mail Centre, Bendigo 3554  
 P: (03) 5441 4821  
 F: (03) 5441 2788  
 P: 0427 679 038  
 E: jenciem@rmcg.com.au



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# Table of Contents

<b>Executive summary</b>	<b>3</b>
<b>1 Introduction</b>	<b>10</b>
1.1 Project Purpose and Objectives .....	10
1.2 Asset-based Salinity Management Framework .....	10
<b>2 Study Methodology</b>	<b>12</b>
<b>3 Literature Review</b>	<b>14</b>
3.1 Salt Tolerant Pastures (Introduced) .....	14
3.2 Salt Tolerant Native Grasses .....	16
3.3 Weed Potential of Plant Species used to Vegetate Saline Sites .....	18
3.3.1 Tall Wheat Grass ( <i>Lophopyrum ponticum</i> ) (TWG) .....	18
3.3.2 Other weedy species .....	22
<b>4 Observations from Fieldwork</b>	<b>24</b>
4.1 Overview of Issues .....	24
4.2 Review of Saline Discharge Management Actions - Case Study Sites .....	25
4.2.1 Target Area Summary – Colac - Eurack .....	27
4.2.2 Target Area Summary: Corangamite .....	35
4.2.3 Target area summary: Geelong – Connewarre .....	41
4.2.4 Target Area Summary: Geelong Connewarre .....	42
4.2.5 Target area summary: Illabarook .....	45
4.2.6 Target area summary: Pittong .....	51
4.2.7 Target area summary: Lismore - Derrinallum .....	58
<b>5 Project conclusions</b>	<b>64</b>
5.1 Groundwater trends .....	64
5.2 Recommended management actions by target area .....	65
5.3 Distinguishing between primary and secondary salinity .....	67
5.4 Selecting plant species appropriate to plant on secondary salinity sites .....	68
<b>6 Overall project recommendations</b>	<b>70</b>
<b>References</b>	<b>71</b>
<b>Appendix 1: Salt Tolerant Plants for Potential use on Secondary Salinity Sites, Corangamite CMA Region</b>	<b>77</b>
<b>Appendix 2: Evidence of Tall Wheat Grass Invasion</b>	<b>79</b>
<b>Appendix 3: Tall Wheat Grass Guidelines</b>	<b>81</b>
<b>Appendix 4: Ramsar sites within the Corangamite CMA region</b>	<b>82</b>
<b>Appendix 5: Case study reports – Colac - Eurack</b>	<b>83</b>
<b>Appendix 6: Case Study Reports – Lake Corangamite</b>	<b>86</b>

<b>Appendix 7: Case Study Reports – Geelong - Lake Connewarre</b>	<b>87</b>
<b>Appendix 8: Case Study Reports – Illabarook</b>	<b>89</b>
<b>Appendix 9: Case Study Reports – Pittong</b>	<b>91</b>
<b>Appendix 10: Field Site Reports – Lismore - Derrinallum</b>	<b>92</b>

**Acronyms used in this report, include:**

CCMA - Corangamite Catchment Management Authority

CSAP - Corangamite Salinity Action Plan

EM -

TA - Target Area

RCT - Resource Condition Target

DSE - Department of Sustainability and Environment

MA – (Salinity) Management Action

DPI - Department of Primary Industry (Victoria)

CAMS- Catchment Activity Management System

SGSL - Sustainable Grazing on Saline Land

CSAP - Corangamite Salinity Action Plan

VDSMN - Victorian Dryland Salinity Monitoring Network

TWG - Tall Wheat Grass

## Executive Summary

### Introduction

RMCG was commissioned by the Corangamite Catchment Management Authority (CCMA) to undertake a study of treatment options for saline discharge areas.

The purpose of the project was to:

- Evaluate the best treatment options for each target area and develop additional treatment options (where needed) for saline discharge areas in the Corangamite Region.

### Project approach

The approach taken has focused on management actions to achieve agreed objectives for saline discharge management, as outlined in the Corangamite Salinity Action Plan (CSAP). This has involved the preparation of a series of discharge management case studies incorporating local information about existing management actions (MAs) covering land salinity asset types in a number of target areas.

The methodology involved:

- A review of published literature, incentives documentation (from Department of Primary Industries [DPI] officers and CAMS data), consultation with stakeholders and field work; and
- Fieldwork including preparation of case study information reviewing and confirming suitable MAs.

The fieldwork and review of salinity management actions concentrated in six target areas:

- Colac – Eurack, Corangamite, Geelong - Lake Connewarre, Illabarook, Pittong and Lismore-Derrinallum.

Reporting of the fieldwork findings and observations during this study provided a detailed description of each target area and the sites visited, including an update on current groundwater trends and a review of saline discharge management issues and appropriate management actions. The fieldwork has enabled an assessment of the circumstances under which there are limited options for discharge treatment; particularly where nearby environmental values restrict the choice of the usual management actions.

### Literature review

The literature review was a small component of this study and as such it is not presented as a comprehensive review of the Australian literature. However, a substantial proportion of the most recently published work in this area has been reviewed for this study.

There is much evidence in the literature that saline land is capable of supporting some productive grasses and legumes as pastures. For a limited number of species, pasture systems have been devised that are profitable and the benefits outweigh the financial costs associated with establishment and maintenance, and the risk of failure. These include pasture plants such as Tall Wheat Grass (TWG), Tall Fescue, Strawberry/Balansa clovers and Puccinellia, depending on the degree of waterlogging and salinity at a particular site.

There is little question that these species can perform well given the right establishment inputs and management expertise. They offer a viable feed source for grazing sheep in late summer and can go a long way toward filling a vital feed gap.

There is, however, some acknowledgement in the literature that the establishment, management and utilisation of sown saltland pastures can entail ongoing difficulties for many farmers, and adoption in many areas remains low. Some local studies have found that well adapted volunteer plant species can perform well, and that grazing management to improve the composition of desirable species in volunteer “pastures” can be a productive alternative to sowing improved pastures.

A number of indigenous grass species occur naturally in saline sites and require consideration and further evaluation as species potentially useful for establishing on sites of secondary salinity. The main advantage of native species will be reduced weed potential.

Based on local knowledge, field assessment, and personal communications with experts and the literature, this study has put forward a list of 62 plant species as potentially useful on saline sites in the Corangamite region. Of the 62 plant species listed, none are rated as being as invasive as Tall Wheat Grass. Five species are considered highly invasive, 14 as moderately invasive, 13 as having low invasiveness, and three as non-invasive. Of particular significance are 23 species whose invasiveness has not been assessed because they are not known to be naturalised in Victoria, or weed risk assessments have not been published.

With respect to Tall Wheat Grass, the evidence we collected, including literature review, personal communications with experts and field observations made during this study, indicates that:

- Tall Wheat Grass is one the most seriously invasive grass weed species in temperate Australia;
- It has a much wider ecological amplitude than suggested by others, being able to invade many non-saline and non-waterlogged sites of at least moderate fertility;
- Tall Wheat Grass, by extrapolation from numerous sites observed by us, is now naturalised in thousands of locations in Victoria and hundreds of locations in the Corangamite CMA region. The distribution and age structure of populations indicates that it its rapidly recruiting and expanding its range;
- It forms dense, tall, mono-specific swards that destroy subordinate species and prevent the recruitment of all species;
- Vast areas of the Corangamite CMA region are being invaded and will be invaded without appropriate management. These include all Ramsar areas, all upper saltmarshes, estuaries and riparian environments (eg. Barwon and Moorabool Rivers) and grassy woodlands;
- Numerous threatened flora and fauna species in the region are at risk, eg. the critically endangered, Victorian Volcanic Plains endemic, Salt-lake Tussock-grass (*Poa sallacustris*) and saltmarsh habitats of the critically endangered Orange-bellied Parrot. Both species are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*; and
- Tall Wheat Grass has shown by widespread occurrence to be very adept at dispersal without the direct agency of humans (i.e. planted deliberately).

## Selecting Plant Species Appropriate to Plant on Secondary Salinity Sites

In selecting plant species for particular sites many factors need consideration. The objectives for each site need to be clearly established and prioritised for each kind of treatment. Should the site be rehabilitated to provide useful forage to boost farm productivity, or are the objectives to stabilise soils to prevent scalding; lower discharge/reduce water tables; produce wood products (including carbon sequestration) honey or essential oils, for example. Alternatively, the objectives of rehabilitation could be mostly around protecting and enhancing the environmental values of the site. This is of high importance where there are native species present on primary saline sites.

Having established acceptable objectives for revegetation of a site, a number of guidelines will then apply (aside from technical and economic parameters guiding selection) and these will include:

- Weed risk of the species: Weedy species should be avoided as much as possible. Where their use cannot be avoided there should be a rigorous evaluation of the on-site and off-site risks, and in the event that the species does become naturalised, responsibilities for management need to be clearly established;
- Further evaluation of the species: Many species will need to be evaluated by local trials as there are no 'silver bullets' at the present time; and
- Site-specific constraints: While there is much environmental similarity enabling classes of sites to be identified based on soil types, salinity levels etc, there are likely to be site-specific attributes as well. To this extent a limited range of uniform treatments may not be appropriate.

Further critical evaluation and trialling is required to determine which plant species are suitable for establishing on secondary salinity sites in the CCMA. Noteworthy species are discussed below.

## Project Conclusions

This project reviewed current treatments of saline discharge areas and confirmed where these are appropriate and identified where additional treatments are needed. The findings have been validated through some field-based research and a review of relevant literature.

### *Groundwater Trends*

There has been a general downward trend in groundwater levels in bores screened at all depth intervals since the mid 1990s, with a more noticeable falling trend since 2003. These downward trends are apparent in all geomorphic land units. Falls in groundwater levels of around four metres are not uncommon.

### *Recommended Action by Target Area*

Some conclusions and recommendations on the best saline discharge treatment options for each target area follow:

### Colac-Eurack & Lake Corangamite target areas

#### Conclusions:

- Landholders in the Colac-Corangamite area have a mixture of expectations about improving the agricultural productivity of affected sites and some have either planted TWG (with mixed success) or intend to plant TWG.
- Where sites retain native shrubland and other saline adapted species, it would seem that tree planting needs to be carefully targeted in a volcanic plains environment.
- The current suite of management actions are limited and there needs to be an expansion of treatment options that can both meet farmer's objectives around raising the productivity of affected sites, and at the same time, pose no significant threat to nearby environmental assets.
- Natural salt lakes are often under the jurisdiction of public land asset managers and natural vegetation recovery using fencing and grazing management (where applicable) is an effective management action in these situations.
- Landholders in this area are unlikely to be 'life-style' farmers and will have a strong production and farm business focus. They will also have the skills and means to sow salt tolerant pasture and will demand productive alternatives to TWG on sites where it is unacceptable.
- In saline areas away from the main discharge lakes system, where groundwater levels have lowered even marginally, some of these areas may be becoming less hostile to plant growth. Springtime in the southwest saw good leaching rains this year.
- **Recommendation: *Given that the CSAP specifies that within these target areas, the assets threatened by salinity are chiefly environmental, sowing to TWG is not a suitable discharge treatment.***
- **Recommendation: *If current winter-spring rainfall patterns persist and groundwater levels continue to stabilise, more passive treatments, such as fencing for natural vegetation recovery, or sowing less invasive species such as Tall Fescue and salt tolerant clovers (Balansa and Strawberry) should be considered.***

### Geelong – Connewarre target area

#### Conclusions:

- The environmental assets at risk, including Reedy Lake and Lake Connewarre are under the jurisdiction of public land managers with a strong environmental objective around preserving the ecology of naturally saline areas. Natural vegetation recovery using fencing and grazing management (where applicable) are effective management actions at sites where agricultural land adjoins public land.
- Treatment actions that can both meet landholder's objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets are desirable.
- Landholders in this area are more likely to be 'lifestyle' rather than full-time farmers and may have lesser expectations around increasing the agricultural production of what

appears to be mostly primary saline areas (compared for example with those farming around Colac).

- **Recommendation: *Given that the CSAP specifies that within these target areas, the assets threatened by salinity are chiefly environmental, sowing to TWG is not a suitable discharge treatment.***

#### Illabarook target area

##### Conclusions:

- Secondary discharge occurs in association with drainage lines and alluvial valley floors, which means that the use of TWG is restricted in its application due to the risks of invasion of riparian environments. Spiny Rush is aggressive and difficult to remove once it has a stronghold and there is a lack of alternative salt tolerant species that will prevent Spiny Rush reinfestation after its removal.
- The affected areas tend to be degraded and highly modified environments with few (if any) native species remaining, so active intervention is necessary to reduce the impacts of scalding, erosion and salt and sediment wash-off into nearby waterways. Fencing to control grazing on these areas to allow for natural regeneration of desirable species is not a suitable management action. It's too passive.
- Some landholders will prefer a grassed or pasture option and at the moment this will be restricted to using less invasive legumes (Strawberry and Balansa clovers) and exotic grass species such as Tall Fescue. Previous trial work had concluded that soil salinities are invariably too high for these species, however, if falling groundwater levels continue or stabilise it is likely that these species will perform better in these situations in the future.
- **Recommendation: *Given that scalded and degraded areas tend to be small as a proportion of the landscape (i.e. narrow areas associated with a moderately incised drainage system) small woodlots using salt tolerant tree species would be a useful and preferred treatment option.***

#### Pittong target area

##### Conclusions:

- Secondary discharge in drainage depressions is being treated with surface drainage in combination with salt tolerant pasture species, mainly TWG, Tall Fescue and clovers. This is a suitable and effective treatment and implementation of discharge treatments are being driven through an active local landholder group.
- The implementation question is more about setting an appropriate incentive level that reflects the public: private benefit mix and that will be sufficient to trigger the amount of adoption desired to meet water and land salinity targets specified in the CSAP.
- **Recommendation: *An analysis of the current and future incentive rate should be undertaken to facilitate increased adoption.***

### Lismore-Derrinallum target area

#### Conclusions:

- The areas being treated tend to be naturally brackish to semi-saline environments with poorer drained soils in depression areas - topographically low points in the landscape, which would be periodically inundated, or active shallow drainage lines. In such sites it is difficult to reliably distinguish between primary and secondary salinity.
- Observations confirmed that the current suite of management actions for the Lismore-Derrinallum target area are limited and that there needs to be an expansion of treatment options that can both meet individual farmer's objectives around raising the productivity of these sites and/or protecting biodiversity values.
- TWG is invasive in this Volcanic Plains environment and tree planting in some situations could be depriving wetlands and drainage lines of increasingly important environmental flows.
- Again, landholders in this area are unlikely to be 'life-style' farmers and will have a strong production and farm business focus. Many will have the skills and means to sow salt tolerant pasture and will demand productive alternatives to TWG on sites where it is now considered to be unacceptable.
- **Recommendation: Given that native plant species tend to be persisting in affected areas, TWG is an inappropriate management action in these situations.**
- **Recommendation: The applicability of tree planting along brackish (rather than saline and degraded) drainage lines in a volcanic plains environment should also be considered on a case-by-case basis.**

#### Overall project recommendations

In light of these findings, a further set of recommendations has been developed.

These include:

1. Review and refine protocols used to identify primary versus secondary salinity sites to ensure that those making assessments and providing incentives to landholders can apply the most suitable treatment for a site.
2. Review and reconsider current TWG planting guidelines for use in the volcanic plains bioregion. Given that native species tend to persist in salt affected areas, and that the CSAP acknowledges that it is environmental assets that are most at risk in this bioregion, sowing TWG is not a suitable discharge treatment.
3. Trial and evaluate further plant species for use in saline areas in each of the target areas. This is particularly urgent in the Volcanic Plains bioregion, keeping in mind, that under a stabilising groundwater environment some presently useful plant species (such as clovers and Tall Fescue) may become more effective.
4. Review information (published and unpublished) relating to the distribution, biology and ecology of all plant species inhabiting saline sites to provide more rigour in the assessment of saline sites for salinity management actions. Such a study would widely sample vegetation, classify and map the vegetation, determine its conservation significance and management requirements.

5. Undertake a wide-ranging survey of regional inland saline and non-saline wetlands to identify sites of local, regional, state, national and international biodiversity conservation significance. Such a study would collate all data, widely sample the vegetation, classify and map indigenous and partly exotic vegetation communities, identify (so far as possible) primary and secondary salinity sites/areas, evaluate conservation significance, threats and management requirements.
6. Develop a practical cost-benefit assessment protocol that can be used for assessing all secondary salinity sites that may require treatment. This would include an assessment of the objectives of proposed management actions and the economic, social and environmental costs and benefits of treatment. It is likely that a range of criteria would need to be developed and these would be based on factors where there are available data sets.
7. -Any assessment also needs to be considered in the context of longer-term global climate change scenarios and the likely impact on groundwater levels and salinity.
8. Revisit the Victorian Dryland Salinity Monitoring Network (VDSMN) monitoring sites and conduct electro-magnetic (EM) surveys to assess any further changes in areas of saline discharge and soil salinities. This updated knowledge would provide further direction on suitable plant species to trial and evaluate, now and into the future.

# 1 Introduction

## 1.1 Project Purpose and Objectives

The Corangamite Salinity Action Plan (CSAP) uses an assets-based approach to identify priority areas for salinity investment. There are approximately 17,250 ha of recognised saline areas in the Corangamite Region, of which over half are considered to be primary (natural) rather than secondary salinity (Nicholson et al. 2006a).

Investigations into groundwater processes over the past decade have pointed to extensive regional flow systems operating in the Corangamite region which has challenged previous assumptions about recharge control having preference over discharge management (DPI 2006).

RMCG has been commissioned by the Corangamite Catchment Management Authority (CCMA) to undertake a study of treatment options for saline discharge areas in the region.

The purpose of the project is to:

- Evaluate the best treatment options for each target area and develop additional treatment options (where needed) for saline discharge areas in the Corangamite Region.

The objectives of this project are to:

- Make an assessment of the issues and problems arising in treated saline discharge areas in the Corangamite Region.
- Review current treatments and confirm where these are appropriate and where additional treatments are needed.
- Validate these through some field-based research.
- Evaluate and recommend additional treatment options (engineering and biological) for saline discharge areas in the Corangamite Region.

It is intended that this project will deliver a set of practical recommendations on suitable treatment options for management of saline discharge areas in the Corangamite Region.

## 1.2 Asset-based Salinity Management Framework

An asset-based approach was adopted to select twelve target salinity locations in the CCMA region. Criteria outlined in the CSAP includes the size of salt affected areas threatening catchment assets, capacity of asset managers to undertake management action, including attitudes and willingness to address salinity problems, and availability of technologies to treat salinity.

This study focuses on the Target Areas (TA) where land salinity has been identified as substantially affecting assets. The CSAP has set a Resource Condition Target (RCT) for land salinity in eight out of the 12 target areas. The RCT specifies that there be no net gain in secondary salinity over 2005 levels by 2010.

The CSAP identifies five primary asset types, each comprising a number of secondary assets. These are summarised in Table 1.

**Table 1-1 Assets threatened by saline discharge**

Primary Asset	Secondary Asset	Risks and issues
Land	Agricultural land Public land	Reduced productivity of saline agricultural grazing land, salt washoff from discharge sites into waterways, eroded and scalded soils
Biodiversity	Terrestrial, riparian & wetland vegetation VROT species	High conservation value native vegetation and loss of naturally saline ecosystems
Cultural & Heritage	Archaeological, National Estate	Some Ramsar sites on National Estate register
Infrastructure & utilities	Road and rail network, towns, electricity, gas, water and communications assets	Development on the fringes of the City of Colac encroaching into salinised land Premature breakdown of roads
Water quality	Wetlands, rivers	Threats to urban water supplies, groundwater dependent and freshwater wetlands

Source: Nicholson et al. (2006b)

This study is about investigating expanded treatment options to reduce the negative impacts of land salinity, focusing on landholder responses rather than other asset managers in the region such as local councils, State government (Parks Vic/DSE) or utility and service providers (Telstra, VicRoads, V-Line).

Salinity management actions (MAs) that aim to reclaim saline agricultural land and reduce salt wash-off into waterways can have negative consequences on other biodiversity or cultural and heritage assets.

The current suite of MAs for some Target Areas are limited and that there needs to be an expansion of treatment options that can both meet landholder's objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets.

Having clear objectives for managing saline discharge areas will assist in choosing between salinity management options at any given site.

## 2 Study Methodology

The overall approach has involved the preparation of a series of discharge management case studies incorporating local information about existing MAs covering land salinity asset types in a number of target areas.

The methodology has involved:

- A review of published literature, active incentives documentation (from DPI officers and CAMS data), consultation with stakeholders and field work
- Preparation of case study information reviewing and confirming suitable MAs incorporating an update of the salinity status and trends (where information is available) within each target area
- Identification of some of the problems or issues relating to those target areas where there are limited discharge management options
- Making recommendations about alternative discharge management options, where needed.

The analysis includes a review of current trends in water tables and the salinity status within some target areas in the Region. The fieldwork has enabled an assessment of the circumstances under which there are limited options for discharge treatment; particularly where nearby environmental values restrict the choice of the usual management actions.

The approach taken has focused on management actions to achieve agreed objectives for saline discharge management, as outlined in the Corangamite Salinity Action Plan.

This study focuses on the Target Areas where land salinity has been identified as affecting assets. The CSAP has set a Resource Condition Target (RCT) for land salinity in eight out of the 12 target areas. The RCT states that there be no net gain in secondary salinity over 2005 levels by 2010. Figure 2.1 shows all 12 Target Areas identified in the CSAP.



Figure 2.1. Twelve Salinity Target Areas – identified in the CSAP

### **Selection of species for saline sites**

The selection of species as potentially useful for establishing on saline sites, was based on: the literature (see Appendix 1) and a direct personal knowledge of the ecology, biology and distribution of the Victorian and Australian flora. It is stressed that no attempt has been made to comprehensively review the Australian literature.

The determination of attributes of salinity and waterlogging tolerance (Appendix 1) is similarly based on information from the literature and from personal observations (of G. Carr).

Exclusion of some species mentioned in the literature (eg. *Atriplex semibaccata*) is based on the judgment from personal knowledge that they have no potential as species for saline sites in the CCMA region.

Plant names in this report follow the *Census of the Vascular Plants of Victoria* (Walsh and Stajsic 2007), the Australian Plant Name Index [www.anbg.gov.au/cgi-bin/apri](http://www.anbg.gov.au/cgi-bin/apri) and for the few exotic species not recorded in these listings, the names are as used in the literature cited. An asterisk (\*) preceding a plant name indicates that it is exotic.

### **Fieldwork**

Field data collection including botanical and salinity assessment of sites and further consultation with stakeholders was undertaken during mid-September 2007.

The fieldwork and review of salinity management actions has concentrated in six target areas. These are:

- Colac Eurack – 3 sites
- Corangamite – 1 site
- Geelong Lake Connewarre – 2 sites
- Illabarook – 2 sites
- Pittong – 1 site
- Lismore Derrinallum – 5 sites

While a land salinity RCT has been set for Murdeduke, Warncoort and Modewarre target areas, there are presently no DPI personnel working directly in these districts. The CSAP identifies these target areas to be lower priority than others. This has meant that these areas were not visited as part of the fieldwork.

### 3 Literature Review

#### 3.1 Salt Tolerant Pastures (Introduced)

Saline land is capable of supporting some productive grasses and legumes as pastures. For a limited number of species, pasture systems have been devised that are profitable and the benefits outweigh the financial costs associated with its establishment and maintenance, and the risk of failure. These include pasture plants such as Tall Wheat Grass, Tall Fescue, Strawberry/Balansa clovers and Puccinellia, depending on the degree of waterlogging and salinity at a particular site. On moderate to severe salinised sites, Tall Wheat Grass has been proved to be an outstanding performer in many situations, however, its weediness has raised serious concern about its use in many parts of the southwest.

There is ongoing trialling of saltland pastures occurring across salt affected regions of Australia. Some of the major areas of recent and ongoing work include:

- *Sustainable Grazing on Saline Land* (SGSL) program (recently concluded) – preliminary results from each of the producer network sites are outlined by DPI (2006b) in *Sustainable Grazing on Saline Lands Final Report, Victorian and Tasmania Program*.
- On-going trials being undertaken through various CRC for Plant-Based Management of Dryland Salinity programs (across NSW, Vic, SA & WA), Department of Primary Industries (Vic), Land Water & Wool and Primary Industries and Resources (SA).

The commercial sector is also involved in saltland species research. NyPa Australia Pty. Ltd. is a biotechnology company formed to evaluate and commercialise plants adapted to saline conditions. NyPa in cooperation with RIRDC and State agencies in South Australia, Western Australia and Victoria have investigated the use of NyPa owned cultivars of the halophyte *Distichlis* spp. in salt affected areas (Leake et al. 2002).

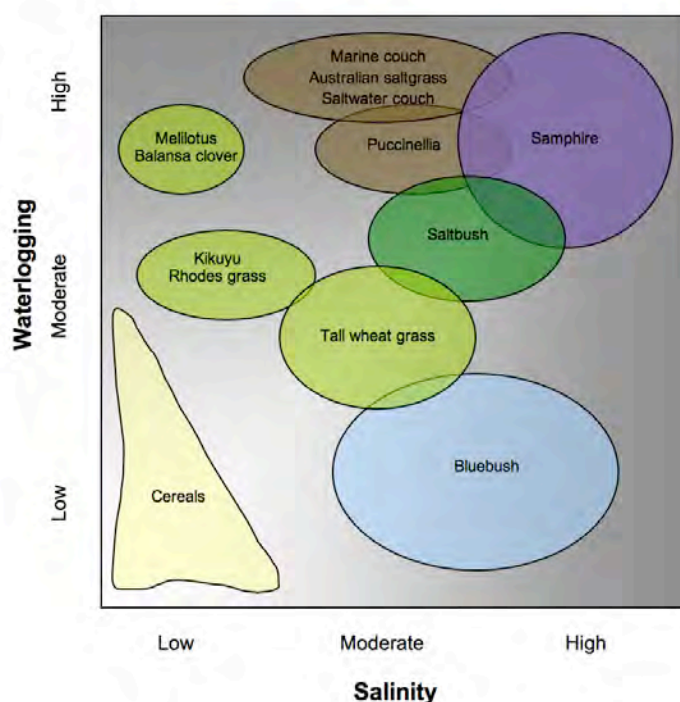
The performance of a number of introduced halophyte grasses for use on salt affected land began to be trialled in the mid 90s and continue to be evaluated. These include:

- NyPa Wild Wheat™, (*\*Distichlis palmeri*) a non-gluten grain
- NyPa Forage, (a *\*Distichlis spicata* clone) a valuable animal feed
- NyPa Turf, (a *\*Distichlis spicata* clone) a drought resistant turf

The development and use of a commercial perennial grain or forage crop for saline discharge zones is a number of years off in Australia (Sargeant & Leake 2003).

Land Water & Wool's Sustainable Grazing on Saline Land sub-program sponsored the production of a comprehensive publication, *Saltland Pastures in Australia – a practical guide* (2<sup>nd</sup> Edition) in 2003. The guide provides a wide-ranging overview of pasture plants with nutritive value for grazing animals, their salinity and waterlogging tolerance, production performance, establishment and management.

The relative rankings of different saltland pasture species have been summarised in a salinity/waterlogging matrix, as shown in Figure 3.1.



**Figure 3.1. Broad grouping of saltland plants according to their relative salinity/waterlogging tolerances**

(adapted from Barrett-Lennard 2003)

As part of Land Water & Wool's SGSL program there were 13 Victorian Producer Network sites, of which four of these were in the Corangamite region. These are part of a national network of more than 120 group-based projects aiming to improve skills and knowledge of saltland management. The SGSL project ran over 5 years, completing in December 2006 with final results and conclusions presently being written up in a number of formats for distribution to farmers and other stakeholders.

The CCMA region sites were at Murdeduke, investigating the environmental and agricultural benefits of grazing salt tolerant vegetation (both indigenous and exotic) and at Pittong, Mt Mercer and Illabarook, looking at localised establishment and grazing methods, and benefits of saltland pastures (production and salinity). A further relevant site outside the region was at Dunkeld, near Hamilton, studying Tall Wheat Grass (*Lophopyrum ponticum*) management techniques and quantifying grazing benefits in a high rainfall zone.

In WA a range of pasture species from saltbush to sub-tropical perennial grasses have been established on previously degraded and unproductive land arising from about 60 farmer based trial sites. Key learnings from the WA sites include (Hardy et al. 2006):

- SGSL producer network has reinvigorated interest in saltland pastures;
- The project created a learning environment that is focused on problem solving, is interactive (between farmers, and researchers), is practical and field based;
- Farmers learn best from visual mediums and particularly from other farmers; and
- Ongoing support structures will be required to sustain these reinvigorated efforts in saltland management.

Research in SA has looked at the performance of *Puccinellia* (*\*Puccinellia ciliata*) in conjunction with Balansa clover and nitrogen and phosphorus additions in response to continuous and strategic grazing. Balansa Clover persistence has been found to be an on-going challenge with this system. This system has been found to be more productive than unimproved salt scalded areas supporting principally Sea Barley-grass (*\*Hordeum marinum*) and Samphire (*Halosarcia* spp.) (Edwards n.d).

The production performance of some of these grazing trials, conducted under the SGSL initiative, are summarised in the Table below:

Improved pasture species	Establishment cost \$/ha	Improved stocking rate	Increase in wool GM \$/ha	Rate of return p.a (assumed >10 yr life)
Tall Wheat Grass, Balansia, Strawberry Clover, Hamilton Vic	\$300 - 400	12 DSE/ha	\$162	25%
Puccinellia, Keith, SA	\$175	4 DSE/ha	\$86	47%

Source: Fitzpatrick et al. (2006)

There is little question that these species can perform well given the right establishment inputs and management expertise. They offer a viable feed source for grazing sheep in late summer.

There is, however, some acknowledgement in the literature that the establishment, management and utilisation of sown saltland pastures mean ongoing difficulties for many farmers, and adoption in many areas remains low (Jones 2006).

Under the same SGSL project, McCaskill & Pollard (2006) found in a grazing trial at Dunkeld, Vic, that while sown salt tolerant pastures carried more stock (30 – 100%) volunteer pastures in saline sites supported higher individual weight gains, especially on the more saline sites (10 – 25 dS/m). It was concluded that well adapted volunteer species can perform well and grazing management to improve the composition of desirable species in volunteer “pastures” can be a productive alternative management action to sowing improved pastures.

### 3.2 Salt Tolerant Native Grasses

A number of indigenous grass species occur naturally in saline sites and require consideration and further evaluation as species potentially useful for establishing on sites of secondary salinity. Such species, by definition, would not become weedy, unlike the exotic Tall Wheat Grass and *Puccinellia ciliata*. Weiss and Laconis (2001) advocated trials of Adamson’s Blown Grass (*Lachnagrostis adamsonii*) and perhaps other species as a potential replacement for Tall Wheat Grass.

Indigenous Victorian grass species in coastal and inland saline sites (Walsh 1994, Carr unpubl. data), include: *Austrodanthonia caespitosa* (Common Wallaby-grass), *Cynodon dactylon* var. *pulchellus* (Couch), *Diplanthe fusca* (Brown Beetle-grass), *Distichlis distichophylla* (Australian Salt-grass), *Eragrostis infecunda* (Southern Cane-grass), *Eragrostis parviflora* (Weeping Love-grass), *Lachnagrostis adamsonii* (Adamson’s Blown-grass), *Lachnagrostis filiformis* (Common Blown-grass), *Poa orba* (Lake Omeo Tussock-grass), *Poa poiformis* var. *poiformis* (Coast Tussock-grass), *Puccinellia stricta* var. *perlaxa* (Plains Saltmarsh-grass) and *P. stricta* var. *stricta* (Australian Saltmarsh-grass), *Sporobolus*

*mitchellii* (Rat-tail Couch), *Sporobolus virginicus* (Salt-couch) and *Zoysia macrantha* ssp. *macrantha* (Prickly Couch) and *Zoysia macrantha* ssp. *walshii* (Walsh's Couch). It should be noted that there are some differences of opinion between state authorities on the native versus exotic status of some species. For example Walsh (1994) considers *Paspalum vaginatum* to be exotic, while Jacobs and Wall (1993) consider it to be native.

Currently there is scant evidence that any of these species are suitable for forage, either because:

- (i) they do not persist in the face of grazing (eg. *Lachnagrostis adamsonii*);
- (ii) they are not competitive against numerous robust exotic species (such as Tall Wheat Grass);
- (iii) they have insufficient quality as forage (eg. palatability, nutritional value);
- (iv) they are not readily and cheaply established (eg. seed easily harvestable), and
- (v) they are species that are not climatically suitable (in the Mediterranean climate of the Corangamite CMA).

Some species however, have been trialled: *Cynodon dactylon*, *Diplanthe fusca*, *Distichlis distichophylla*, *Sporobolus mitchellii* and *S. virginicus* (see Appendix 1 and references therein), but there appear to be no indicators or recommendations as yet about the use of any of these species for establishing on saline sites for forage. Some of the species, especially *D. Distichophylla*, are likely to be useful to provide vegetation cover on saline scalds and to stabilise saline soils to prevent erosion.

Trials in NSW have recently reported mixed results with a range of perennial "couch" grasses, both native and introduced (Semple et al. 2003a, Semple et al. 2006). *Distichlis distichophylla* and *Cynodon dactylon* were highest performers in terms of persistence and groundcover across the most severely scalded sites but were found to have low forage value with some weed potential.

\**Paspalum vaginatum* and \**Paspalum distichum* produced the highest levels of quality forage on summer-moist sites of moderate to low salinity. *Sporobolus virginicus* was the most salt tolerant and capable of producing high groundcover levels and biomass, however, appeared sensitive to defoliation and therefore grazing.

Where groundcover is a high priority, low forage value species such as Australian Salt Grass (*Distichlis distichophylla*) could have application on either high environmental value areas or small-scale areas on agricultural land. There is also an advantage of not necessarily needing fencing (as indicated in Semple et al. 2003b).

Trials in WA found that after eight years, the introduced \**Distichlis spicata* improved the physical properties of saline soils. In particular, the study found improvement in aggregate stability and saturated hydraulic conductivity (Sargeant et al. 2006). These are measures of the soils physical fertility and relate to the potential of the soil to disperse, become waterlogged and erode. These parameters are important because the benefits of treating these areas are around reducing salt wash-off and scalded land prone to erosion.

The main advantage of native species will be reduced weed potential.

### 3.3 Weed Potential of Plant Species used to Vegetate Saline Sites

About 70 % of all weed species in Victoria have been deliberately introduced (Carr et al. 1992, Carr 1993) including almost all of the most invasive Weeds of National Significance. This applies also to species deliberately introduced to Australia from overseas and elsewhere in Australia, for revegetating saline sites (mostly for forage), and there is often a major conflict of interest in the deliberate introductions policy (Carr et al. 1992, Carr 1993, Lonsdale 1994, Bennett and Virtue 2004, Paynter et al. 2003).

Most successful plant species for saline sites that are established by seed (cf. species that are established by tubestock) and those capable of unassisted recruitment such as *Atriplex*, need to behave like weeds to meet the performance criteria, especially unassisted recruitment. Potential weediness of these species accessed for planting on saline sites (especially non - Australian species), may or may not be evaluated by their proponents. Where the focus is mainly agronomic, weediness is often not addressed, for example there is no mention of weediness by Barrett-Lennard (2003) in *Saltland Pastures in Australia: A Practical Guide*. In most of the literature directed at pasture evaluation weediness may be given some mention (eg. by Paynter et al. 2003) or it may be the focus of assessment (eg. Bennett and Virtue 2004, Weiss and Laconis 2001).

Despite the failure to mention weediness of plant species advocated in *Saltland Pastures in Australia* (Barratt-Lennard 2003) which was sponsored by the CRC for Plant-based Management of Dryland Salinity, there has been some belated realisation that this is an issue (Griffiths 2004). The aforementioned CRC has now published a protocol for *Environmental Weed Risk Management in Perennial Systems* (Stone 2006) based on the weed-risk protocol now widely applied to exotic species in Australia.

The statistics for the 62 plant species listed in Appendix 1 as potentially useful plant species on saline sites in the Corangamite CMA are revealing and give cause for major concern. Also relevant in the risk assessment of species for saline sites is the potential for genetic pollution, i.e. introduction of foreign gene pools of indigenous species that may cause genetic problems (Bennett and Virtue 2004, Potts et al. 2003).

<b>Weed risk rating of species/ taxa in Appendix 1</b>
<b>V- Very high risk – 1 species</b>
<b>H- High risk – 5 species</b>
<b>M- Moderate risk – 14 species</b>
<b>L- Low risk – 13 species</b>
<b>U- Risk un-assessed – 23 species</b>
<b>N- Not weedy – 3 species</b>
<b>G- Potential for genetic pollution – 1 species</b>

Some of these weed species are discussed below.

#### 3.3.1 Tall Wheat Grass (*Lophopyrum ponticum*) (TWG)

The following quote, from Weiss and Laconis (2001), gives the background on the promotion of the species as a forage plant for saline sites in southern Australia:

Victorian, New South Wales, South Australian and Western Australian State Government organisations have also promoted Tall Wheat Grass. In July 1987, the

Victorian Department of Conservation, Forests and Lands (now Sustainability and Environment), published the fact sheet, *Growing Tall Wheat Grass on Saline Land*, which was replaced by a revised version in February 1992. The Department of Primary Industries and Resources, South Australia published fact sheets on Tall Wheat Grass and Saltland fodder species (Dooley 1999, Henschke 1999) likewise promoting the use of the species on saline or poorly drained soils. *Saltland Pastures in Australia: A Practical Guide* (Barrett-Lennard and Malcolm 1995) published by the Department of Agriculture Western Australia contains a chapter on *Best Pasture Plants for Saltland*, in which Tall Wheat Grass is included. Numerous other State Government publications, reports, articles, and fact sheets have promoted the use of this species (eg. Chaffey et al. 1992, Chin, n.d., McCarthy 1992, McPhie 1973, Saunders 1997).

In recent years Tall Wheat Grass has been widely recognised as weedy by DSE and other agencies promoting the species.

Weiss and Laconis (2001) assessed the weed potential of Tall Wheat Grass and reached the following conclusions:

Tall Wheat Grass is not a highly invasive species and is as potentially invasive as the noxious weeds African Lovegrass, Poverty Weed, St. Johns Wort, Bathurst Burr, Golden Thistle, Camelthorn and Great Muellein. It has the potential to invade a wide range of open grassland habitats, pastures, saline affected open fields, dune communities, roadsides and native grassland throughout Victoria. However, it will not withstand or establish in areas of cultivation or heavy overstorey. Tall Wheat Grass is not as invasive as Blackberry, Boneseed or Ragwort, and when compared to other noxious grasses it is not as invasive as Serrated Tussock or African Feather-grass but is as invasive as Spiny burr-grass or African lovegrass.

The main issue with Tall Wheat Grass is not how invasive it is in its own right but the deliberate dispersal of the plant by humans. Tall Wheat Grass is not invasive compared to most of the noxious weeds or environmental weeds already assessed. Management and prevention of spread onto adjoining natural areas should be the course of action for all land managers.

Weiss and Laconis (2001, p.17) summarized and concluded their assessment and presented the following recommendations:

Tall Wheat Grass has been promoted in Victoria as a relatively salt tolerant pasture grass since the 1980s. Since Tall Wheat Grass does not possess any adaptations to aid in seed dispersal, deliberate human spread is probably the most significant means of dispersal. It is moderately invasive although not in the same extent as Serrated Tussock or African Feather-grass. It has the potential to invade 10.4 million hectares of dryland pastures, native grassland, open woodlands, saline areas, and estuarine wetlands of Victoria.

It is unsuitable to declare Tall Wheat Grass as a noxious weed under the Catchment and Land Protection Act 1994 as this would prevent beneficial use of the plant in salt affected pastures where there is little or no impact on natural flora or fauna. There is little or no research into other alternatives to Tall Wheat Grass as a saline tolerant pasture species.

However, the report concludes:

Tall Wheat Grass invasion of saltmarsh areas should be listed as a threatening process under The Flora and Fauna Guarantee Act.

DNRE should discourage, prevent and dissuade the deliberate planting of Tall Wheat Grass on natural saline areas or adjacent areas. The Department should also have a policy, guidelines or recommendations on where Tall Wheat Grass can be used and where it should not.

The Department undertake weed risk assessment of species that are presently being promoted or investigated for future agricultural use. The use of standard Weed Risk Assessment code of practise and Plant Management Protocols should be adopted across DNRE to reduce the risk of further weeds.

The use of native and endemic species such as Adamson's blown-grass or non-invasive species as an alternative to Tall Wheat Grass should be investigated.

The evaluation by Weiss and Laconis (2001) is unsubstantiated because it was based on scant data and anecdote, and also on some irrelevant information extrapolated from overseas experiences. It was not based on other than fragmentary data on TWG distribution as a naturalised plant in Victoria, and it was based on literature review, without fieldwork.

Virtue and Melland (2003) presented a more realistic evaluation of TWG as it related to the South Australian situation. However they concluded that its invasion was likely to be restricted to native vegetation overlying shallow water tables, but it scored as a medium to high weed risk in regions where this habitat was more common.

A major criticism in the TWG assessment by Weiss and Laconis (2001) is that they did not evaluate the species in the field. There are now thousands of sites where TWG has naturalised in Victoria (i) near where it was planted; (ii) at sites distant from where it was planted; and (iii) in a wide array of environmental situations.

The evidence we have collected, including the literature, personal communications with experts and observations made during this study (Carr et al. 1992; Ecology Australia 1994, 2001; Trengove 1994, pers. comm.; Carr unpubl. data; V. Stajsic, National Herbarium of Victoria, pers. comm.; M. White, DSE pers. comm.; A. Pritchard, DSE, pers. comm.; T. Barlow, DSE, pers. comm.; Virtue and Melland 2003; Carr and White 2000) indicate that:

- Tall Wheat Grass is one the most seriously invasive grass weed species in temperate Australia
- It has a much wider ecological amplitude than suggested by Weiss and Laconis (2001) and Virtue and Melland (2003), being able to invade many non-saline and non-waterlogged sites of at least moderate fertility.
- Tall Wheat Grass, by extrapolation from numerous sites observed by us, is now naturalised in thousands of locations in Victoria and hundreds of locations in the Corangamite CMA region. The distribution and age structure of populations indicates that it its rapidly recruiting and expanding its range.
- It forms dense, tall, mono-specific swards that destroy subordinate species and prevent the recruitment of all species.
- Vast areas of the Corangamite CMA region are being invaded and will be invaded without appropriate management. These include all Ramsar areas (Refer to Appendix 3), all

upper saltmarshes, estuaries and riparian environments (eg. Barwon and Moorabool Rivers) and grassy woodlands.

- Numerous threatened flora and fauna species in the region are at risk, eg. the critically endangered, Victorian Volcanic Plains endemic, Salt-lake Tussock-grass (*Poa sallacustris*) (Carter and Walsh 2005) (Refer to Plate 1 Appendix 2) and saltmarsh habitats of the critically endangered Orange-bellied Parrot. Both species are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
- Tall Wheat Grass, far from being the poor disperser which 'does not possess any adaptations to aid in seed dispersal' (Weiss and Laconis 2001) is very adept at dispersal without the direct agency of humans (i.e. planted deliberately). Even if this were true it is irrelevant because short-distance contagious dispersal would ultimately lead to vast, very widespread population.
- A series of photos are shown in Appendix 2 (Plates 1 – 6) depicting TWG invasion outside its intended planted area.

### **Evaluation of Tall Wheat Grass Guidelines**

The CCMA and DPI have developed guidelines to assist in selecting secondary salinity sites for sowing Tall Wheat Grass (Appendix 3). When scoping the tasks for this project, it was agreed that the consultants would review these guidelines.

In light of the above comments about the distribution, dispersal and impacts of Tall Wheat Grass, we conclude the following:

- Determination of a primary (no Tall Wheat Grass planting) versus a secondary salinity site is often fraught with difficulty (see Section 4.1)
- The 'wetland type' – in effect the significance of a wetland – cannot be evaluated for 'high value' and 'other wetlands (regionally important)' in many cases. Very little is known or documented about regional wetlands other than for avifaunal values.
- The presence of 'threatened species and habitats' is rarely known and if not known can only be determined by survey of the site by qualified botanists and zoologists at the appropriate time of the year (seasonal considerations). The DSE Biodiversity database is often extremely limited and limiting.
- Any distance-related criteria (1m, 20m, 50m) for appropriate widths of buffers are (contra Weiss and Laconis 2001) irrelevant in view of the very wide dispersal capability of TWG
- 'Flood frequency' is also an irrelevant consideration in view of the dispersal capability of TWG.
- Questions concerning the landholders capability to appropriately manage TWG, while in the ideal world are relevant, in the real world are of doubtful relevance, for example if land changes ownership, or landowners (for a multitude of practical reasons beyond their control) do not implement or maintain appropriate management (that is maintain the desired grazing regime for TWG).

### 3.3.2 Other weedy species

Some 62 plant species taxa are listed in Appendix 1 as potentially useful for planting on secondary salinity sites in the Corangamite CMA region. An assessment of their potential for adoption is outlined in Section 5.

Of the 62 plant species listed, none are rated as being as invasive as Tall Wheat Grass. Five species are considered highly invasive, 14 as moderately invasive, 13 as having low invasiveness, and three as non-invasive. Of particular significance are 23 species whose invasiveness has not been assessed because they are not known to be naturalised in Victoria, or weed risk assessments have not been published. Notable among these species are the exotic *Atriplex* (saltbush) species from North and/or South America (*A. lentiformis* and *A. undulata*) (see Barrett-Lennard 2003), and seven species of *Melaleuca* (paperbark/honey-myrtle) mostly from Western Australia. The exotic *Atriplex*, whether non-Australian or from Western Australia (*A. amnicola*) (see Barrett-Lennard 2003) pose a particular risk and they should be treated as highly dangerous. As with TWG the dangers may not be posed at the location where they are planted, but at a distance because of seed dispersal by 'natural' or arthropogenic vectors. It is misleading to assume (as did Weiss and Laconis (2001) for Tall Wheat Grass) that any species necessarily has a poor dispersal mechanism which will limit its spread.

*Melaleuca* species are amongst the most saline-tolerant and waterlogging tolerant woody species available for planting on saline sites, but they pose a particular threat because of very high seed production and very small seeds which are very readily dispersed by water, wind, motor vehicles etc. No fewer than 14 *Melaleuca* species are naturalised in Victoria (Walsh and Stajsic 2007, Carr unpubl. data) of which seven are Victorian species naturalised outside their range (eg. Carr 1993).

Indigenous species in Appendix 1 which naturally occur in the bioregions of the Corangamite CMA (Otway Plain, Victorian Volcanic Plain, Otway Ranges, Warrnambool Plain and Central Victorian Uplands) include species of coastal and inland saltmarshes, and species of estuaries. These 14 species, none of which are widely dispersed indicators of secondary salinity (Sainty and Associates and SGL SALTdeck Taskforce 2006, Allen 2007), have no weed potential because, as halophytes, they will be confined to salt-affected lands, or have low weed potential.

Many *Eucalyptus* species are salt tolerant, including species that do not naturally occur on saline sites (Bell and Williams 1997, Niknam and McComb 2000, van der Moezel et al. 1991). Other species, notably the 13 *Eucalyptus* species, have moderate or low weed potential, although many have not been evaluated. As trees, they generally represent very tractable weed problems, if control should be required. It should be noted that at least 25 *Eucalyptus* species are naturalised in Victoria (Walsh and Stajsic 2007, Carr et al. 1992, Carr unpubl. data), but they are low-level weeds. There are additional species known to be salt tolerant and new salt-tolerant taxa have been recently described from Western Australia (Nicholle 2005, Nicholle and Brooker 2005).

Of the species in Appendix 1, genetic pollution (Potts et al. 2003) is relevant only to *Eucalyptus camaldulensis* (salt-tolerant selections). *Eucalyptus camaldulensis* is widespread and abundant as an indigenous species, especially on the Victorian Volcanic Plain, in the study area.

The list is by no means exhaustive, for example additional *Eucalyptus* and *Melaleuca* species could have been included; see for example Department of Agriculture WA (2007).

*Acacia* species many of which are moderately salt-tolerant, eg. *A. saligna* Western Wreath Wattle have been avoided because of their weed potential as they have very long-lived soil-stored seed banks and are bird dispersed. Many *Acacia* species are naturalised in Victoria (Carr et al. 1992, Walsh and Stajsic 2007).

Recommendations regarding the use of species listed in Appendix 1 are given in Section 5.

## 4 Observations from Fieldwork

### 4.1 Overview of Issues

A number of issues were raised by stakeholders during the consultation part of scoping this project. These included:

- Concerns about the weediness of TWG yet it is currently the most commonly used species for reclaiming saline land
- Limited alternative species (to TWG) that will reclaim and increase agricultural production on saline land
- Uncertainty felt by DPI extension officers when applying the TWG guidelines in the field
- Difficulty in distinguishing between primary and secondary salinity
- Groundwater and discharge area response to prolonged dry cycle
- Effects of climate on the costs and benefits of salinity investment
- Differing land management objectives held by public land managers, landholders and DPI extension staff.

#### **Distinguishing between sites of secondary versus primary salinity**

In managing secondary salinity the identification of primary versus secondary salinity sites is fundamental. As recognised in the CSAP, primary sites should not be treated as salinity discharge areas requiring management focused on increasing their agricultural potential. These areas are important environmental assets supporting salinity adapted ecosystems.

M.J. Allen (1996) outlined a method for assessing dryland salinity based on the level of salinity (established by soil testing) and the presence of indicator plant species (native and exotic obligate or facultative halophytes). The Corangamite Saline Ecosystems Assessment Kit (C.S. Allan 2007) is currently the document and protocol used to identify primary versus secondary salinity sites in the Corangamite CMA region, where about half of the mapped saline land is primary salinity (Nicholson et al. 2006a; P. Dalhaus, in Allen 2007) (see Gibbons and Gill 1964). These are coastal and non-coastal systems, the latter with 'residual' salinity (Allen 2007).

Allen (2007) utilised the floristic composition of vegetation at a site to distinguish between sites of primary and secondary salinity in the region, viz.:

The likelihood that a site is naturally saline can be inferred from vegetation composition using the following criteria:

- A site is likely to be a primary salinity site if it has a high diversity of native salt tolerant species that have low capacities for colonising newly saline sites
- This assertion is less valid if the secondary salinity site is connected to a primary salinity site from which otherwise poor coloniser species can readily disperse
- A site with few poor colonisers may be a secondary salinity site, or may be a highly disturbed primary salinity site

Salinity tolerance of plant species were categorised by Allen (2006) as follows:

- **Freshwater situations** – Places where the maximum salinity of surface water or pore water over the course of the year is low enough to not adversely affect most glycophytes (salt intolerant plants) – generally no more than 2% to 5% of the salinity of seawater.
- **Brackish situations** – Places where the maximum salinity of standing or pore water is high is enough to affect glycophytes, but generally less than 20% the salinity of seawater.
- **Saline situations** – Places where the maximum salinity of standing or pore water is between 20% the salinity of seawater and the salinity of seawater (35 grams per litre).
- **Hypersaline situations** – Places where the maximum salinity of standing or pore water over the course of the year is significantly higher than that of seawater.

As indicated by Allen (2007) and as we found during fieldwork, it is sometimes very difficult to determine if a site is naturally saline (primary salinity) or salinity is a function of post-settlement land use (secondary salinity) or a combination of both. We know very little about the biology and ecology, including dispersal, of halophytes (native and exotic) or their ecological interactions, as acknowledged by Allen (2007). What we do know is essentially based on inference from field observations.

## 4.2 Review of Saline Discharge Management Actions - Case Study Sites

Field data collection including botanical and salinity assessment of sites and further consultation with stakeholders was undertaken during September 2007.

The fieldwork and review of salinity management actions has concentrated in six target areas. These are:

- Colac Eurack – 3 sites
- Corangamite – 1 site
- Geelong Lake Connewarre – 2 sites
- Illabarook – 2 sites
- Pittong – 1 site
- Lismore Derrinallum – 5 sites

The project team gratefully acknowledge the local DPI field officers for their valuable assistance in providing information and facilitating field visits enabling the development of these case studies. Specifically these were Linda Murray (Colac), Neil James (Ballarat), David Lean (Geelong) and Lisa Miller (Geelong).

Three broad discharge treatment options have been identified in the CSAP. Each has varying applicability within particular target areas. The treatments reviewed as part of the fieldwork are (after CSAP 2006, Nicholson et al. 2003):

1. **Protection and management of discharge areas to allow natural vegetation recovery.**
  - involves landclass fencing and improved management to allow natural vegetation to regenerate. Can involve periodical grazing and weed control.
  - there are 2 sub treatments: i) fencing only, and ii) fencing with trees.
2. **Protection and management of discharge areas with establishment of additional vegetation.**
  - involves landclass fencing and improved management of saline areas.
  - there are two sub treatments: i) saline revegetation options which include native grasses/herbs or trees, primarily for biodiversity values, and ii) saline revegetation options which include improved pastures, fodder plants, trees (indigenous or forestry) for production values.
3. **Waterlogging control on discharge areas in conjunction with and without establishment of additional vegetation.**
  - involves planning and implementation of altered surface water movement using shallow surface drains to intercept lateral flows of perched groundwater and/or prevent water ponding that restricts plant growth. Usually surface drains are cut into and collect shallow seepage or ponded water (<40cm deep). These are typically arranged across contour on minor grades for safe water carriage.

The following section provides a description of each target area, including an update on current groundwater trends and a review of saline discharge management issues and appropriate management actions.

## 4.2.1 Target Area Summary – Colac - Eurack



### Description

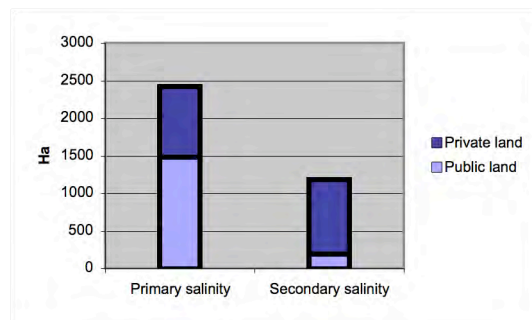
The Colac-Eurack target area encompasses approximately 34,000ha extending from south of the City of Colac northwards. This area includes a series of shallow lakes and wetlands extending from Lake Colac to Lake Weering to the north. Assets at risk are predominantly environmental including saline adapted vegetation communities and water habitat dependent bird species. Agricultural land is salinity affected in broad depressions and areas fringing natural groundwater discharge lakes.

### Salinity Processes

Salinity is mostly primary in origin eg. Lake Beeac is a groundwater discharge lake comprising a hypersaline environment.

To the north of Colac, there is a Quaternary GFS overlying a Stony Rises GFS (both local systems). Cycles of salinity have been associated with climate change during the Quaternary period. More recent land use driven hydrologic changes have exacerbated salinity, though its spread is largely anecdotal (Nicholson et al. 2006b).

### Land Assets Affected



### Water Table Trends

Bore hydrographs in this region indicate a steady to declining trend in water table depth over the past 15 years. Some representative groundwater hydrographs are shown in the next section.

### Land Assets Resource Condition Target

- no net gain in the area affected by secondary saline discharge over 2005 levels by 2010

### Salinity Hotspots (see map over page)

- Oudit Supplementary Treatment Area, and part of the Barongarook and Deans Creek Catchment
- Primary salinity affecting public land under grazing leases in the Eurack and Lough Calvert areas.
- Secondary salinity on private grazing land north of Eurack and Irrewarra.

### Local Discharge Management Issues

- Agricultural land, of which a large proportion is public land, is mostly affected by what is believed to be secondary expansion of primary salinity.
- Difficulty in distinguishing between primary and secondary salinity.
- Meeting variable objectives held by public and private asset managers.
- Tall Wheat Grass is restricted in its application due to the proximity of salt affected land to naturally saline wetland and lake environments.
- Current salinity treatments offer only marginally better agricultural return than when left untreated and many farmers are unconvinced of the return on investment in salt tolerant perennial pastures.

Mapped Salinity – Colac Eurack

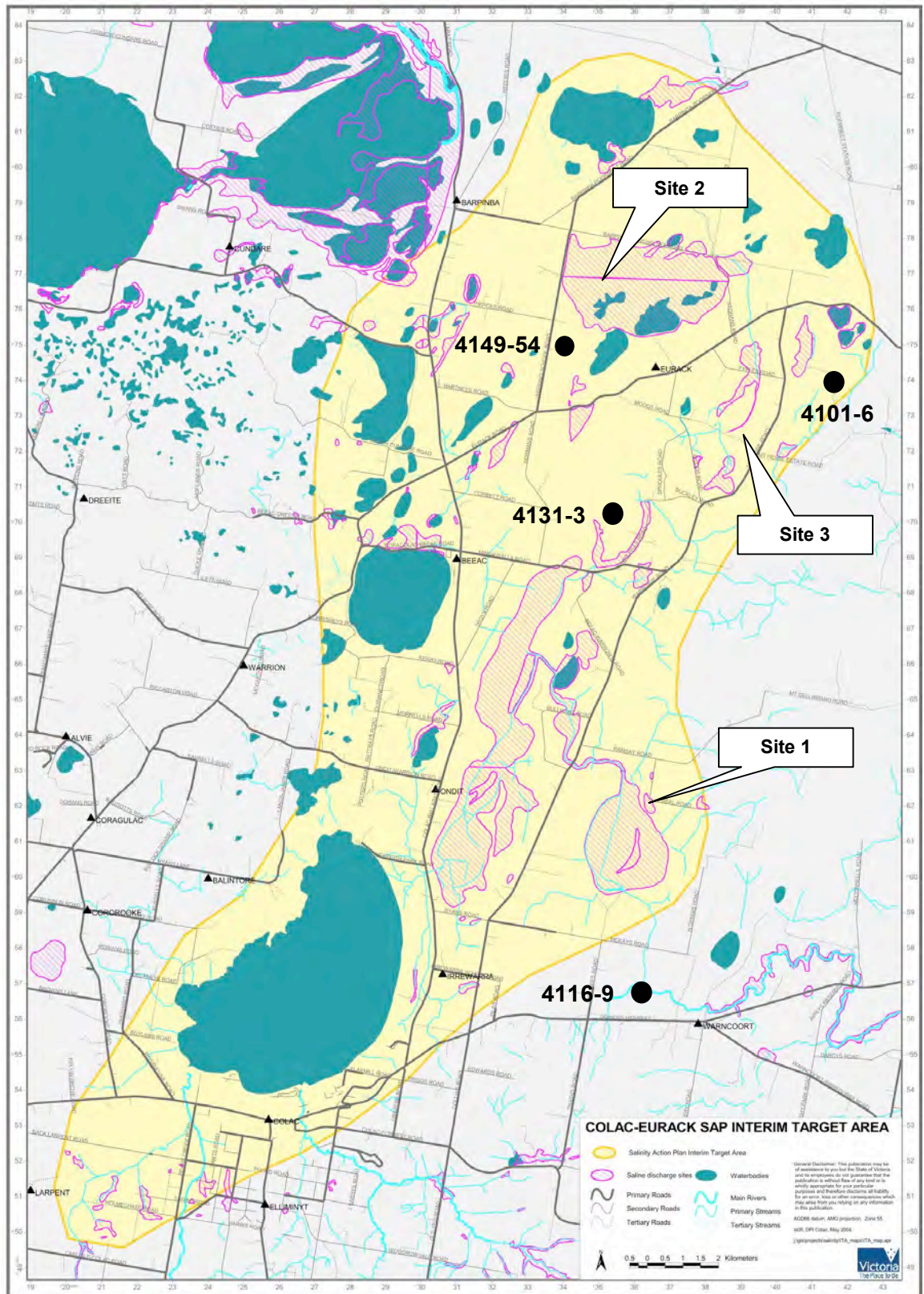


Figure 4.1 Expressions of primary and secondary salinity and location of case study sites

The table below provides a description of case study sites visited.

Site no.	Discharge treatment	Location	Road & site name
1	<b>Establishment of additional vegetation</b> – improved agric. pasture	Northern edge Lake Turrumbong/The Sanctuary	Beal Rd
2	<b>Natural vegetation recovery</b> – fencing & grazing management only <b>Establishment of additional vegetation</b> – improved agric. pasture sp.	Upper Lough Calvert	Bapinba-Winchelsea Rd
3	<b>Establishment of additional vegetation</b> – improved agric. pasture sp.	South East of Eurack	Woods Rd

### Land salinity and watertable trends – Colac-Eurack

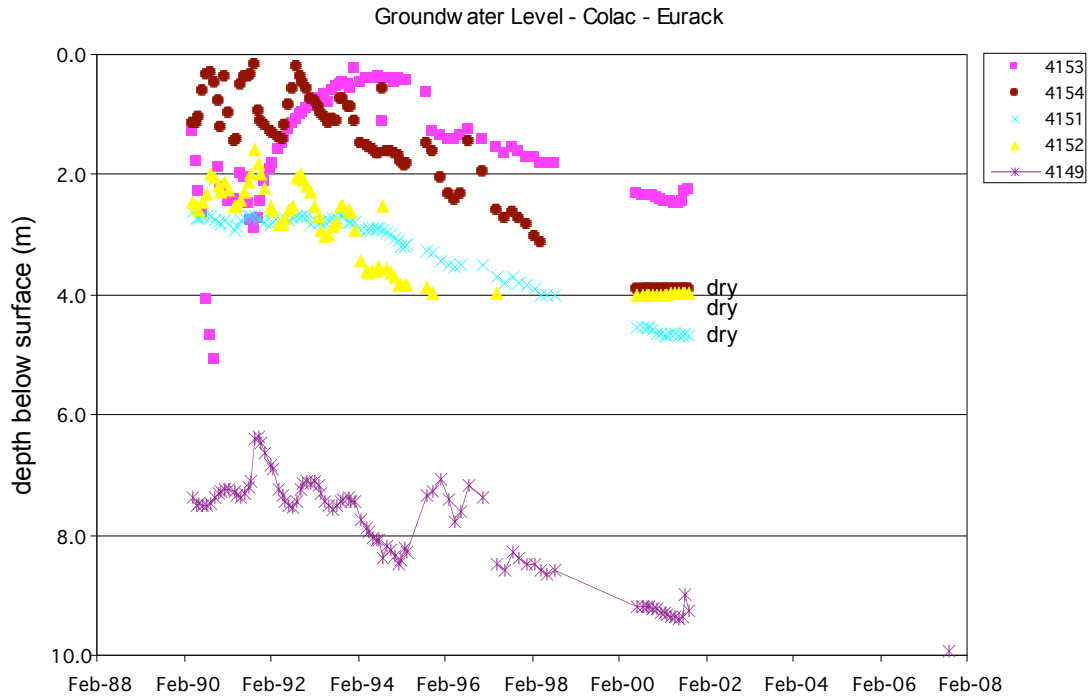
Recently updated groundwater hydrographs for bores in the Colac-Eurack region indicate a steady to declining trend in water table depths over the past 15 years. This trend is evident in the large majority of monitoring results reviewed. This is typical across the region for bores that are positioned away from the influence of lakes, and for those monitoring the deep flow system.

The response of bores monitoring the intermediate and shallow system is strongly influenced by whether the bores are located in the regional discharge vicinity of lakes i.e. with an upward hydraulic gradient. These bores show a relatively steady trend level (with typical seasonal fluctuations).

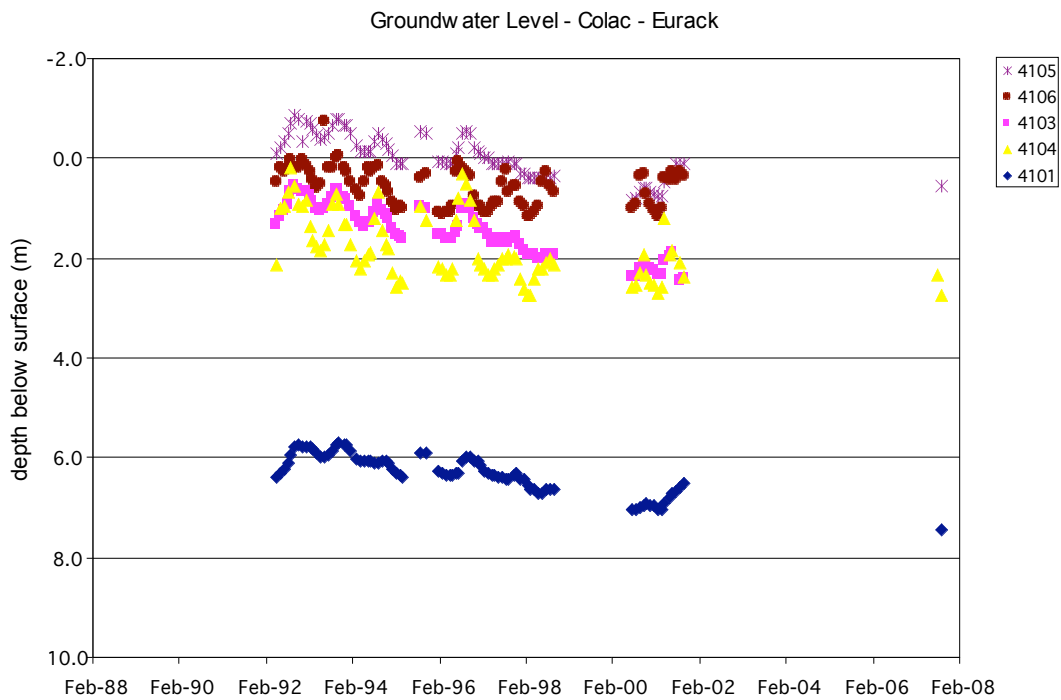
The overall regional decline reflects the extended period of below average rainfall, with a decline apparent in many bores, some since mid-1994.

Figures 4.2 and 4.3 are representative of a typical falling trend while Figure 4.4 in the main discharge area shows a steady level in the shallow system, despite a declining level in the deeper system. Figure 4.5, east of the Colac township, shows a rising trend in the deeper aquifer, and a steady trend in the shallow and intermediate aquifers. The different response in the deeper aquifer to the bores in the other figures indicates this bore is in a different groundwater flow system. Although a regional decline is noted in many bores, the response is not shown in all aquifers.

The approximate locations of these monitoring bores are indicated on Figure 4.1 (previous page).



**Figure 4.2 Nested site – Upper Lough Calvert**



**Figure 4.3 Sites east of Eurack**

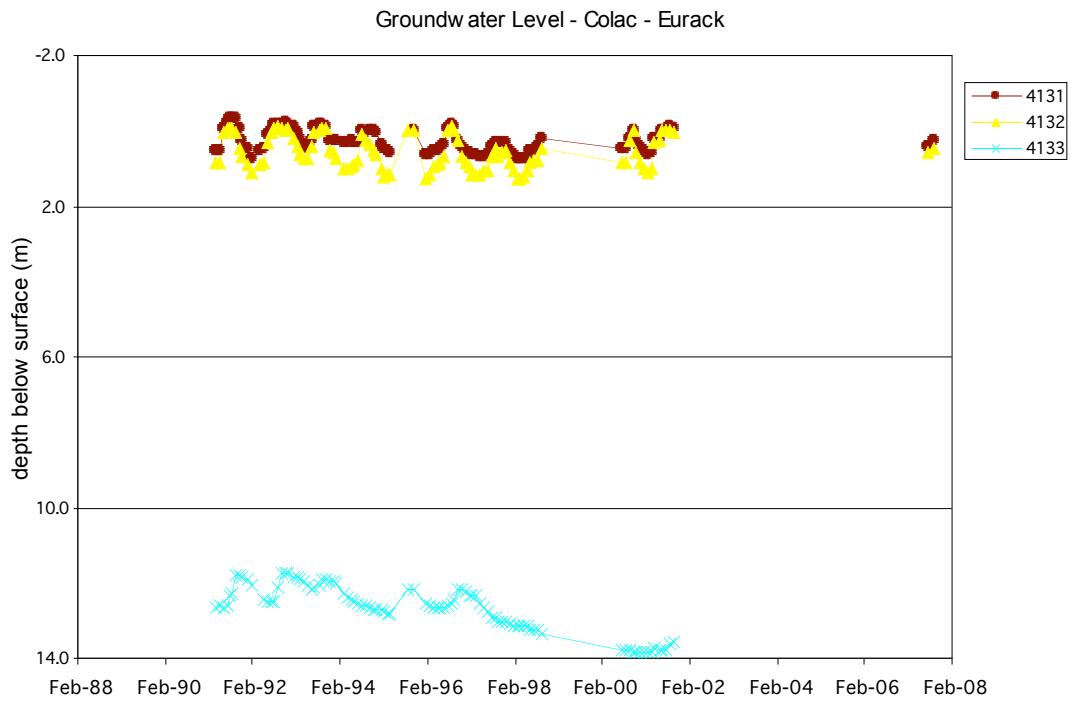


Figure 4.4 Sites east of Beac

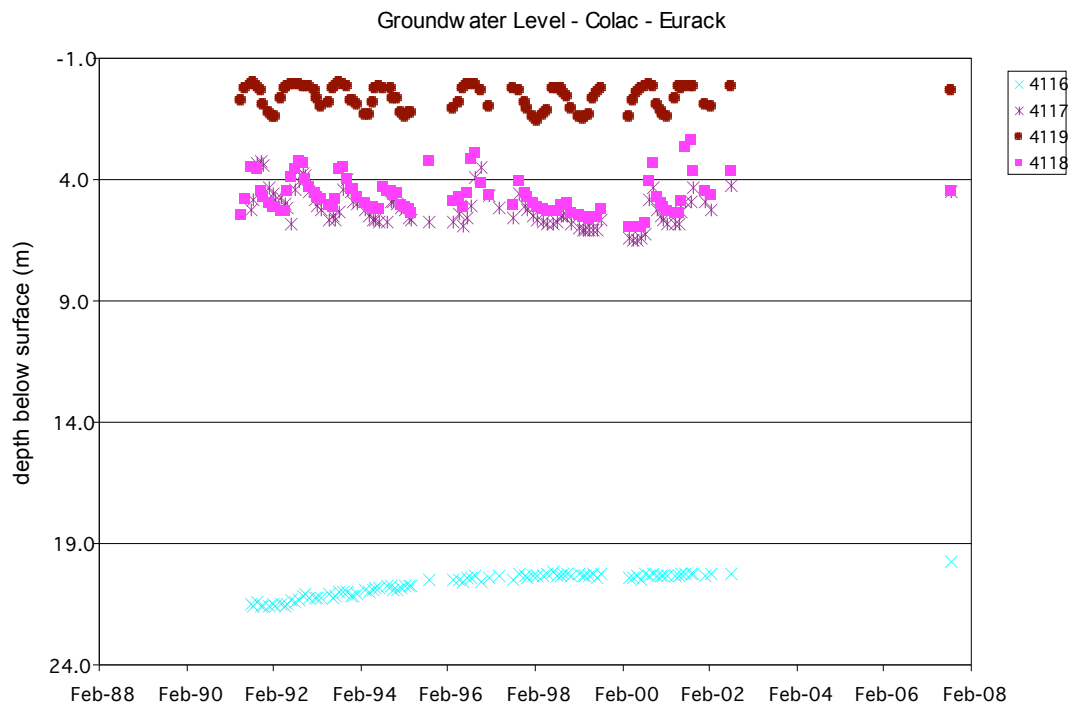


Figure 4.5 Site east of Colac township

Some bores recently monitored are now dry which could indicate poor construction or silting up, however, in many cases it is likely that the groundwater level is now below the screened interval. This is shown as a flat groundwater level on some hydrographs.

The shallow bores within groundwater discharge areas (assumed to be a groundwater level within 2 m of surface) often do not show a declining groundwater level, or only a minor decline. This reflects the dominance of the flow systems unaffected by climatic influences, and that groundwater discharge areas remain discharge areas, even within extended dry periods and despite regional declining levels.

Significant changes to the water balance are needed to drop the groundwater levels sufficiently to stop them being groundwater discharge areas, particularly in this target area, which in terms of its physiography and geomorphology has been a groundwater discharge zone since before European settlement.

Fluctuations in shallow bores with a groundwater level near surface, and in close proximity to lakes may also be buffered by the proximity of these nearby discharge features, in contrast to bores situated further from lakes. For example, Figure 4.3 bores east of Eurack are located outside a major groundwater discharge area and tend to show a decline, even in the shallow groundwater levels.

There are six saline discharge sites being monitored as part of the Victorian Dryland Salinity Monitoring Network (VDSMN) in the Corangamite region. One of these sites is located in the Colac-Eurack Target Area. Primary Industries Research Victoria (PIRVic) have developed and reported on protocols relating to a combination of mapping techniques including soils salinity testing, vegetation indicators and geophysics eg. GPS and EM38 survey (Clark & Allan 2005).

Observations by local DPI officers suggest that the area of saline discharge is contracting in this Target Area. The most recent salinity discharge monitoring, conducted in the year 2000, indicated that the water table had dropped approximately 1.0 m in the Beac district over the previous 4 years with a corresponding 13% reduction in the total salt affected area. Updated hydrographs to September 2007 indicate that the water table has lowered a further 0.5 m in this district and it is expected that there has been a further reduction in the area of discharge. An updated assessment of the area of discharge in the vicinity of the VDSMN monitoring site would verify these trends.

### Current discharge management actions to reduce land salinity

The following 3-year management action targets and saline discharge management actions (MAs) are prescribed in the CSAP, Colac Eurack Target Area report:

Discharge treatment	Public land ha	Private land ha
1. Natural vegetation recovery – fencing only	27	66
2. Natural vegetation recovery – fencing & trees	-	132
3. Establishment of additional vegetation – trees and/or pasture	18	78
Total ha	45	276

Source: Nicholson et al. (2006b)

Information collected during field visits to three sites in the Colac-Eurack target area has been summarised in Appendix 5. Information was collected through botanical assessment

of salt affected sites, general observation, discussion with landholders and DPI officers, and review of incentive data within the CAMS database.

No clear boundary between primary and secondary salinity could be distinguished at these sites. The large majority of salinity appeared primary with apparent expansion into agricultural grazing land. These areas tended to host poorer drained soils residing in depression areas that appear to be topographically natural extensions of primary discharge sites.

Given the importance of local environmental assets, an assessment of the suitability of currently prescribed discharge management actions for each case study site, is provided below:

Discharge management actions	Site 1 Beal Rd	Site 2 Bapinba- Winchelsea Rd	Site 3 Woods Rd
	Suitability		
1. Natural vegetation recovery – fencing only			
2. Natural vegetation recovery – fencing & trees			
3. Establishment of additional vegetation – trees			
4. Establishment of additional vegetation – improved agric. pasture spp.			

Options suitability to sites visited	
High	
Moderate	
Low	

The landholders consulted have various expectations about improving the agricultural productivity of these sites and each had either planted Tall wheat grass (TWG), with mixed success, or intends to plant TWG. Given that the CSAP specifies that within this target area, the assets threatened by salinity are chiefly environmental, there is a dilemma about TWG as a suitable discharge treatment at each of these sites.

Where sites retain a high degree of naturalness, it would seem that tree planting also has only limited suitability in the volcanic plains bioregion (site 2). Where the site has a high degree of modification (sites 1 and 3) some tree planting may be appropriate. Due to the invasiveness of TWG it is deemed inappropriate at sites 1 and 2 due their close proximity to the Sanctuary and Upper Lough Calvert wetland systems. While the area sown to TWG at site 3 is subject to periodic inundation, it is positioned upstream of any defined drainage depression which reduces the risk of TWG plants invading the natural salt lake where the drainage ultimately discharges (see case study notes in Appendix 5 for details).

## Conclusions

Those saline areas in close proximity to lakes are to some extent buffered by the presence of dominant intermediate and regional flow systems and will retain shallow watertables. This may well be desirable given that falling groundwater levels at a regional scale could begin to dry out groundwater dependent ecosystems, including brackish to saline wetland areas and groundwater discharge lakes.

Away from the lakes systems where less dominant intermediate and regional flow systems operate, there is evidence of even shallow groundwater levels continuing to fall in response to the extended dry and it is likely that current areas of saline discharge will contract if current rainfall patterns continue. Reclaiming these areas through controlled grazing and introducing salt tolerant vegetation (trees, shrubs, native grasses, and pasture species) is likely to be successful.

This confirms that the current suite of MAs for the Colac-Eurack target area are limited and that there needs to be an expansion of treatment options that can both meet farmer's objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets. These are often under the jurisdiction of public land asset managers with a strong environmental objective around preserving the ecology of naturally saline areas. Natural vegetation recovery using fencing and grazing management (where applicable) is an effective management action in these situations.

These limitations in options were previously identified in a review of asset manager and stakeholder response to the early stages of implementation of the SAP (Nicholson 2005). For the Colac-Eurack TA, the review concluded that "Salinity investment on primary saline areas (public and private) should result in a net gain in diversity of the area treated".

## 4.2.2 Target Area Summary: Corangamite



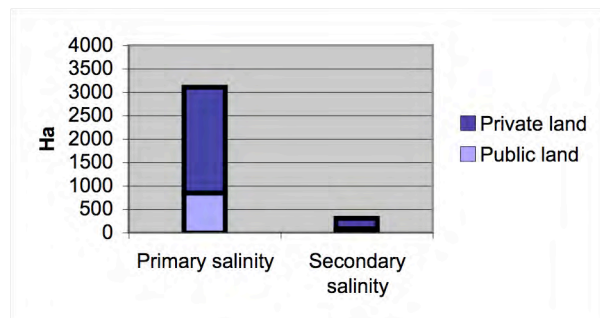
### Description

The area encompasses almost 89,000 ha comprising Lake Corangamite and adjoining lakes and wetlands. The assets at risk are mostly environmental with many of these listed as Australian wetlands of national and international importance. Due to various drainage diversion and other interventions, the ecology and hydrology of many of these groundwater dependent ecosystems has been changed. The management of the Woody Yaloak Drainage Diversion Scheme and its affect on the environmental values of Lake Corangamite is under review (Dahlhaus 2003).

### Salinity Processes

Around 90% of the mapped salinity is primary of which over 70% is on private land. The dominant GFS is the regional aquifer within the Volcanic Plains basalt. Local GFS's occur in the Quaternary alluvium and the Stony Rises and there is an intermediate GFS present in the Pliocene Sands aquifer.

### Land Assets Affected



### Water Table Trends

Recently updated groundwater hydrographs for bores in the Lake Corangamite region indicate a steady to declining trend in water table depths over the past 15 years.

### Land Assets Resource Condition Target

- no net gain in the area affected by secondary saline discharge by 2015 (compared with 2005)

### Salinity Hotspots (see map over page)

- About 2/3rds of salinity has been identified as primary, occurring on private land around Lake Martin and the Cundare Pool to the east of Lake Corangamite.
- Other instances of mostly primary salinity occur around Wool Wool, Duverney and Lakes Struan and Milangi, in the north and northwest.

### Local Discharge Management Issues

- Agricultural land, of which a large proportion is private land, is mostly affected by what is believed to be secondary expansion of primary salinity.
- Likely expansion of discharge areas in response to proposed raising of the water level in Lake Corangamite (under review).
- Tall wheat grass is restricted in its application due to the proximity of salt affected land to naturally saline wetland and lake environments.
- Current salinity treatments offer only marginally better agricultural return than when left untreated and many farmers are unconvinced of the return on investment in salt tolerant perennial pastures.

Mapped Salinity - Corangamite

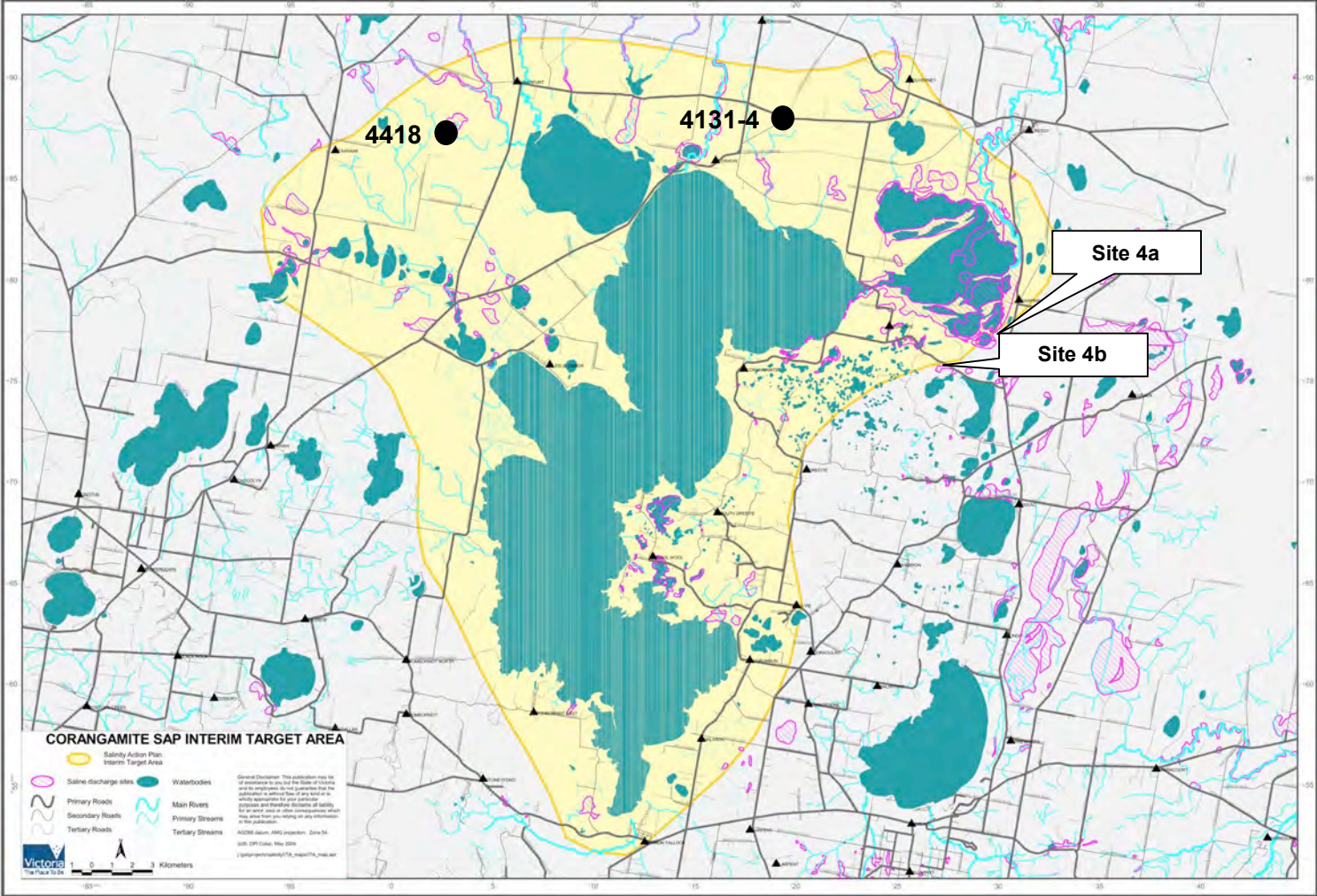


Figure 4.6 Expressions of primary and secondary salinity and location of case study sites

The table below provides a description of case study sites visited.

Site no.	Discharge Treatment	Location	Road & Site Name
4a	Establishment of additional vegetation – improved agric. pasture	South of Lake Martin	Cundare Rd
4b	Establishment of additional vegetation – improved agric. pasture & trees	South of Lake Martin	C/nr Culdare-DuverneyRd & Swans Rd

### Land salinity and watertable trends – Corangamite

Recently updated groundwater hydrographs for bores in the Lake Corangamite region indicate a steady to declining trend in water table depths over the past 15 years. This trend is evident in the large majority of monitoring results reviewed. The overall decline reflects the extended period of below average rainfall, with a decline apparent in many bores, and some since mid-1994.

Figure 4.7 shows sites at Foxhow and demonstrates a decline in the deeper, regional aquifer (bore 92658). The shallow and intermediate flow systems (where groundwater levels are close to the surface) are essentially unaffected by climatic effects. This is typical of groundwater levels being either maintained by a nearby surface water body (lake or creek) or being located in a groundwater discharge area, or both.

The approximate locations of these monitoring bores are indicated on Figure 4.6 (previous page).

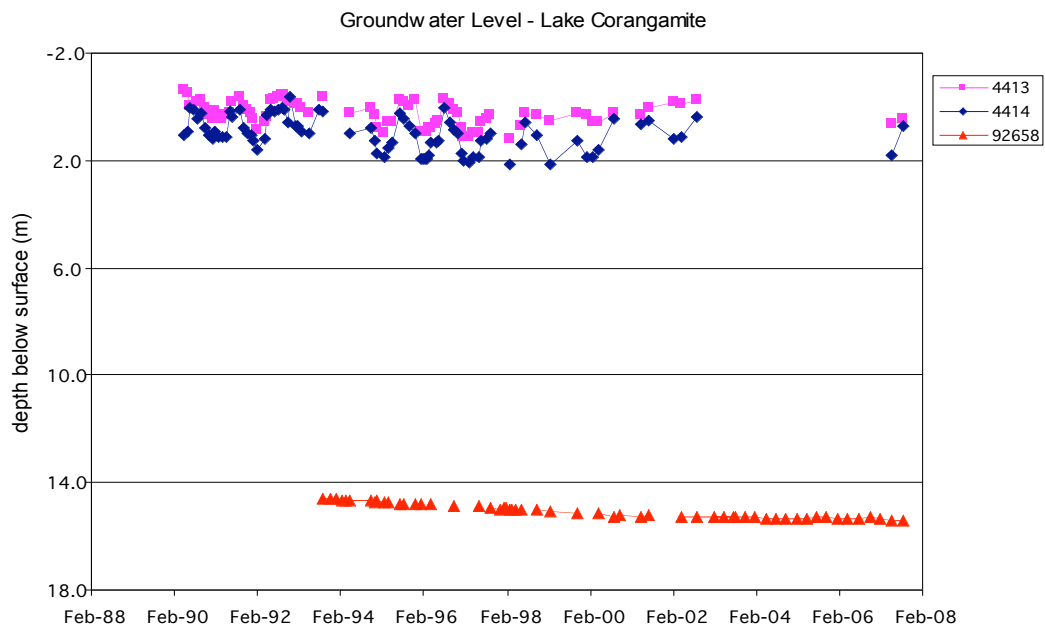
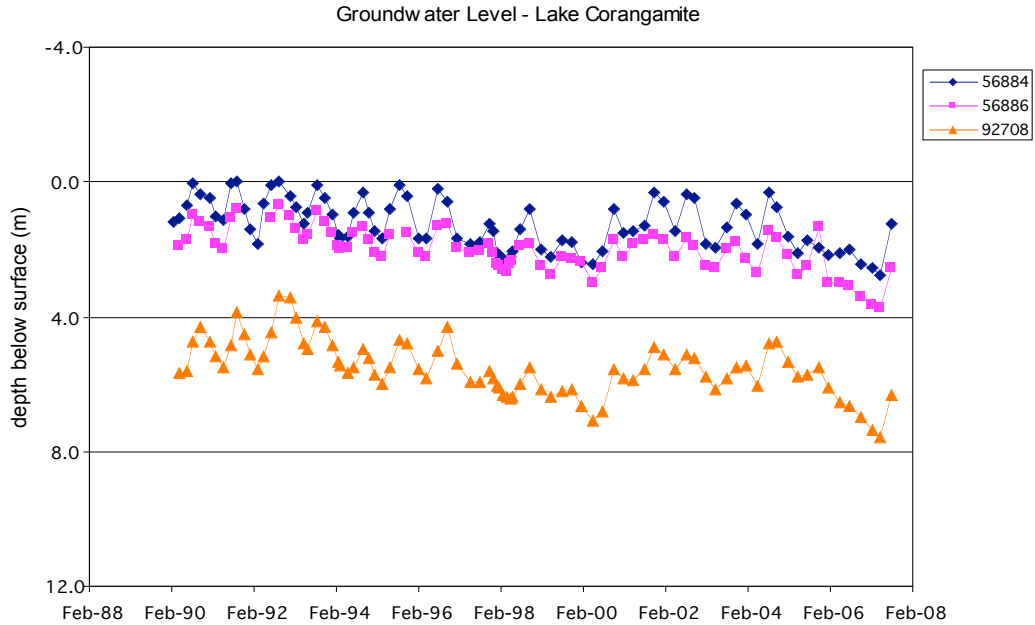


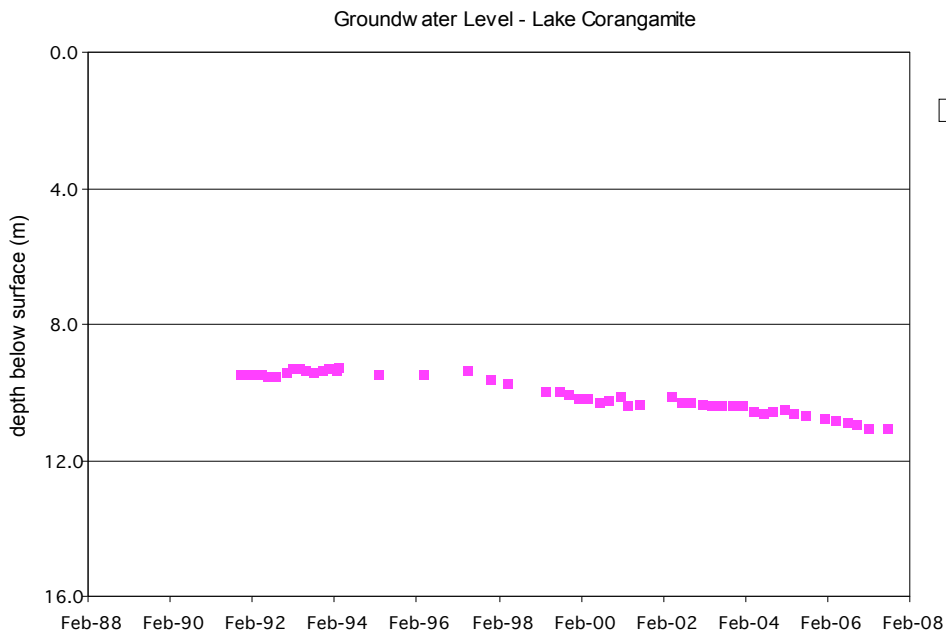
Figure 4.7 Sites at Foxhow

Figure 4.8 shows bores within the State Observation Bore Network in the deeper regional marl/limestone and Pliocene Sands aquifers beneath the Newer Volcanics aquifer, located

west of Leslie Manor, while Figure 4.9 shows a bore in the Newer Volcanics basalt east of Foxhow. All bores show a downward trend from around 1993, a slight recovery then stabilisation from 2000 to late 2005, then a marked decline since then.



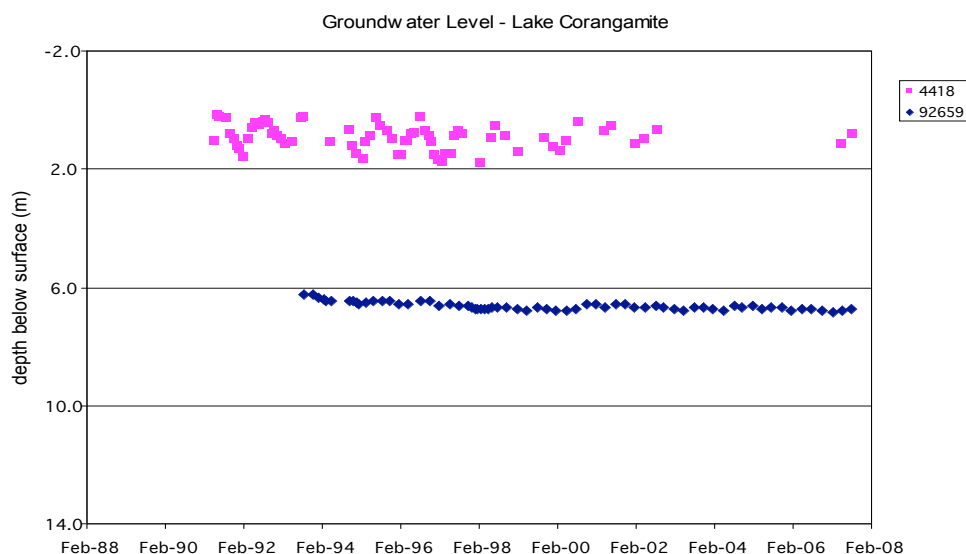
**Figure 4.8 Sites west of Leslie Manor**



**Figure 4.9 Site east of Foxhow**

This response is markedly different from that shown in bores in Figure 4.10. These bores are near Lake Gnarpurt and inferred to represent a groundwater discharge area. Similar to

observations for the Colac-Eurack Target area, bores in the groundwater discharge area, because of adjacent lakes, appear to be only slightly affected by regional climatic effects, showing only a slight decline over the monitoring period.



**Figure 4.10 Sites NE Lake Gnarpurt**

It is notable that shallow bores within groundwater discharge areas (assumed to be groundwater level within 2 m of surface) often do not show a declining groundwater level, or only a minor decline. This reflects the dominance of the flow systems essentially unaffected by climatic influences, and that groundwater discharge areas remain discharge areas, even within extended dry periods despite regional declining levels.

More significant changes to the water balance are needed to drop the groundwater levels sufficiently to prevent them being groundwater discharge areas.

#### Current discharge management actions to reduce land salinity

The following 3-year management action targets and saline discharge management actions are prescribed in the CSAP, Corangamite Target Area report:

Discharge treatment	Public land ha	Private land ha
1. Natural vegetation recovery – fencing only	-	81
2. Natural vegetation recovery – fencing & trees	-	81
3. Establishment of additional vegetation – trees and/or pasture	-	132
Total ha	-	276

Source: Nicholson et al. (2006c)

Information collected during field visits to two nearby sites in the Corangamite target area has been summarised in Appendix 6. Information was collected through botanical assessment of salt affected sites, general observation, discussion with a landholder and the local DPI officer, and review of incentive data within the CAMS data base.

As in the case of Colac-Eurack TA, no clear boundary between primary and secondary salinity could be distinguished at these sites. The large majority of salinity appeared primary with some expansion into agricultural grazing land. These areas tended to host poorer drained soils residing in depression areas that appear to be topographically natural extensions of primary discharge sites.

Given the importance of local environmental assets, an assessment of the suitability of currently prescribed discharge management actions for each case study site, is provided below:

Discharge management actions	Sites 4a & 4b Cundare Rd	Options suitability to sites visited	
	Suitability	High	Moderate
1. Natural vegetation recovery – fencing only			
2. Natural vegetation recovery – fencing & trees			
3. Establishment of additional vegetation – trees			
4. Establishment of additional vegetation – improved agric. pasture spp.			

The two sites visited were part of the one farm. The land is highly modified, having been drained and intensively farmed i.e. sown to improved perennials (comprising TWG, Clovers and Tall Fescue), and grazed by sheep and cattle.

Due to the site’s position in the landscape i.e. on the upstream side of the Cundare Rd about 500 metres from the edge of Lake Martin (a naturally saline lake) and the sound management expertise of the landholder, TWG presents a low environmental risk, however, it is unclear whether this management action would now be permitted under the CCMA/DPI TWG guidelines.

Sowing TWG into this landscape without good grazing management could lead to relatively rapid invasion into areas outside the sown area, including roadsides and naturally saline lakes and wetlands. The level of modification of these sites means that the option of fencing to allow for natural vegetation recovery would be unlikely to provide environmental benefits.

### Conclusions

Again, this confirms that the current suite of MAs for the Corangamite TA are limited and that there needs to be an expansion of treatment options that can both meet landholder’s objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets.

There is a regional decline in groundwater levels apparent further from the main discharge area and lakes. It would seem that a more significant and extended change to regional hydrology would be needed to markedly affect these natural discharge areas, which is likely to be a good situation for the many naturally saline groundwater dependent ecosystems present in this TA. Natural vegetation recovery using fencing and grazing management (where applicable) is an effective management action at sites where agricultural land adjoins public land and/or natural discharge lakes.

### 4.2.3 Target area summary: Geelong – Connewarre



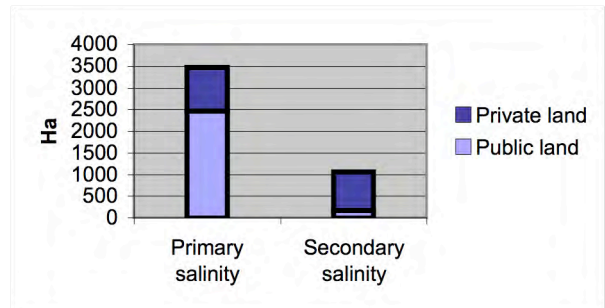
#### Description

The Geelong – Connewarre target area is around 13,000 ha including the Lower Barwon and Thompson Creek estuarine wetlands and saltlands. Assets at risk include naturally saline estuarine and coastal areas supporting coastal saltmarsh and mangrove shrublands. These areas are experiencing changed hydrological conditions largely due to urban encroachment and associated pressures (changed surface drainage flows, irrigated lawns, impervious surfaces etc). Agricultural and infrastructure assets are also at risk.

#### Salinity Processes

Specific hydrogeological investigations of the nature and cause of secondary salinity are yet to be undertaken. Salinity is presumed to be mostly associated with coastal and estuarine wetlands and lakes, and there has been reporting of expressions of secondary salinity on agricultural land surrounding these natural systems.

#### Land Assets Affected



#### Water Table Trends

Water level trends are unknown since groundwater monitoring bores have only recently been established in this target area.

#### Land Assets Resource Condition Target

- no net gain in the area affected by secondary saline discharge by 2015, compared with 2005

#### Salinity Hotspots (see map over page)

- North eastern edge of Lake Connewarre
- Lower reaches of the Barwon River near the South western part of Reedy Lake
- Stony Creek and surrounding Breamlea area

#### Local Discharge Management Issues

- Encroaching urbanisation is contributing to changed hydrological and salinity conditions on the Peninsula.
- The targeted areas are mostly affected by what is believed to be secondary expansion of primary salinity on private land, adjacent public lakes and wetlands assets.
- Difficulty in distinguishing between primary and secondary salinity.
- Meeting the mixed objectives held by public and private asset managers.
- Tall Wheat Grass is deemed inappropriate in this TA due to the proximity of salt affected land to Ramsar-listed or significant wetlands.
- Affected land next to important environmental assets needs to be managed particularly sensitively, yet this land is mostly managed by landholders who are looking for a reasonable agricultural return.

4.2.4 Target Area Summary: Geelong Connewarre

Mapped Salinity – Geelong Connewarre

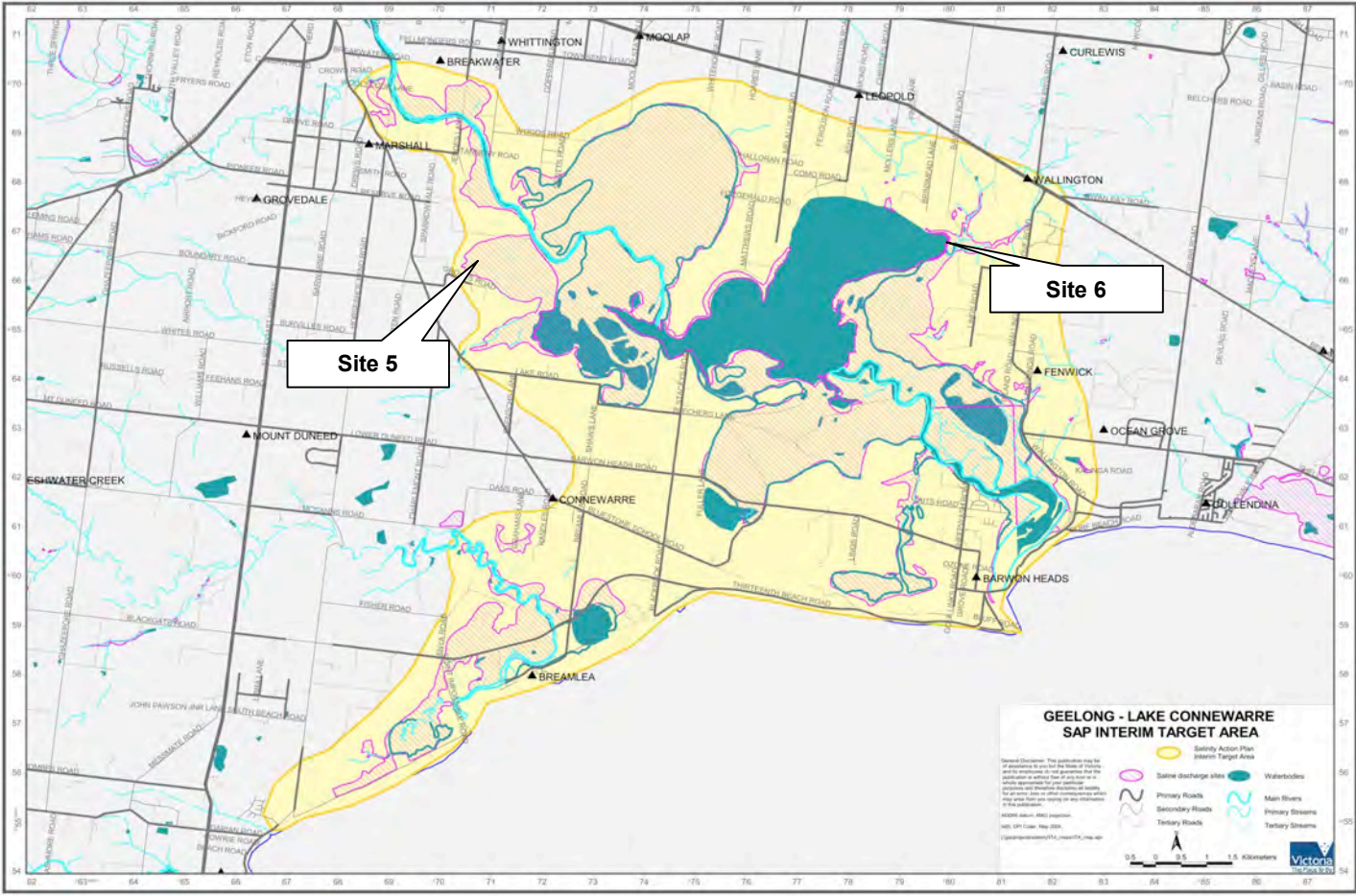


Figure 4.11 Expressions of primary and secondary salinity and location of case study sites

The table below provides a description of case study sites visited.

Site no.	Discharge treatment	Location	Road & site name
5	<b>Establishment of additional vegetation</b> – improved agric. pasture	West of Reedy Lake – off Barwon Heads Rd	Groves Rd
6	<b>Natural vegetation recovery</b> – fencing & grazing management only	North east corner – lake Connewarre	Bawtree Rd

### Current discharge management actions to reduce land salinity

The following 3-year management action targets and saline discharge management actions are prescribed in the SAP, Geelong – Connewarre Target Area report.

Discharge treatment	Public land ha	Private land ha
1. Natural vegetation recovery – fencing only	99	81
2. Natural vegetation recovery – fencing & trees	-	111
3. Establishment of additional vegetation – trees and/or pasture	-	12
<b>Total ha</b>	99	204

Source: Nicholson et al. (2006)

Information collected during field visits to two sites in the Geelong - Connewarre target area has been summarised in Appendix 7. Information was collected through botanical assessment of salt affected sites, general observation, and discussions with local DPI officers, and review of incentive data within the CAMS database.

As in the case of the Colac-Eurack and Corangamite TAs, no clear boundary between primary and secondary salinity could be distinguished at these sites. The large majority of salinity appeared primary with some expansion into agricultural grazing land. These areas tended to host poorer drained soils residing in depression areas that appear to be topographically natural extensions of primary discharge sites.

Given the importance of local environmental assets, an assessment of the suitability of currently prescribed discharge management actions for each case study site, is provided below:

Discharge Management Actions	Site 5 Groves Rd	Site 6 Bawtree Rd
	Suitability	
▪ 1. Natural vegetation recovery – fencing only	High	High
▪ 2. Natural vegetation recovery – fencing & trees	Moderate	Moderate
▪ 3. Establishment of additional vegetation – trees	Low	Low
▪ 4. Establishment of additional vegetation – improved pasture	Low	Low

Options suitability to sites visited	
High	Dark Blue
Moderate	Medium Blue
Low	Light Blue

While the land at site 5 is highly modified and has been grazed intensively, there are many native salt tolerant species across the site having recolonised right up to the edge of Reedy Lake. The landholder is concerned about the low productivity of the site and is interested in sowing salt tolerant perennials. Due to its close proximity to Reedy Lake, TWG is deemed inappropriate at this site, however the high soil salinity means there is a limited choice of suitable species.

TWG was established at site 6 some years previously and there is evidence that grazing management has led to a proportion of the pasture being allowed set seed and begin to invade toward the edge of the lake.

A recent incentive has been provided for the landholder at site 6 to erect about 2000 m of fencing to protect the saltmarsh communities around the lake fringe from cattle grazing. There is also evidence of salinisation of a drainage depression draining into the creek, however, the use of TWG is inappropriate in this landscape and there is a need to identify alternative management strategies.

### **Conclusions**

These observations confirm that the current suite of MAs for the Geelong-Connewarre TA are also limited.

The environmental assets at risk, including Reedy Lake and Lake Connewarre are under the jurisdiction of public land managers with a stronger environmental objective around preserving the ecology of naturally saline areas than adjoining landholders.

Natural vegetation recovery using fencing and grazing management (where applicable) is an effective management action in this TA.

Treatment actions that can both meet landholder's objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets would be desirable. It should be noted that landholders in this TA are more likely to be lifestyle rather than full-time farmers and may have lesser expectations around increasing the agricultural production of these primary saline areas (compared with farmers in the Corangamite and Colac-Eurack TAs, for example). Nil respondents (from within the Bellarine region) to a recent social benchmarking survey indicated dryland salinity is undermining the productive capacity of their properties (Curtis 2006).

#### 4.2.5 Target area summary: Illabarook



#### Description

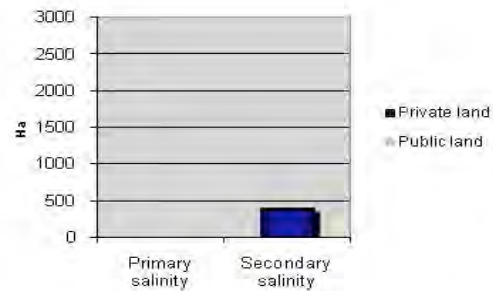
The Illabarook Target Area comprises about 20,000 ha extending from Cape Clear in the west to Mt Mercer in the east. It takes in a number of upper tributaries of the Woody Yaloak River.

Illabarook has been identified as a substantial contributor to high salt loads in the Woody Yaloak River and Lake Corangamite.

#### Salinity Processes

Secondary saline discharge occurs as three different processes and geological formations. Saline discharge is occurring at the base of the Pliocene sands and gravels overlying bedrock, at the boundary of the Newer Volcanics and the underlying bedrock and as baseflow into drainage lines dissected into the bedrock. The most obvious expression of saline discharge in the Illabarook landscape is in the alluvial flats and drainage lines.

#### Land Assets Affected



#### Water Table Trends

There has been a general downward trend in groundwater levels since 1998 in bores screened at depth intervals, with a most noticeable trend since 2003.

#### Land Assets Resource Condition Target

- - no RCT for reducing land salinity is specified in the CSAP. RCTS have been set for recharge control which is a priority.

#### Salinity Hotspots (see map over page)

- Grazing and cropping land associated with gully and sheet erosion between Cape Clear and Mt Mercer
- Riparian vegetation at risk from saline discharge along Illabarook and Moonlight Creeks
- Key tributaries contributing to rising salinity trends in the Woody Yaloak River recorded at Cressy

#### Local Discharge Management Issues

- Secondary salinity is closely associated with creeklines and other natural drainage depressions.
- Spiny Rush is particularly aggressive in these landscapes and once removed needs to be replaced with vigorous plant species to prevent reinfestation.
- Tall Wheat Grass needs to be buffered and carefully managed in these landscapes to ensure it does not invade into riparian communities.
- Primary responsibility for both recharge and discharge implementation is with the Woody Yaloak Catchment Group.

Mapped Salinity - Illabrook

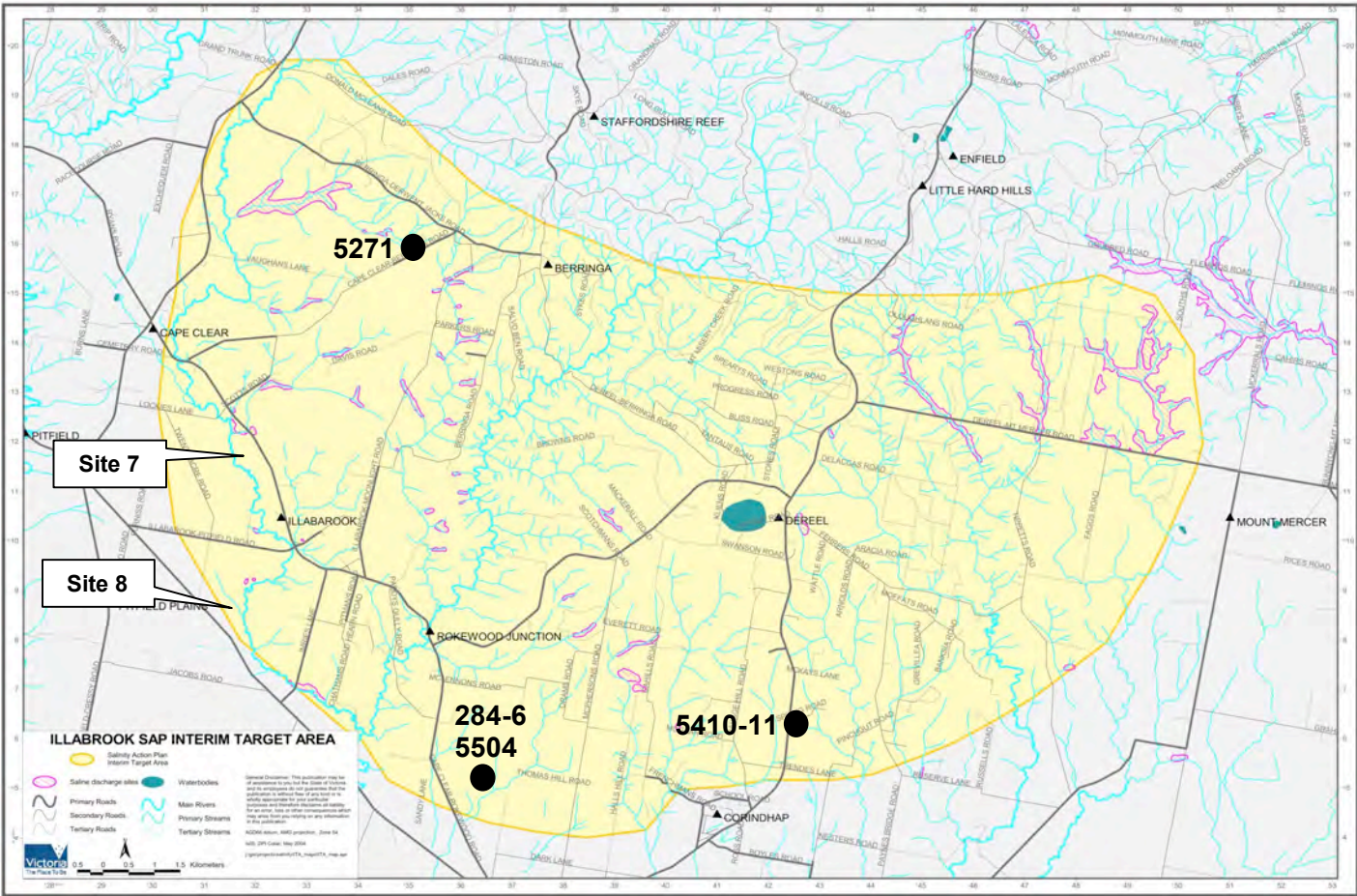


Figure 4.12 Expressions of primary and secondary salinity and location of case study sites

The table below provides a description of case study sites visited.

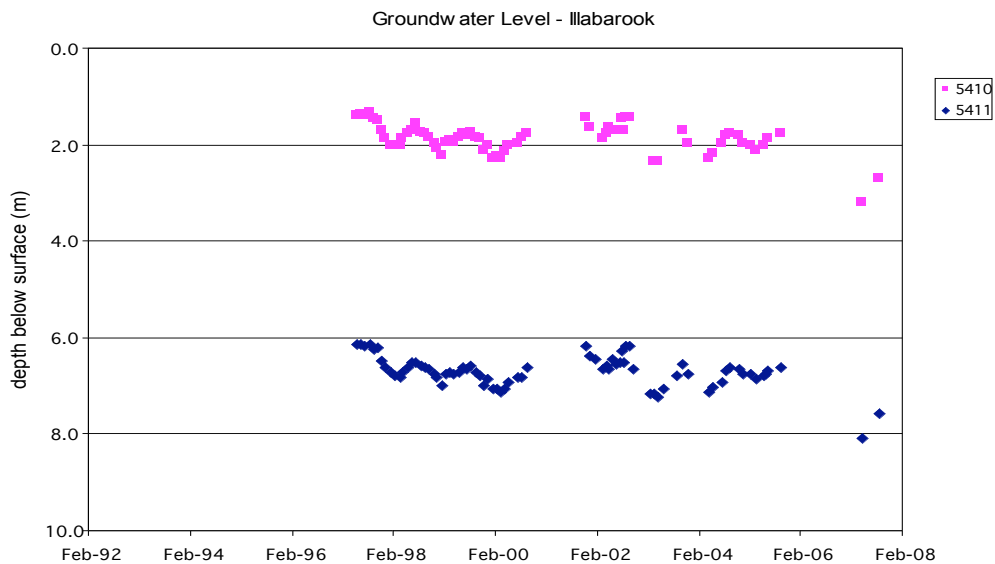
Site no.	Discharge treatment	Location	Road & site name
7	Establishment of additional vegetation – trees	Illabarook Flora Reserve	Cape Clear-Rokewood Rd
8	Establishment of additional vegetation – trees & improved agric. pasture spp.	Illabarook Creek	Imries Lane

**Land salinity and watertable trends – Illabarook**

Recently updated groundwater hydrographs for bores in the Illabarook region indicate a slight downward trend in water table depths over the past 15 years. Recent groundwater level measurements indicate an increase in the rate of decline over the last three years.

Figures 4.13 and 4.14 are in the southern part of the target area in close proximity to the case study sites. These show a steady decline in deep, regional groundwater levels, with the overall decline reflecting the extended period of below average rainfall. Bore no. 284, in Figure 4.15, with a groundwater level 29 m below ground surface, also shows the impact of reduced rainfall. Figure 4.16 in the north west of the Target Area shows a decline, also likely to be due to climatic effects.

The approximate locations of these monitoring bores are indicated on Figure 4.12 (previous page).



**Figure 4.13 Nested site – North of Corindhap**

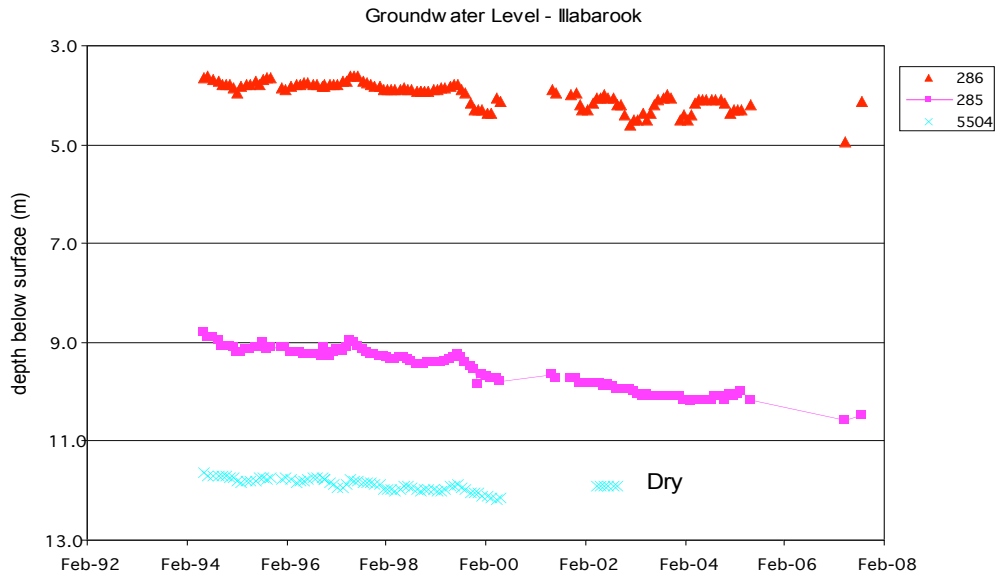


Figure 4.14 Nested site – Deep bores (west of Corindhap)

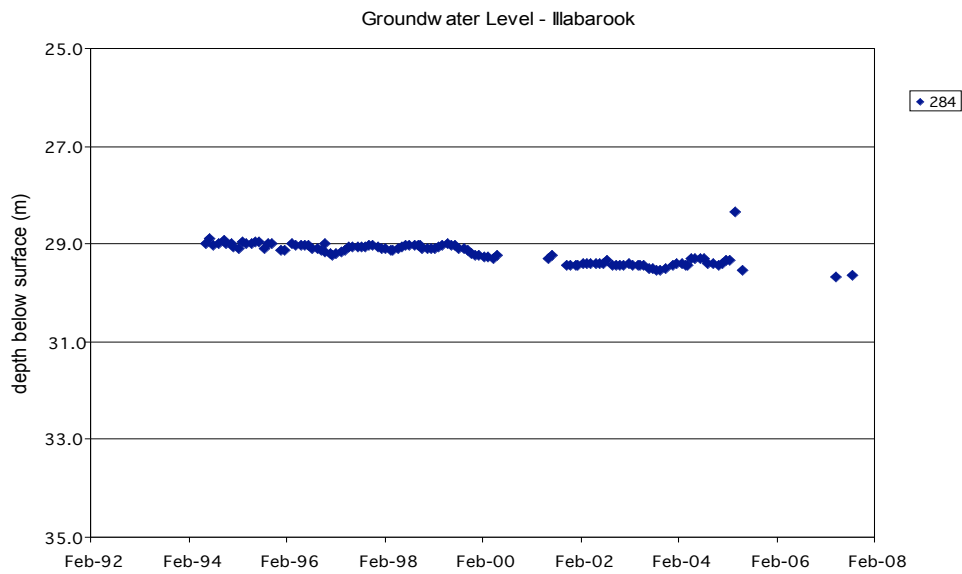
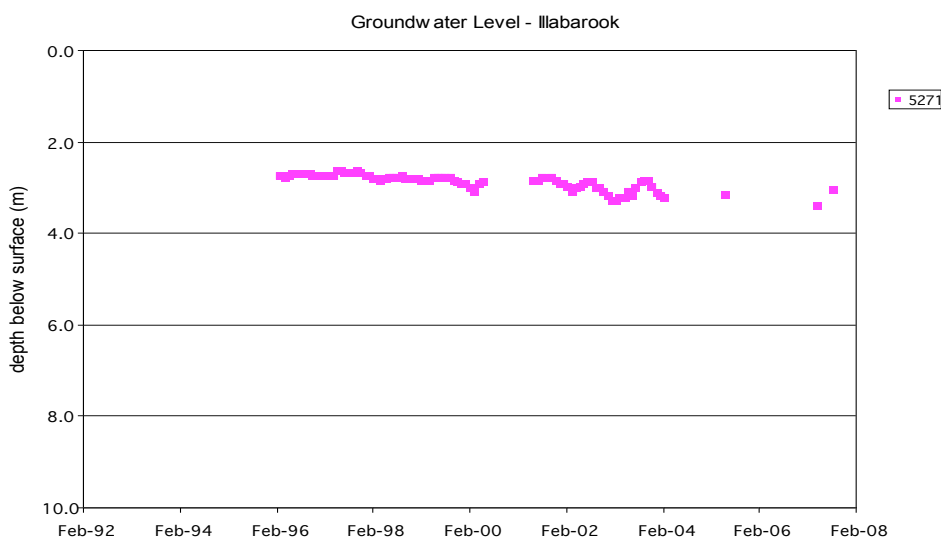


Figure 4.15 Site west of Corindhap – Deep bore (screen 40-42m)



**Figure 4.16 Site – east of Cape Clear (north west part of Target Area)**

It is not known how the system will respond to a return to more usual winter-spring rainfall conditions, however, it could be expected that these declining groundwater levels would stabilise without too much delay.

**Current discharge management options to reduce land salinity**

The following 3-year management action targets and saline discharge management options are prescribed in the CSAP, for the Illabarook target Area:

Discharge Treatment	Public Land ha	Private Land ha
5. Waterlogging control in conjunction with additional vegetation		178
Total ha	-	178

Source: Nicholson et al. (2006d)

Information collected during field visits to two sites in the Illabarook target area has been summarised in Appendix 8.

Information was collected through botanical assessment of salt affected sites, general observation, and discussions with local DPI officers, and review of incentive data within the CAMS database. As distinct from the Colac-Eurack, Corangamite and Geelong-Connewarre TAs, expressions of secondary salinity could be easily identified at these sites. Saline groundwater discharge was evident in all but a few of the alluvial flat and drainage lines throughout the area. An assessment of the suitability of currently prescribed management actions (MAs) for each case study site, is provided below:

Discharge Management Options	Site 7 Cape Clear- Rokewood Rd	Site 8 Imries Lane	Options suitability to sites visited	
	Suitability		High	Moderate
5. Waterlogging control & additional vegetation cover				

The CSAP identifies waterlogging control and additional vegetation cover as a suitable discharge management action for this target location. The area of saline discharge occurring at the two sites visited was small-scale and would be unlikely to warrant substantial investment in surface drainage to alleviate waterlogging. Due to the presence of vigorous infestations of Spiny Rush at both sites, the option of fencing to achieve natural vegetation recovery has limited application. This has been clearly demonstrated at the Parks Victoria reserve (site 7), where trees are struggling to survive where planted amongst untreated Spiny Rush along the Illabarook Creek. Site 8, located further downstream of the Illabarook Creek, hosts a project underway where the landholder has removed the Spiny Rush from the affected area and is assessing options for further treatment.

A previous trial site indicated that salt tolerant pasture species such as TWG, Tall Fescue and various clovers had failed to establish and prevent reinfestation of Spiny Rush. At that time (mid 1990s) soil salinity and scalding was considered too severe to support these species (Neil James pers. comm.), however, in light of falling groundwater levels it is likely that these species could now perform better in these situations.

### **Conclusions**

There has been a general downward trend in groundwater levels since 1998 in bores screened at all depth intervals, with a most noticeable falling trend since 2003.

Spiny Rush is particularly aggressive in these landscapes and once cleared needs to be replaced with vigorous plant species to prevent re-infestation. Any sowing of Tall Wheat Grass, however, would need to be buffered against the risks of invasion into riparian communities along the creek. Small scale woodlots using salt tolerant tree and shrub species would seem to be a reasonable option for reclaiming affected land and reducing saline wash-off from many affected sites in this target location. There will always be an on-going difficulty in keeping sites free of re-infestation with Spiny Rush following its removal.

A non-invasive native grass that can compete with Spiny Rush re-infestation would be ideal for planting at these sites, however, there are no known species that would perform in this environment. Treatments that can both meet farmer's objectives around raising the agricultural productivity of these sites, and at the same time, pose no significant threat to nearby riparian assets are not yet available.

## 4.2.6 Target area summary: Pittong



### Description

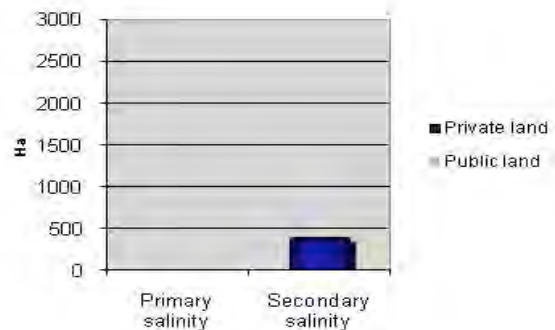
The Pittong Target Area is around 6,300 ha and comprises the upper catchment of the Naringhil Creek, a tributary of the Woody Yaloak River.

Recent expansion in saline areas (measured between 1996 – 2000) is contributing to high salt loads in the Woody Yaloak River and Lake Corangamite.

### Salinity Processes

Saline discharge is expressed as springs discharging in the alluvial flats and drainage lines sourced from fractures in the underlying granite. Shallow groundwater flows and soil waterlogging in the valley flats are best controlled by improving surface drainage and introducing salt tolerant vegetation. Tree belts are being used to intercept lateral flows while salt tolerant perennial pastures are being sown in the lower slope and discharge areas to increase evapotranspiration and reduce salt wash-off (Nicholson et al. 2006).

### Land Assets Affected



### Water Table Trends

Recently updated groundwater hydrographs for bores in the Pittong region indicate a steady to declining trend in water table depths since 1997, accelerating from 2003.

### Land Assets Resource Condition Target

- no net gain in the area affected by secondary saline discharge by 2015 (compared to 2005)

### Salinity Hotspots (see map over page)

- Secondary salinity on grazing and cropping land south west of Pittong has recently expanded in area - measured to be affecting a further 8% of the designated discharge monitoring site over the 4 year monitoring period (1996 – 2000). More recent figures are presently unavailable.
- Rising salinity trends in the Woody Yaloak River, measured at Cressy, with salt loads being sourced from the upper catchment of the Naringhil Creek

### Local Discharge Management Issues

- The main elements of salinity control are interception tree belts (principally recharge control), surface drainage and additional salt tolerant vegetation, designed to reduce salt loads into the Woody Yaloak River and rehabilitate salt affected land.
- Neighbourhood group planning with widespread participation by farmers in the Pittong TA, are working together to reduce salinity with assistance and support provided through the Woody Yaloak Catchment Group.
- Extensive and detailed investigations in this TA has meant that landholders have confidence in salinity treatments and are active in implementing both recharge and discharge treatments.

Mapped Salinity – Pittong

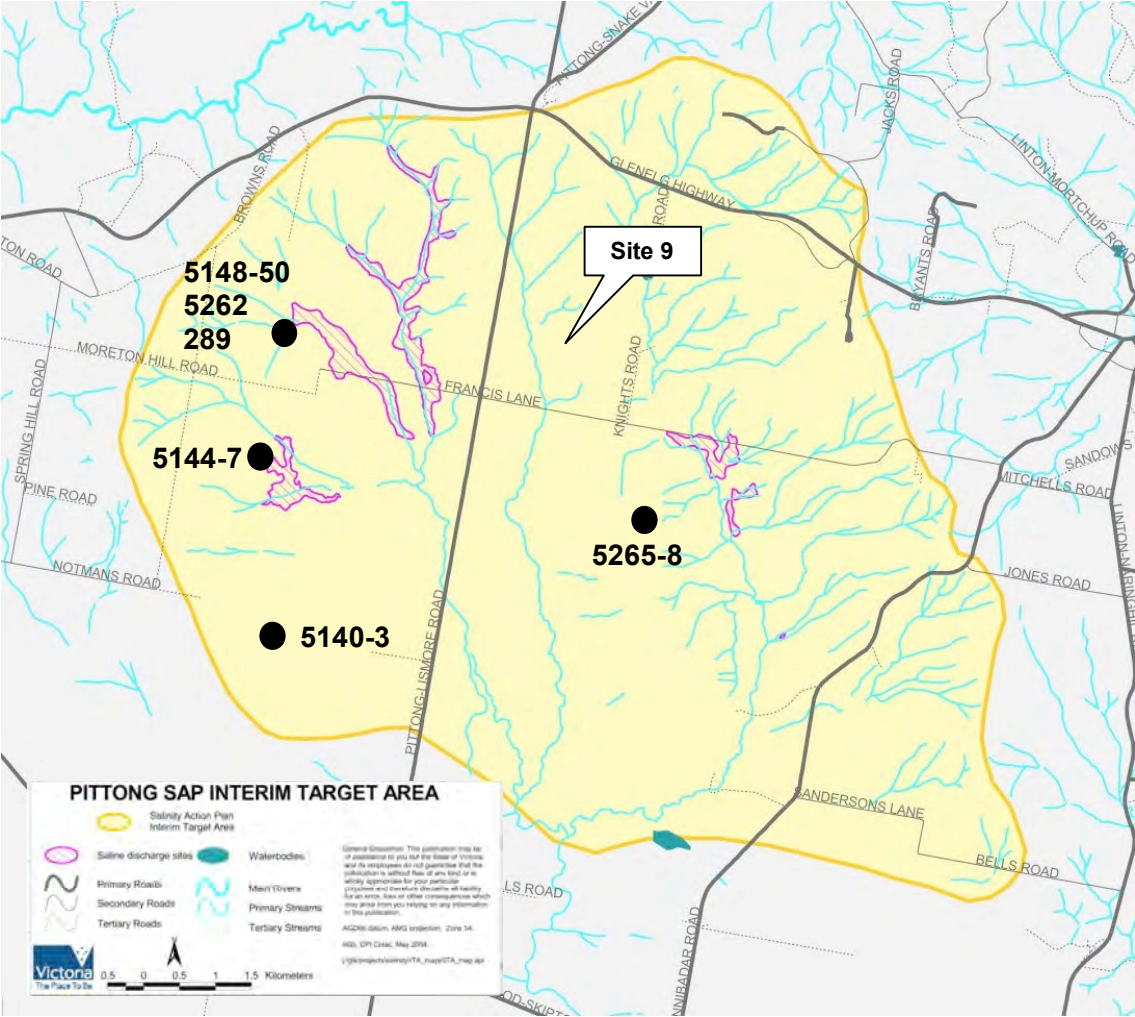


Figure 4.17 Expressions of Primary and Secondary Salinity

The table below provides a description of case study sites visited.

Site no.	Discharge treatment	Location	Road & site name
9	Waterlogging control on discharge areas in conjunction with establishment of additional vegetation – salt tolerant perennial pasture	East of Skipton	Morton Hill Rd

### Land salinity and watertable trends – Pittong

Recently updated groundwater hydrographs for bores in the Pittong region indicate a steady to declining trend in water table depths over the past 15 years. This trend is evident in the large majority of monitoring results reviewed. The overall decline reflects the extended period of below average rainfall, with a decline apparent in many bores since late 1997, accelerating from 2003.

It is notable that the decline is most apparent in deeper bores, however in contrast to other target areas, a similar decline is also shown in shallow watertables in some groundwater discharge areas (see Figure 4.18). The approximate locations of these monitoring bores are indicated on Figure 4.17 (previous page).

Figure 4.18 bores were all reportedly drilled to a depth of 17 m and are indicating an almost identical downward trend even though they have a marked difference in measured depth to watertable. Even with a decline in water level, in two bores (5146 and 5147) the level is still within 2 m from ground surface. This means that in some settings, even with an extended decline in groundwater level, there may be no noticeable decrease in groundwater discharge (and salt affected) area, even though the volume of discharge and hence salt build-up may have reduced. Where there is a significant salt store in the soil, such a decline in flux would have no noticeable affect.

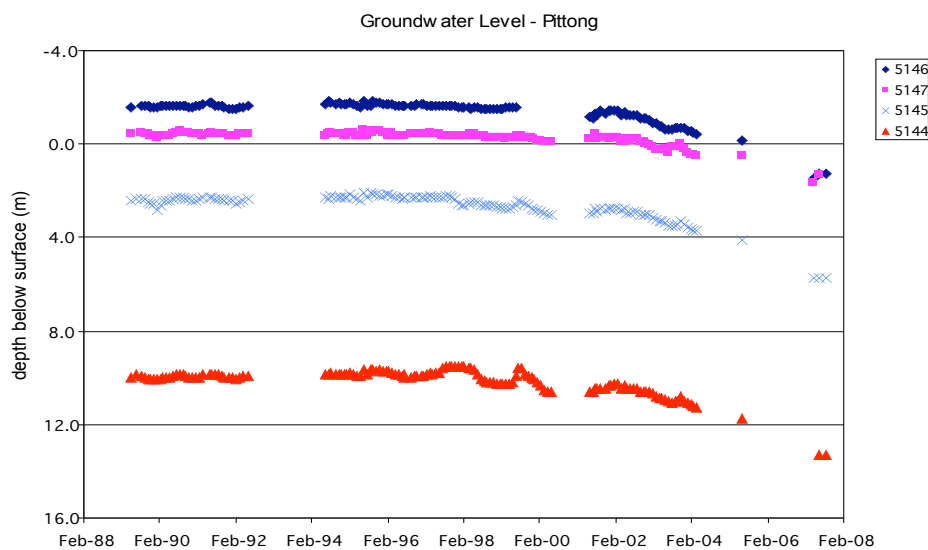
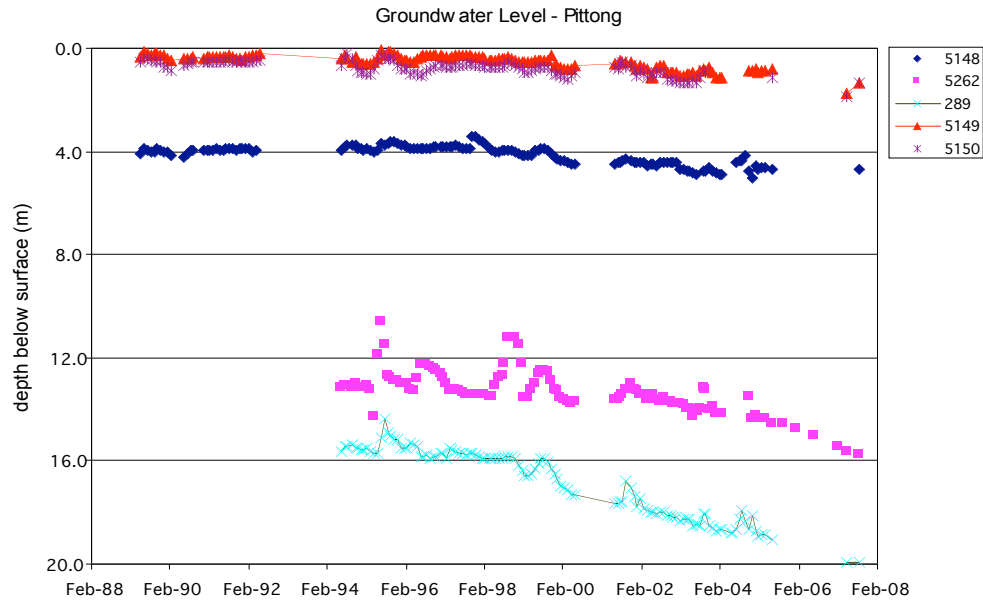


Figure 4.18 Nested site – western part of target area

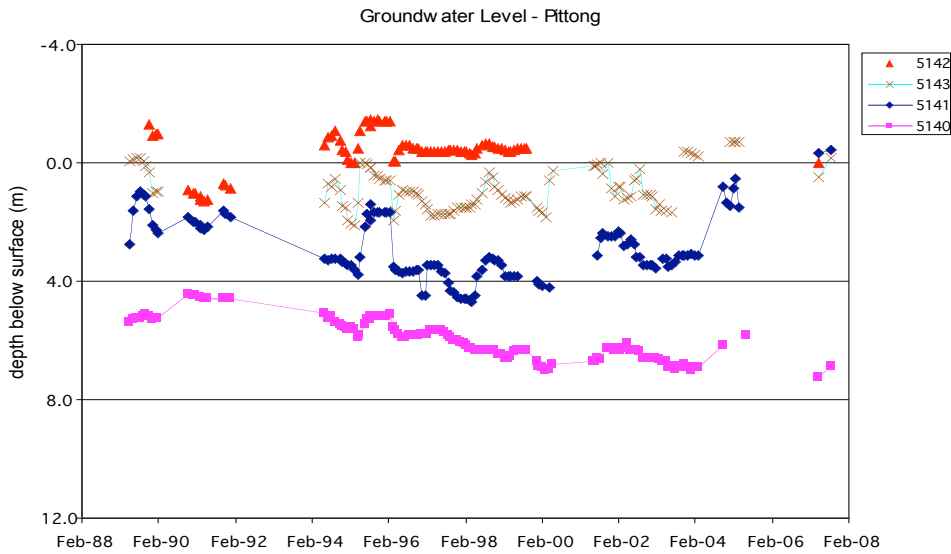
By contrast, Figure 4.19 shows only a slight impact of climatic conditions on shallow groundwater. For example, bore 5150 is screened within 7 m of surface, and better reflects the groundwater conditions in that zone. The rate of groundwater level decline in the shallow system is less than the regional decline shown in deeper bores. Water levels in deeper bores (5262, 289) have dropped up to 4 m since late 1997.



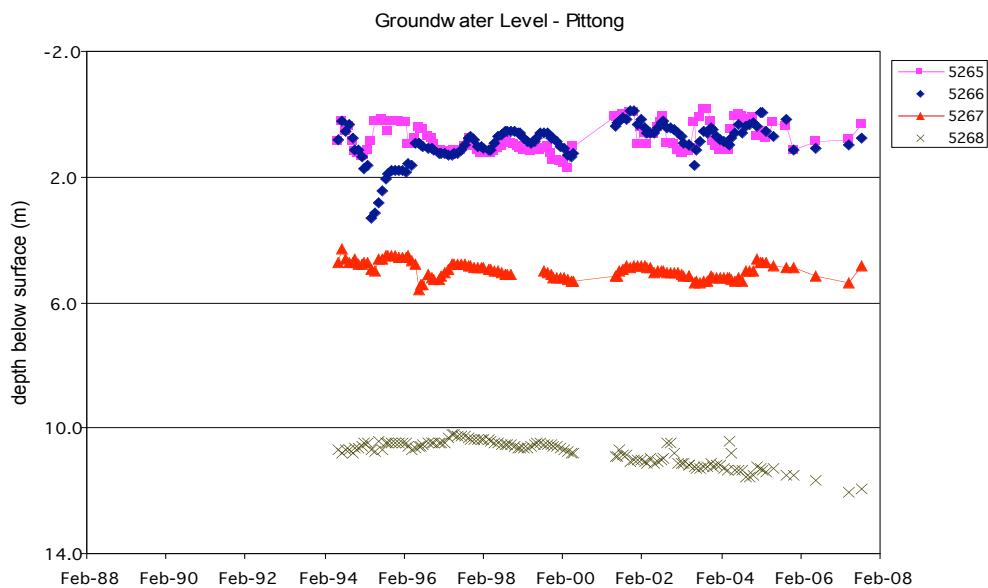
**Figure 4.19 Northwestern part of target area**

Figures 4.20 and 4.21 in contrast, show monitoring in the southern part of the Target Area. These appear to show a different response in groundwater levels to bores in the northern part of the catchment. Trends are generally steady and in some sites (Figure 4.20 – bores 5141, 5143) a rise in groundwater level has been reported. This in an area where a deep bore (5140) shows a decline.

This is indicative of a system where the down-gradient part of the flow system is still maintained by high up-gradient pressure. In essence, the volume in storage has not yet declined sufficiently to have an impact in the downgradient area. This has implications for management measures, and suggests a relatively long period before actions in the upper catchment could affect groundwater levels in the southern part of the catchment (at least in the shallow and intermediate flow systems).



**Figure 4.20 South west – lower in catchment**



**Figure 4.21 South – lower in catchment**

The most recent salinity discharge monitoring, south west of Pittong, indicated that there had been recent expansion of salinity (Clark & Allan 2005). Secondary salinity was measured to be affecting a further 8% of the designated discharge monitoring site over the 4 year monitoring period (1996 – 2000). The water table had lowered only slightly at the Pittong monitoring site (0.4 m) over the previous 4 years, however, updated hydrographs to September 2007 indicate that the water table has lowered a further 0.5 – 1 m in the vicinity of the discharge monitoring site over the past 7 years. An updated EM survey is needed to determine the affects of a lower water table on the area of saline discharge.

### Current Discharge Management Actions to Reduce Land Salinity

The following 3-year management action targets and saline discharge management actions are prescribed in the CSAP for the Pittong TA:

Discharge treatment	Public land ha	Private land ha
Waterlogging control on discharge areas in conjunction with establishment of additional vegetation – salt tolerant perennial pasture	-	132
Waterlogging control	-	435
Total ha		587

Source: Nicholson et al. (2006e)

Information collected during field visits to one site in the Pittong target area has been summarised in Appendix 9. Information was collected through botanical assessment of the salt affected site, general observation and discussions with the local DPI officer.

An assessment of the suitability of currently prescribed discharge management options for the case study site, is provided below:

Discharge Management Options	Site 9. Morton Hill Rd	Options Suitability to Sites Visited	
	Suitability	High	Moderate
Waterlogging control on discharge areas in conjunction with additional vegetation – salt tolerant perennial pasture			
Waterlogging control	Not determined		

Given that there are relatively large areas of secondary salinity on properties in this target location, landholders are likely to have considerably higher expectations about improving the agricultural productivity of these sites than some other target areas. A large area of TWG (20 ha) has been successfully established at the case study site 9, in conjunction with the construction of surface drains to reduce waterlogging. TWG is an appropriate pasture option given that the treated area is part of the upper catchment of a lower landscape drainage depression and there is a relatively low risk of TWG invasion into natural waterways or wetland areas.

### Conclusions

There is a steady decline in water tables in the upper catchment areas of the Pittong TA. This will take some time to be felt in the lower catchment area where water tables remain steady or even continue to rise (as measured in some bores). The affects on the area of discharge are undetermined at the present time.

A clear understanding of the groundwater flow systems and local variations within these would enable better targeting of management measures. Different approaches are likely to be suitable for northern and southern parts of Target Area.

Observations indicate that the current suite of MAs is satisfactory and there is widespread participation by farmers through the Woody Yaloak Catchment Group. With saline discharge treatments working well, the implementation issues are more likely to be around setting an appropriate incentive level that will trigger the desired level of adoption on a case-by-case basis.

#### 4.2.7 Target area summary: Lismore - Derrinallum



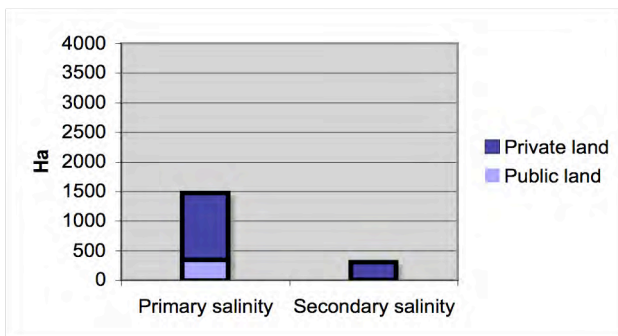
#### Description

The Lismore-Derrinallum TA comprises around 16,400 ha. The land is mostly managed by full-time landholders farming sheep and beef cattle grazing dryland pasture with some cropping. There are areas of low relief with poorly developed drainage systems interspersed with better drained bank soils, for example. There has been a slow expansion of secondary salinity observed, which is being mitigated by discharge management treatments.

#### Salinity Processes

This TA encompasses the zone between the central highlands and the volcanic plains. There are 6 groundwater flow paths operating making salinity processes complex and varied: Quarternary alluvium, Stony rises and Granite (local), Pliocene sands and Central Highlands volcanic (intermediate) and the regional Volcanic plains basalt aquifer. Managing creekline degradation is a current priority since there are no feasible options for reducing recharge being recommended in this landscape (Dahlhaus 2003).

#### Land Assets Affected



**Water Table Trends** Recently updated groundwater hydrographs for bores in the Lismore-Derrinallum region indicate a steady to declining trend in water table depths over the past 15 years.

#### Land Assets Resource Condition Target

- no net gain in the area affected by secondary saline discharge by 2015 (compared to 2005)

#### Salinity Hotspots (see map over page)

- Lake Toolirook, an important environmental asset between Derrinallum and Lismore, has an undetermined risk of salinity.
- Saline discharge along creeklines (8 km mapped), including Salt Creek, Haunted Gully, Browns Waterholes and Mundy Gully, draining into Lake Gnarpurt near Foxhow.
- Salinity in poorly drained saline depressions on the volcanic plains, around Derrinallum township.

#### Local Discharge Management Issues

- Difficulty in distinguishing between primary and secondary salinity in various naturally brackish to semi-saline environments.
- Tall Wheat Grass is restricted in its application due to the proximity of salt affected land to naturally brackish wetland, lake and creek environments.
- Appropriate treatment of poorly drained areas with a wide range of salinities supporting remnant native grassland species.
- The Lismore Land Protection Group drives a lot of the revegetation, land and waterway works and the focus is presently on treating degraded creeklines through tree planting.

Mapped Salinity – Lismore Derrinallum

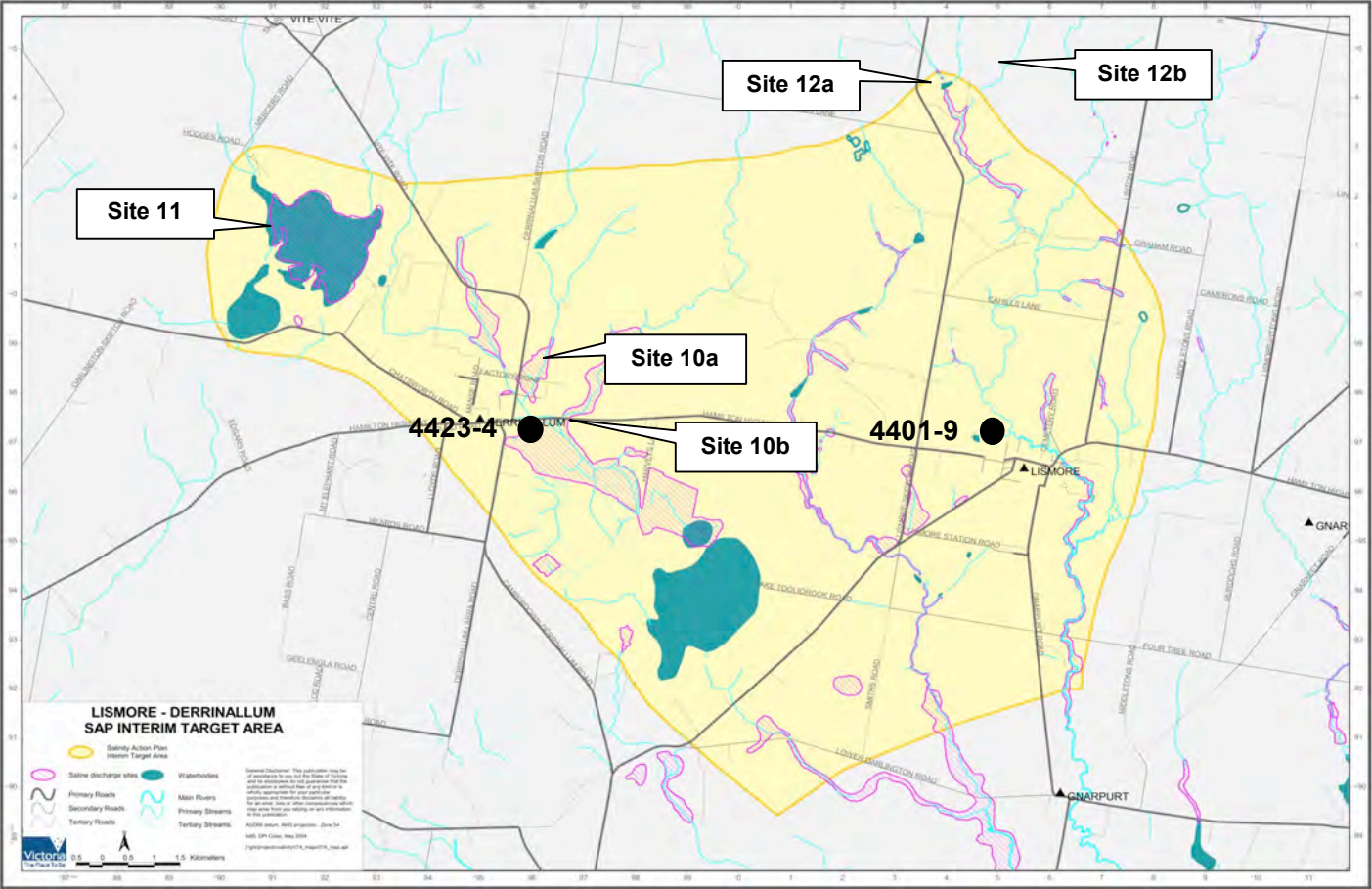


Figure 4.22 Expressions of primary and secondary salinity and location of sites visited

Case study sites reviewing previous incentive projects were not identified for the Lismore Derrinallum target area because the previous DPI extension officer had recently left the area. Notwithstanding a number of sites were visited and observations were made about their salinity status and various treatments being adopted. These are listed in the table below:

Site no.	Location	Road name
10a	Derrinallum township outskirts	Hamilton Highway and railway crossing
10b	NE of Derrinallum township	Derrinallum-Vite Vite Rd
11	Lake Logan	Mt Elephant Estate Rd
12a	Tributary of Browns Waterholes	Eight Mile Lane
12b	Browns Waterholes	Eight Mile Lane

### Land salinity and watertable trends – Lismore Derrinallum

There is relatively limited groundwater monitoring in this Target Area. As with other TAs, recently updated groundwater hydrographs for bores in the Lismore-Derrinallum region indicate a steady to declining trend in water table depths over the past 15 years. This trend is evident in the large majority of monitoring results reviewed. The overall decline reflects the extended period of below average rainfall, with a decline apparent in many bores, some since around mid-1994.

A steady trend is shown in the watertable beneath discharge areas as indicated in Figures 1 and 2. The approximate locations of these monitoring bores are indicated on Figure 4.22 (previous page).

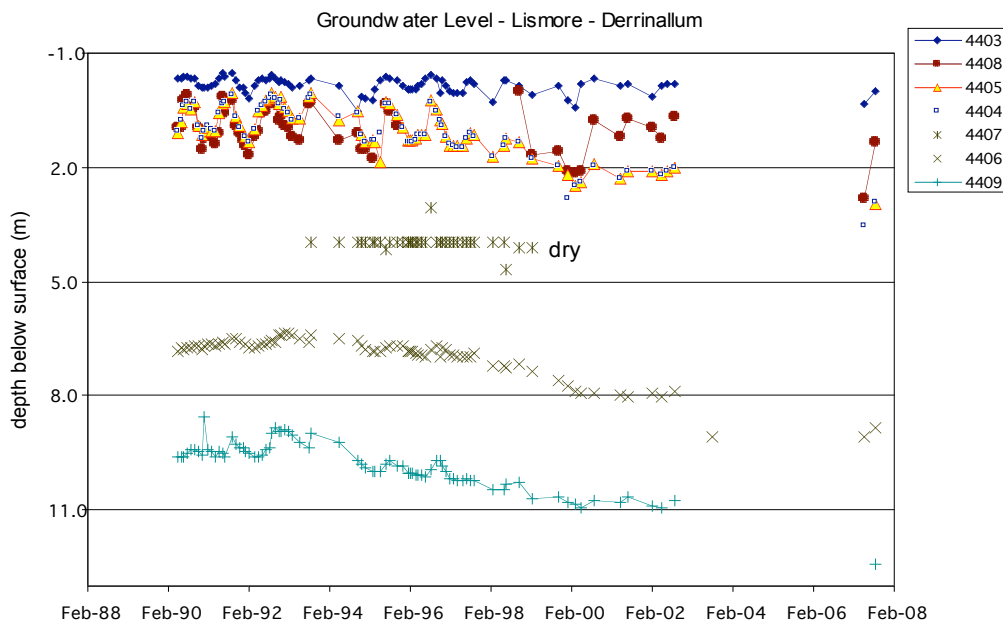
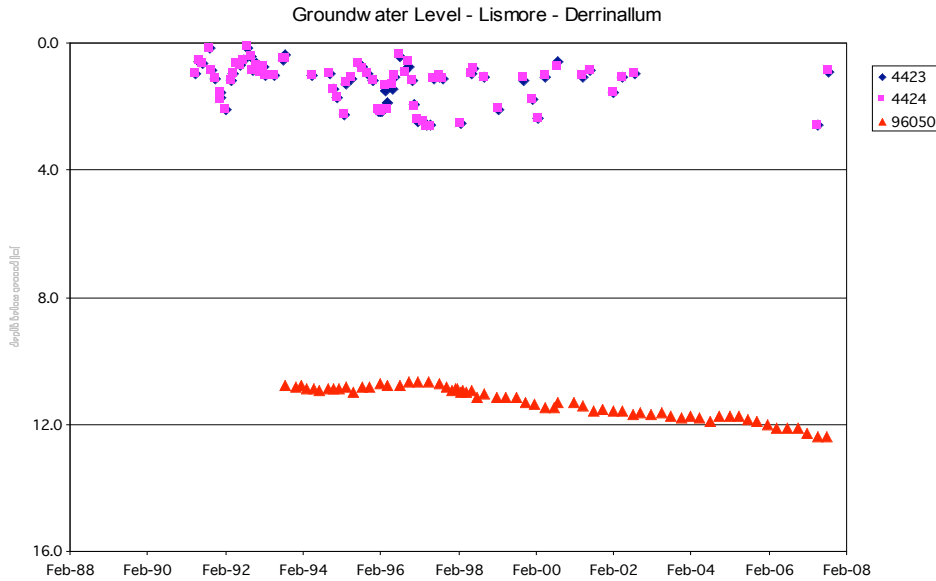
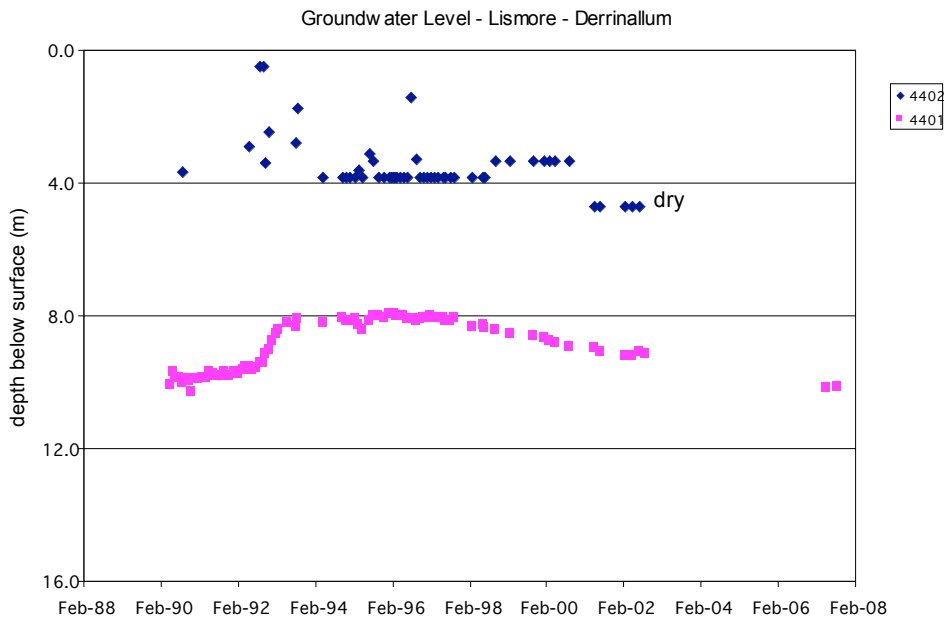


Figure 4.23 Nested sites – west of Lismore



**Figure 4.24 Nested site – east of Derrinallum**

It is notable that the decline is most apparent in deeper bores, representing downward trending regional groundwater conditions, while the bores with the shallowest groundwater depth (in groundwater discharge areas) show a relatively steady trend (eg. bore 4403), at least until the period 2003 to 2007 (Figures 4.23 and 4.24) when there has been a slight decline.



**Figure 4.25 Nested site – west of Lismore**

Some bores recently monitored are now dry (eg. Figure 4.25) which could indicate poor construction or silting up, however, in many cases it is likely that the groundwater level is now below the screened interval.

### Current discharge management options to reduce land salinity

The following 3-year management action targets and saline discharge management options are prescribed in the CSAP, Lismore Derrinallum Target Area report:

Discharge Treatment	Public land ha	Private land ha
1. Natural vegetation recovery – fencing only	21	69
2. Natural vegetation recovery – fencing & trees	-	-
3. Establishment of additional vegetation – trees and/or pasture	-	48
Total ha	21	117

Source: Nicholson et al. (2006f)

Case study sites reviewing previous incentive projects were not identified for the Lismore Derrinallum target area because the previous DPI extension officer had recently left the area. Notwithstanding, a number of sites were visited and observations were made about their salinity status and various treatments being adopted.

In a recent survey, 30 – 40% of respondents in the wider Lismore area reported plants on their property showing signs of salinity, yet they were usually small in area (< 4 ha) in size (Curtis 2006). About 40% of respondents also reported having undertaken government funded work on their property over the past 5 years.

This indicates that there is already a relatively high level of farmer engagement in this TA. Dryland salinity, however, was not rated as an important issue, in terms of undermining the long-term productive capacity of properties. Previous asset manager consultation indicated that landholders in this TA were unconvinced of the return on investment in treating discharge areas and that the severity of salting had improved over the past decade (Nicholson et al 2003). Some landholders expressed a preference for retaining these lesser productive saline areas to retain their biodiversity values. To induce any additional treatment of discharge areas in this TA it will be important to set an appropriate incentive level to achieve the desired level of adoption.

Similar to other TAs, shallow bores within groundwater discharge areas (assumed to be groundwater level within 2 m of surface) tend not to show a declining groundwater level, or only a minor decline. This reflects the dominance of the flow systems unaffected by climatic influences, and that groundwater discharge areas remain discharge areas, even within extended dry periods despite overall regional declining levels.

More significant changes to the water balance are needed to lower groundwater levels sufficiently to prevent groundwater discharge. In these cases, local control measures, to reduce salt wash off, and minimise the spread of salt-affected area are likely to provide greatest benefit.

The Lismore Land Protection Group drives a lot of the revegetation, land and waterway works in the TA.

The sites visited and observations made are summarised in Appendix 10.

## Conclusions

A number of sites visited were naturally brackish to semi-saline environments. These areas tended to host poorer drained soils residing in depression areas that appear to be topographically low points in the landscape which would be periodically inundated, or shallow drainage lines. In many cases it was difficult to reliably distinguish between primary and secondary salinity. However, given the geology (base and salt-rich Newer Volcanics) and the fact that much of the landscape was formerly treeless Plains Grassland (i.e. recharge areas probably little modified functionally) much of these areas may not be substantially different from the pre-settlement hydrological and salinity conditions.

Given that there are native species persisting in many affected areas, TWG is mostly an inappropriate management action. The applicability of tree planting along brackish (rather than saline and degraded) drainage lines in a volcanic plains environment should also be considered on a case-by-case basis. In planting trees on such sites the water yields need to be considered in respect of the terminal wetlands (streams or swamps) lower in the catchment. Tree planting in some instances could be depriving these wetlands of important environmental flows.

Earlier stakeholder consultation indicated that some landholders expressed a preference for retaining these lesser productive saline areas to retain their biodiversity values, while others are interested in more active intervention to increase their production eg. surface drainage, oversowing previously treated areas with introduced and productive agricultural species. It is likely that the biodiversity values of the vegetation planted to trees was variously low (exotic pasture) to moderate or even high, depending upon the floristic composition and structure of the vegetation (partially indigenous and exotic vegetation).

These observations confirm that the current suite of management actions for the Lismore-Derrinallum target area are limited and that there needs to be an expansion of treatment options that can both meet individual farmer's objectives around raising the productivity of these sites and/or protecting biodiversity values (where applicable).

## 5 Project Conclusions

This project reviewed current treatments of saline discharge areas and confirmed where these are appropriate and identified where additional treatments are needed. The findings have been validated through some field-based research and a review of relevant literature.

### 5.1 Groundwater Trends

There has been a general downward trend in groundwater levels in bores screened at all depth intervals since the mid 1990s, with a more noticeable falling trend since 2003. These downward trends are apparent in all geomorphic land units. Falls in groundwater levels of around four metres are not uncommon.

Observations by local DPI officers suggest that the area of saline discharge is contracting in many districts. The most recent salinity discharge monitoring (conducted in the year 2000 at Beeac) indicated that the water table had lowered over the previous four years with a corresponding reduction in the total salt affected area. Hydrographs updated to September 2007 indicate that the water table has lowered further and it is expected that there has been a further reduction in the area of discharge.

By contrast, year 2000 salinity discharge monitoring, south west of Pittong, indicated that there had been recent expansion of salinity. The water table had lowered only slightly at the Pittong monitoring site over the previous four years, however, hydrographs updated to September 2007 indicate that the water table has lowered a further 0.5 – 1 m in the vicinity of the discharge monitoring site over the past seven years.

On the Volcanic Plains, saline areas in close proximity to lakes are to some extent buffered by the presence of dominant intermediate and regional flow systems and it is expected that they will retain shallow watertables despite the prolonged dry cycle. More significant changes to the water balance are needed to drop the groundwater levels sufficiently to prevent them being groundwater discharge areas. This may well be desirable given that falling groundwater levels at a regional scale could begin to dry out groundwater dependent ecosystems, including brackish to saline wetland areas and groundwater discharge lakes.

Away from the lakes systems where less dominant intermediate and regional flow systems operate, there is evidence of even shallow groundwater levels continuing to fall in response to the extended dry and it is likely that current areas of saline discharge will contract if current rainfall patterns continue.

## 5.2 Recommended Management Actions by Target Area

Some conclusions and recommendations on the best saline discharge treatment options for each target area follow:

### *Colac-Eurack & Lake Corangamite target areas*

#### **Conclusions:**

- Landholders in the Colac-Corangamite area have a mixture of expectations about improving the agricultural productivity of affected sites and some have either planted TWG (with mixed success) or intend to plant TWG.
- Where sites retain native shrubland and other saline adapted species, it would seem that tree planting needs to be carefully targeted in a volcanic plains environment.
- The current suite of management actions are limited and there needs to be an expansion of treatment options that can both meet farmer's objectives around raising the productivity of affected sites, and at the same time, pose no significant threat to nearby environmental assets.
- Natural salt lakes are often under the jurisdiction of public land asset managers and natural vegetation recovery using fencing and grazing management (where applicable) is an effective management action in these situations.
- Landholders in this area are unlikely to be 'life-style' farmers and will have a strong production and farm business focus. They will also have the skills and means to sow salt tolerant pasture and will demand productive alternatives to TWG on sites where it is unacceptable.
- In saline areas away from the main discharge lakes system, where groundwater levels have lowered even marginally, some of these areas may be becoming less hostile to plant growth. Springtime in the southwest saw good leaching rains this year.
- **Recommendation: *Given that the CSAP specifies that within these target areas, the assets threatened by salinity are chiefly environmental, sowing to TWG is not a suitable discharge treatment.***
- **Recommendation: *If current winter-spring rainfall patterns persist and groundwater levels continue to stabilise, more passive treatments, such as fencing for natural vegetation recovery, or sowing less invasive species such as Tall Fescue and salt tolerant clovers (Balansa and Strawberry) should be considered.***

### *Geelong – Connewarre target area*

#### **Conclusions:**

- The environmental assets at risk, including Reedy Lake and Lake Connewarre are under the jurisdiction of public land managers with a strong environmental objective around preserving the ecology of naturally saline areas. Natural vegetation recovery using fencing and grazing management (where applicable) are effective management actions at sites where agricultural land adjoins public land.

- Treatment actions that can both meet landholder's objectives around raising the productivity of these sites, and at the same time, pose no significant threat to nearby environmental assets are desirable.
- Landholders in this area are more likely to be 'lifestyle' rather than full-time farmers and may have lesser expectations around increasing the agricultural production of what appears to be mostly primary saline areas (compared for example with those farming around Colac).
- **Recommendation: *Given that the CSAP specifies that within these target areas, the assets threatened by salinity are chiefly environmental, sowing to TWG is not a suitable discharge treatment.***

#### *Illabarook target area*

##### **Conclusions:**

- Secondary discharge occurs in association with drainage lines and alluvial valley floors which means that the use of TWG is restricted in its application due to the risks of invasion of riparian environments. Spiny Rush is aggressive and difficult to remove once it has a stronghold and there is a lack of alternative salt tolerant species that will prevent Spiny Rush reinfestation after its removal.
- The affected areas tend to be degraded and highly modified environments with few (if any) native species remaining, so active intervention is necessary to reduce the impacts of scalding, erosion and salt and sediment wash-off into nearby waterways. Fencing to control grazing on these areas to allow for natural regeneration of desirable species is not a suitable management action. It's too passive.
- Some landholders will prefer a grassed or pasture option and at the moment this will be restricted to using less invasive legumes (Strawberry and Balansa clovers) and exotic grass species such as Tall Fescue. Previous trial work had concluded that soil salinities are invariably too high for these species, however, if falling groundwater levels continue or stabilise it is likely that these species will perform better in these situations in the future.
- **Recommendation: *Given that scalded and degraded areas tend to be small as a proportion of the landscape (i.e. narrow areas associated with a moderately incised drainage system) small woodlots using salt tolerant tree species would be a useful and preferred treatment option.***

#### *Pittong target area*

##### **Conclusions:**

- Secondary discharge in drainage depressions is being treated with surface drainage in combination with salt tolerant pasture species, mainly TWG, Tall Fescue and clovers. This is a suitable and effective treatment and implementation of discharge treatments are being driven through an active local landholder group.
- The implementation question is more about setting an appropriate incentive level that reflects the public: private benefit mix and that will be sufficient to trigger the amount of adoption desired to meet water and land salinity targets specified in the CSAP.

- **Recommendation: *An analysis of the current and future incentive rate should be undertaken to facilitate increased adoption.***

*Lismore-Derrinallum target area*

**Conclusions:**

- The areas being treated tend to be naturally brackish to semi-saline environments with poorer drained soils in depression areas - topographically low points in the landscape which would be periodically inundated, or active shallow drainage lines. In such sites it is difficult to reliably distinguish between primary and secondary salinity.
- Observations confirmed that the current suite of management actions for the Lismore-Derrinallum target area are limited and that there needs to be an expansion of treatment options that can both meet individual farmer's objectives around raising the productivity of these sites and/or protecting biodiversity values.
- TWG is invasive in this Volcanic Plains environment and tree planting in some situations could be depriving wetlands and drainage lines of increasingly important environmental flows.
- Again, landholders in this area are unlikely to be 'life-style' farmers and will have a strong production and farm business focus. Many will have the skills and means to sow salt tolerant pasture and will demand productive alternatives to TWG on sites where it is now considered to be unacceptable.
- **Recommendation: *Given that native plant species tend to be persisting in affected areas, TWG is an inappropriate management action in these situations.***
- **Recommendation: *The applicability of tree planting along brackish (rather than saline and degraded) drainage lines in a volcanic plains environment should also be considered on a case-by-case basis.***

### 5.3 Distinguishing between Primary and Secondary Salinity

On the Volcanic Plains no clear boundary between primary and secondary salinity could be distinguished at the sites visited. The large majority of salinity appeared primary with some expansion into agricultural grazing land. These areas tended to have poorer drained soils in depressions that were topographically, natural extensions of primary discharge sites.

Very little is known about natural non-coastal vegetation of saline lands (public and private) in the region but from our observations during this and other studies, several important points can be made:

- There is a unique suite of vegetation types on saline, non-coastal lands in the region (primary salinity sites)
- Many vegetation types (eg. *Halosarcia halocnemoides* shrubland) are very poorly known floristically and structurally, and are essentially undocumented
- Many rare, vulnerable and endangered plant species, and undescribed species, occur in these vegetation communities, and they are the habitats of rare, vulnerable and endangered fauna.
- The communities face major threats such as weed invasion (notably by Tall Wheat Grass) and inappropriate grazing regimes.

## 5.4 Selecting Plant Species Appropriate to Plant on Secondary Salinity Sites

In selecting plant species for particular sites many factors need consideration. The objectives for each site need to be clearly established and prioritised for each kind of treatment. Should the site be rehabilitated to provide useful forage to boost farm productivity, or are the objectives to stabilise soils to prevent scalding; lower discharge/reduce water tables; produce wood products (including carbon sequestration) honey or essential oils, for example. Alternatively, the objectives of rehabilitation could be mostly around protecting and enhancing the environmental values of the site. This is of high importance where there are native species present on primary saline sites.

Having established acceptable objectives for revegetation of a site, a number of guidelines will then apply (aside from technical and economic parameters guiding selection) and these will include:

- Weed risk of the species: Weedy species should be avoided as much as possible. Where their use cannot be avoided there should be a rigorous evaluation of the on-site and off-site risks, and in the event that the species does become naturalised, responsibilities for management need to be clearly established.
- Further evaluation of the species: Many species will need to be evaluated by local trials as there are no 'silver bullets' at the present time
- Site-specific constraints: While there is much environmental similarity enabling classes of sites to be identified based on soil types, salinity levels etc, there are likely to be site-specific attributes as well. To this extent a limited range of uniform treatments may not be appropriate.

Further critical evaluation and trialling is required to determine which plant species are suitable for establishing on secondary salinity sites in the CCMA. Noteworthy species are discussed below.

### Trees and shrubs

*Casuarina* species – acceptable and valuable salt tolerant plants.

*Eucalyptus* species – potentially very useful and with low weed potential. There are additional species known to be salt tolerant and new salt-tolerant taxa have been recently described from Western Australia.

The use of highly salt-tolerant Red Gum (*E. camaldulensis*) should be avoided anywhere in proximity, or potential proximity to natural Red Gum populations to avoid genetic pollution. *Eucalyptus camaldulensis* is widespread and abundant as an indigenous species in the study area, especially on the Victorian Volcanic Plain.

*Melaleuca* species – many species are highly tolerant of salinity and waterlogging but all have unacceptable weed risk except in carefully defined situations. Criteria need to be developed to define high risk sites and evaluation protocols developed to enable their use in low-risk sites.

*Atriplex* spp. – the exotic *A. amnicola* (WA), *A. lentiformis* (Arizona, California) and *A. undulata* (Argentina) should not be planted because of their weed potential. Victorian species are acceptable.

### Indigenous species in the CCMA

These are desirable because of negligible weed risk, however, there is a wide range of suitability from a technical viewpoint. Subject to trial and evaluation, the most useful species are probably *Muehlenbeckia florulenta* (Tangled Lignum), *Distichlis distichophylla* (Australian Salt-grass), *Sporobolus virginicus* (Salt Couch) and *Juncus kraussii* (Sea Rush).

### Grasses

*Chloris gayana* (Rhodes Grass) has high weed potential and should be avoided.

*Distichlis spicata* 'NyPaForage™' is sterile and without weed potential.

*Festuca arundinacea* (Tall Fescue) is regionally abundant and widely used for fodder and soil stabilisation. From a weed risk viewpoint its use should be restricted to sites where it will not pose a risk to nearby wetlands.

*Lophopyrum ponticum* (Tall Wheat Grass), is a highly invasive species and presents an unacceptable risk in many locations, particularly on the Volcanic Plains. It should be used with great caution under clearly defined conditions to minimise risk while populations that have already become naturalised off-site need to be managed.

*Puccinellia ciliata* (Puccinellia) is a very useful forage species but it is invasive (more so than the literature may imply). It is widely naturalised in Victoria and further evaluation of this species is necessary before it can be safely and reasonably advocated for use as a fodder plant on saline sites in this region.

*Puccinellia fasciculata* (Borrer's Saltmarsh-grass) is too small in habit to be useful as forage.

*Sporobolus mitchellii* (Rat-tail couch) as a native plant seems quite promising, along with *S. virginicus* (Salt Couch) and *Distichlis distichophylla* (Australian Salt-grass), however, their forage value is still under question.

Other grass species may be of use (*Cynodon*, *Diplachne*, *Eragrostis*, *Pennisetum*) but await trials to determine if practical and under what environmental and management conditions.

*Paspalum vaginatum* (Saltwater Couch) is likely to be too weedy to make it a candidate for planting in this region.

### Legumes

*Trifolium* spp. (Clovers) and *Melilotus albus* (Bokhara Clover) are an acceptable weed risk and may become more successful for more saline sites if the prolonged dry cycle continues and groundwater levels in discharge areas continue to deepen (or stabilise) and subsequently soil salinities reduce.

The choice of the most suitable plant species for a particular site will need to take into account landscape context, cost of establishment and other implementation factors, and for many species, there remains a lack of resolution around which are the most suitable.

## 6 Overall Project Recommendations

In light of these findings a further set of recommendations has been developed.

These include:

1. Review and refine protocols used to identify primary versus secondary salinity sites to ensure that those making assessments and providing incentives to landholders can apply the most suitable treatment for a site.
2. Review and reconsider current TWG planting guidelines for use in the volcanic plains bioregion. Given that native species tend to persist in salt affected areas, and that the CSAP acknowledges that it is environmental assets that are most at risk in this bioregion, sowing TWG is not a suitable discharge treatment.
3. Trial and evaluate further plant species for use in saline areas in each of the target areas. This is particularly urgent in the Volcanic Plains bioregion, keeping in mind, that under a stabilising groundwater environment some presently useful plant species (such as clovers and Tall Fescue) may become more effective.
4. Review information (published and unpublished) relating to the distribution, biology and ecology of all plant species inhabiting saline sites to provide more rigour in the assessment of saline sites for salinity management actions. Such a study would widely sample vegetation, classify and map the vegetation, determine its conservation significance and management requirements.
5. Undertake a wide-ranging survey of regional inland saline and non-saline wetlands to identify sites of local, regional, state, national and international biodiversity conservation significance. Such a study would collate all data, widely sample the vegetation, classify and map indigenous and partly exotic vegetation communities, identify (so far as possible) primary and secondary salinity sites/areas, evaluate conservation significance, threats and management requirements.
6. Develop a practical cost-benefit assessment protocol that can be used for assessing all secondary salinity sites that may require treatment. This would include an assessment of the objectives of proposed management actions and the economic, social and environmental costs and benefits of treatment. It is likely that a range of criteria would need to be developed and these would be based on factors where there are available data sets.
  - any assessment also needs to be considered in the context of longer-term global climate change scenarios and the likely impact on groundwater levels and salinity.
7. Revisit the Victorian Dryland Salinity Monitoring Network (VDSMN) monitoring sites and conduct electro-magnetic (EM) surveys to assess any further changes in areas of saline discharge and soil salinities. This updated knowledge would provide further direction on suitable plant species to trial and evaluate, now and into the future.

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## Appendix 2: Evidence of Tall Wheat Grass Invasion



Plate 1. A population of the nationally endangered, Victorian Volcanic Plains endemic, Salt-lake Tussock-grass (*Poa sallacustris*) on the shores of Calvert Loch, east of Colac. Tall Wheat Grass (*Lophopyrum ponticum*) is likely to cause the extinction of this EPBC Act-listed species, without appropriate management in the region; it is invading this site (Nov.07).



Plate 2. Tall Wheat Grass (*Lophopyrum ponticum*) invading upper saltmarsh at the Lake Connewarre Ramsar wetland reserve. Indigenous species include Chaffy Saw-sedge (*Gahnia filum*) and Coast Tussock-grass (*Poa poiformis* var. *poiformis*) (Nov.07).



Plate 3. Tall Wheat Grass (*Lophopyrum ponticum*) invading saltmarsh on the north-east shore of Lake Connewarre (Site 6) (Sep.07).



Plate 4. Tall Wheat Grass (*Lophopyrum ponticum*) invading saltmarsh on the estuary of Barwon River near Ocean Grove (Sep.07).



Plate 5. Tall Wheat Grass (*Lophopyrum ponticum*) planted on a secondary salinity site near Fyansford and the Barwon River (Sep.07).



Plate 6. Tall Wheat Grass (*Lophopyrum ponticum*) dominates this road reserve near Pittong (Sep.07).

### Appendix 3: Tall Wheat Grass Guidelines

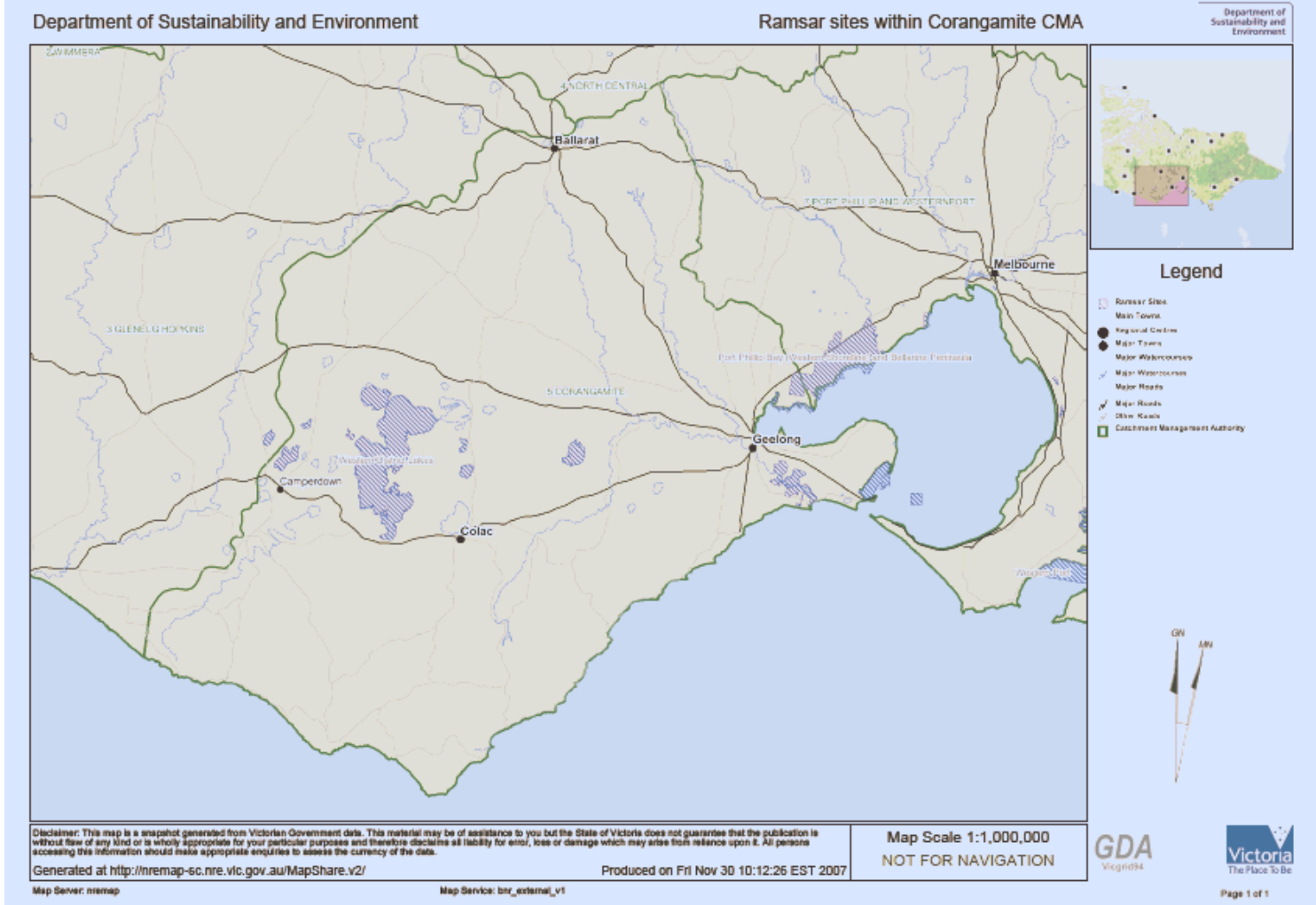
NRM issues /considerations	Yes	No	Boundary Buffer or other actions (recommended minimum distances)
<b>Primary Saline Site</b>			No planting if site identified.
<b>Wetland Type</b>			
Ramsar			No Planting
Directory of Important Wetlands			No Planting
High value wetlands (check with CMA)			50m from adjoining flood plain boundary
Other wetlands (regionally important)			20m from adjoining flood plain boundary
<b>Threatened species &amp; habitats present</b>			Check with DSE Biodiversity
<b>Patch of indigenous remnant vegetation</b>			20m
<b>Natural Waterways (1:25,000 map)</b>			20m
<b>Fence lines</b>			
Internal			1m from edge or 1 drill width of suitable spp.#
External			2m from edge or 1 drill width of suitable spp.#
<b>Constructed drains</b>			
Minor (internal, on-farm, shallow)			1m from edge or 1 drill width of suitable spp.#
Major Drain (local or regional)			50m from edge
Channel			50m from edge
<b>Flood Frequency – 1 in 10 years</b>			20m
<b>Tree belt/plantation**</b>			
Internal			1m from edge or 1 drill width of suitable spp.#
Boundary			2m from edge or 1 drill width of suitable spp.#
<b>The Land holder</b>	<b>Yes</b>	<b>No</b>	<b>Comments</b>
TWG management info/package provided			
Prior TWG management demonstrated			Satisfactory? Not satisfactory?
If no prior management, has applicant good understanding of what is required?			
Skills / capacity to manage TWG?			

\* Are poor native dispersers present?

# suggest most suitable/appropriate alternative spp. or focus improving production on better parts of the property

\*\* revegetated waterways to be treated as waterway

### Appendix 4: Ramsar sites within the Corangamite CMA region



## Appendix 5: Case Study Reports – Colac - Eurack

### Site 1: The Sanctuary, Beal Rd

#### Description

The site is an extension of The Sanctuary wetland system, situated along the northern edge of Lake Turrumbong. Colac Otway planning scheme designates this site as ESO2.

#### Botanical Notes

The vegetation of the site is essentially exotic-pasture with very high cover of Sea Barley-grass (*\*Hordeum marinum*), abundant Perennial Rye-grass (*\*Lolium perenne*), Sweet Melilot (*\*Melilotus indicus*), Strawberry Clover (*\*Trifolium fragiferum*) and Burr Medic (*\*Medicago polymorpha*). Tall Wheat Grass (*\*Lophopyrum ponticum*) is very scattered with low cover (much < 0.1%); the plants were young and quite small.



Project site – area sown to salt tolerant pasture

Project site – aerial view

#### Incentive Summary

- - establishment of 15 ha salt tolerant pasture– TWG, phalaris & strawberry clover
- - fertilizer and gypsum applied
- - 500 trees planted

Year treated: 05/06

Soil test:

1:5 soil salinity test results are 8 dS/m



Project site – topographic view

#### Issues

Very few plants of TWG had persisted at this site following sowing in the year 05/06.

Under current TWG guidelines, it would no longer be acceptable to provide an incentive to establish TWG at this site due to its proximity to naturally saline wetlands.

Given the asset under threat is essentially an extension of a naturally saline lake system, how should this land be managed by the landholder? They have an expectation around increasing production off this site so works should an incentive be given for?

## Site 2: Upper Lough Calvert, Bapinba – Winchelsea Rd

### Description

The site comprises a large area of groundwater discharge lake (public land) under grazing lease adjacent to a substantial area of salt affected private land. This forms the northern part of Loch Calvert, a wetland of national significance.

### Botanical Notes

The vegetation of this site including the 220 ha of public land and much adjoining private land is an extensive primary salinity site with low open Grey Glasswort (*Halosarcia halocnemoides* ssp. *halocnemoides*) shrubland, also with abundant f Austral Seablite (*Suaeda australis*). This is a very rare vegetation type, probably unique to the Victorian Volcanic Plain bioregion. A few other indigenous species are common, eg. Weeping Lovegrass (*Eragrostis parviflora*) but the exotics Sea Barley Grass (*\*Hordeum marinum*), Coast Barb-grass (*Parapholis incurva*), Soft Brome (*\*Bromus hordeaceus*), Wimmera Rye-grass (*\*Lolium rigidum*) and Buck's-horn Plantain (*\*Plantago coronopus*) dominate the vegetation on the less saline part of the system. Also present is a population of the nationally endangered, endemic Salt-lake Tussock-grass (*Poa sallacustris*).



Highly significant Grey Glasswort (*Halosarcia halocnemoides*) shrubland is vulnerable to Tall Wheat Grass invasion (Sep.07)



Project site – aerial view

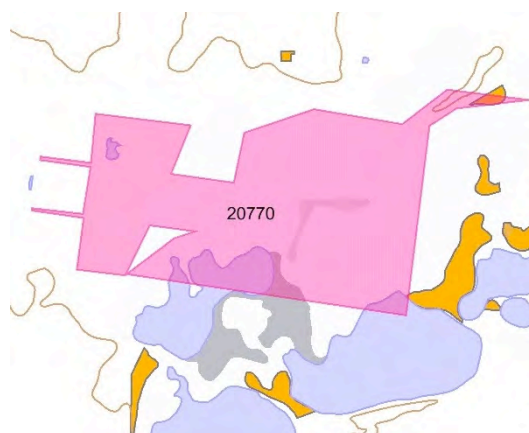
### Incentive Summary

- fencing only to control grazing on 220 ha salt lake (public land under grazing lease)
- establishment of 60 ha of salt tolerant pasture including TWG, strawberry clover, tall fescue, phalaris, and balansia clover
- 1800 trees planted

Year treated: 05/06

### Soil test:

1:5 soil salinity test results ranged between 4.9 – 10.3 dS/m



Project site – topographic view

### Issues

The 60 ha of TWG based pasture sown under the incentive had poor germination and failed to persist. Notwithstanding, the landholder wants to rehabilitate a large area of adjoining salt affected land by sowing TWG and other improved pasture species.

The close proximity of this site to the Upper Lough Calvert naturally saline wetland system makes this a high-risk strategy. There is a need for non-invasive native species to be used at this site.

**Site 3: Eurack, Woods Rd**

**Site Description**

The site is private farmland and part of a broad drainage depression extending into a salt lake. The land is highly modified, having been drained and intensively farmed i.e. sown to improved perennials and grazed by sheep and cattle.

**Botanical Notes**

- - only introduced salt tolerant pasture and weed species were evident.



*Project site – area sown to Tall Wheat Grass*

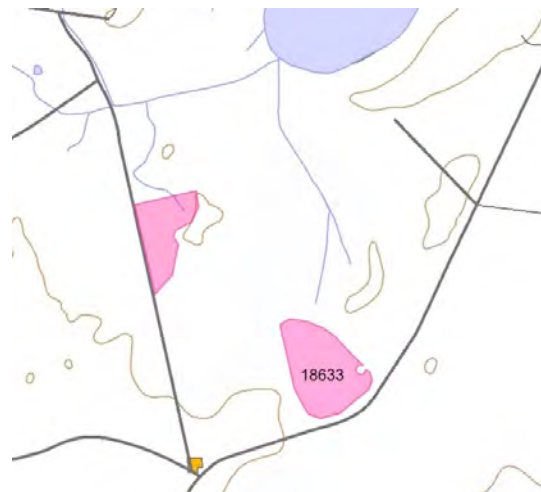


*Project site – aerial view*

**Incentive Summary**

- - establishment of 13 ha of salt tolerant pasture using TWG only
- - 500 trees planted

Year treated: 05/06



*Project site – topographic view*

**Issues**

TWG establishment has been successful and the property owners are experienced in managing the grazing to get the most out of this pasture in terms of production. There was no evidence of poor management leading to invasion of TWG outside the area of sowing.

Due to the management expertise of the landholders and the position of this site i.e. well upstream of the main drainage depression and terminal salt lake, it would seem that TWG is presently being contained at this site.

It is unclear whether an incentive for TWG establishment would now be permitted under the guidelines.

## Appendix 6: Case Study Reports – Lake Corangamite

### Sites 4a & 4b: Lake Martin – Cundare Rd

#### Description

The sites are private farmland and part of a broad drainage depression extending into Lake Martin. The land is highly modified, having been drained and intensively farmed i.e. sown to improved perennials and grazed by cattle.

#### Botanical Notes

The improved pastures are comprised of Tall Wheat Grass (*Lophopyrum ponticum*), Perennial Ryegrass (*Lolium perenne*), White Clover (*Trifolium repens*) and common grasses such as Yorkshire Fog (*Holcus lanatus*). There was little evidence from the pasture composition that this is a saline site. The vegetation of the road reserves has high cover of Phalaris (*Phalaris aquatica*) and Tall Fescue (*Festuca arundinacea*) and Tall Wheat Grass are common. The high cover of Australian Salt-grass (*Distichlis distichophylla*), Brackish Plains Buttercup (*Ranunculus diminitus*) and Sweet Mellilot (*Mellilotus indicus*) among others in the broad drainages leading to Lake Martin indicate primary salinity.



Nearby untreated salt affected site



Project site – aerial view

#### Incentive Summary

- 10 ha salt tolerant pasture established – TWG, perennial rye & white clover
- fertilizer and gypsum applied
- trees planted some years earlier

Year sown/planted: 04/05

- barley was sown in buffers



Project site – topographic view

#### Issues

TWG establishment has been successful and the property owners are experienced in managing the grazing to get the most out of this pasture in terms of production.

Due to the position of this site i.e. on the upstream side of Cundare Rd about 500 metres from the edge of Lake Martin, and the management expertise of the landholder, growing TWG has successfully raised agricultural production and is presently being contained at this site.

It is unclear whether an incentive for TWG establishment would now be permitted under the guidelines.

## Appendix 7: Case Study Reports – Geelong - Lake Connewarre

### Site 5: Reedy Lake, Groves Rd

#### Description

The site is private farmland on the south eastern edge of Reedy Lake on the Bellarine Peninsula.

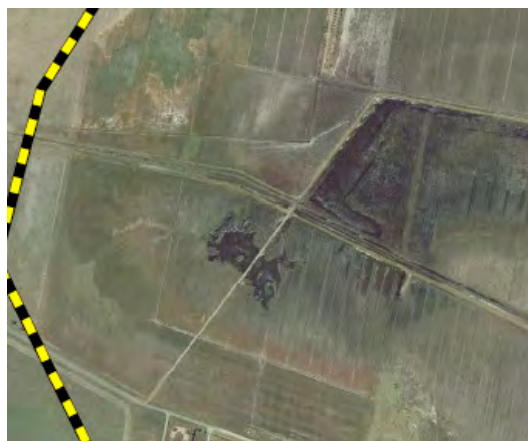
#### Botanical Notes

The pasture contains high cover of native and exotic species. The former probably indicate that the site is one of primary salinity attached to Reedy Lake. Common native species included Beaded Glasswort (*Sarcocornia quinqueflora* ssp. *quinqueflora*), Austral Sea-blite (*Suaeda australis*), Water Buttons (*Cotula coronopifolia*) Rounded Noon-flower (*Disphyma crassifolium* ssp. *clavellatum*) and occasional Black-seed Glasswort (*Halosarcia pergranulata* ssp. *pergranulata*). Exotic species included abundant Sea Barley-grass (*\*Hordeum marinum*), Wimmera Rye-grass (*\*Lolium rigidum*), Puccinellia (*\*Puccinellia ciliata*) (evidently sown), Annual Beard-grass (*\*Polypogon monspeliensis*), Buck's-horn Plantain (*\*Plantago coronopus*) and Common Groundsel (*\*Senecio vulgaris*).

The mixed indigenous and exotic pasture grades into saltmarsh vegetation – a Beaded Glasswort-Rounded Noon-flower herbfield on a salinity and wetness gradient.



Photo – landscape view



Project site – aerial view

#### Incentive Summary

- - no incentive provided since there is an absence of alternative species to TWG which is deemed inappropriate in such proximity to Reedy Lake
- - the landholder, however, wants to increase the agricultural production value of this site



*Puccinellia ciliata* in pasture with Black-seed Glasswort (*Halosarcia pergranulata* ssp. *pergranulata*) (Sep.07)

#### Issues

There are limited options for improving the agricultural productivity of this site, given its high soil salinity, the presence of many native species and close proximity to Reedy Lake.

The soils are predicted to be too saline to consider sowing other less invasive salt tolerant introduced perennials such as Tall Fescue or clovers.

There is a strong need for non-invasive native species as alternatives at this site.

## Site 6: Lake Connewarre, Bawtree Rd

### Description

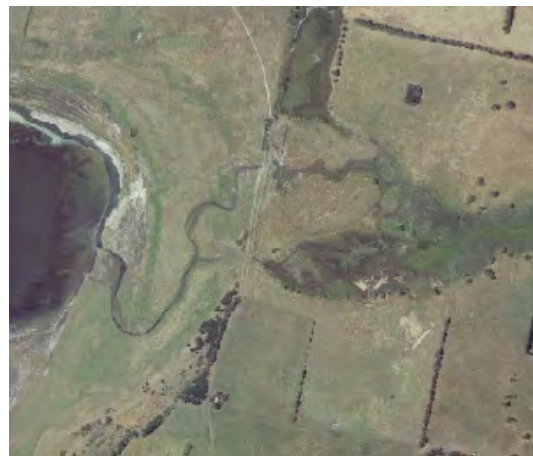
The site is private farmland adjacent to public land comprising the north eastern shores of Lake Connewarre.

### Botanical Notes

Vegetation of the site consists of grazed pasture and the adjoining fenced off saltmarsh on the shore of Lake Connewarre. Composition of the pasture includes Phalaris (*\*Phalaris aquatica*), Common Onion Grass (*\*Romulea rosea*), Cocksfoot (*\*Dactylis glomerata*), Sweet Melilot (*\*Melilotus indicus*) and Tall Wheat Grass (*\*Lophopyrum ponticum* and scattered Spiny Rush (*\*Juncus acutus*). Vegetation in the fenced section is saltmarsh dominated by Beaded Glasswort (*Sarcocornia quinqueflora* ssp. *quinqueflora*), Austral Seablite (*Suaeda australis*), Australian Salt-grass (*Distichlis distichophylla*), Sweet Melilot, Wimmera Rye-grass (*\*Lolium rigidum*), Bromes (*\*Bromus* spp.) and Soursob (*\*Oxalis pes-caprae*). Scattered Tangled Lignum (*Muehlenbeckia florulenta*) also occur here. Tall Wheat Grass is invading the Saltmarsh, mostly on the low rises dominated by exotic annual grasses.



Project site – fencing to protect saltmarsh communities from grazing

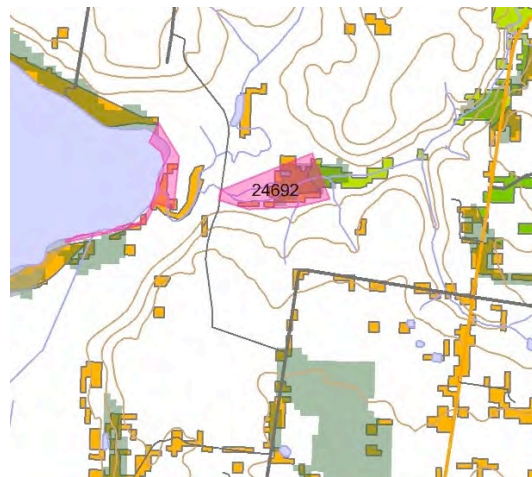


Project site – aerial view

### Incentive Summary

- 40 ha high value primary saline saltmarsh community protected from grazing

Year treated: 05/06



Project site – topographic view

### Issues

Fencing to allow for natural recovery of saltland areas is the only presently available option in this TA due to the presence of high value environmental assets.

A wider range of treatments are desired by the landholder. Rather than simply, “fence and forget”, managed grazing, can enhance the biodiversity of primary saline areas, especially in reducing invasion of more palatable weedy plant species.

## Appendix 8: Case Study Reports – Illabarook

### Site 7: Illabarook Reserve, Cape Clear-Rokewood Rd

#### Description

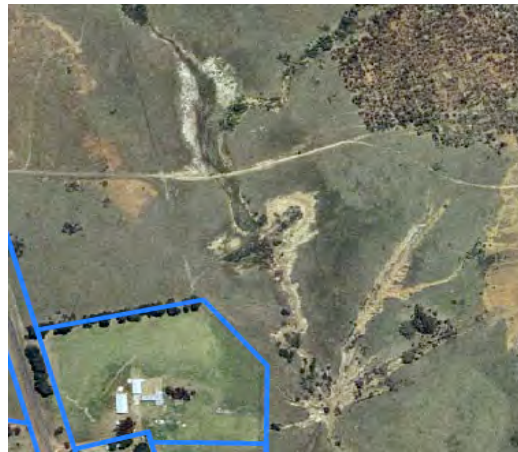
The site is public land managed by Parks Victoria. Revegetation of hill slopes with trees, shrubs and native grasses has helped stabilise the land and reduce sheet and gully erosion. There is saline groundwater discharge occurring in and adjacent to a drainage tributary of the Illabarook Creek.

#### Botanical Notes

This large site with fairly steep slopes and a well-developed drainage line supports native grassland dominated by Kangaroo Grass (*Themeda triandra*), Spear-grasses (*Austrostipa* spp.) and Wallaby-grasses (*Austrodanthonia* spp.) on the slopes. There is a large component of ground flora including lilies and orchids. This derived grassland results from clearing of the eucalypts from the site. The drainage lines are severely degraded with very extensive Spiny Rush (*Juncus acutus*), abundant Phalaris (*Phalaris aquatica*) and Gorse (*Ulex europaeus*). Eucalypts have been planted in the drainage line in an attempt to outcompete the Spiny rush, and a previously mined elevated area (road making-material) has been revegetated with indigenous eucalypts and shrubs. This is part of the upslope recharge area.



Highly degraded drainage line – vegetation has a high cover of Spiny Rush (*Juncus acutus*) and (*Phalaris aquatica*) (Sep.07)



Project site – aerial view

#### Incentive Summary

No incentive provided – public land



Photo – landscape view of rehabilitated upper slopes

#### Issues

Poor performance of trees planted amongst untreated Spiny Rush.

The upper catchment areas of this reserve are being replanted with native species including grasses. There are limited options for preventing re-infestation of Spiny Rush even if removed, as planting TWG or other introduced grasses would be inappropriate on this nature reserve.

## Site 8: Illabarook Creek, Imries Lane

### Description

The site is private farmland adjacent to the Illabarook Creek. Secondary saline discharge has occurred along the creekline and adjoining alluvial flats. The affected area is about 2 ha and the first stage of rehabilitation, comprising Spiny Rush removal, has been undertaken. The landholder and the local DPI officer are currently assessing options for further treatment.

### Botanical Notes

The site, now essentially cleared of Spiny Rush, supports a grazed pasture dominated by salt-tolerant annual and perennial, indigenous and exotic species. These include Water Buttons (*Cotula coronopifolia*), Brookweed (*Samolus repens*), Buck's-horn Plantain (*\*Plantago coronopus*), Sea Barley-grass (*\*Hordeum marinum*) and Toad Rush (*Juncus bufonius*).



Project site – following removal of Spiny Rush



Project site – aerial view

### Incentive Summary

- - Incentive details have not been finalised
- - tree planting, fencing and pasture establishment



Project site – neighboring property without Spiny Rush removal

### Issues

With the Spiny Rush removed there needs to be prompt action to replace it with vigorous plant species to prevent re-infestation. Due to the site's close proximity to the Illabarook Creek, planting TWG would require a substantial buffer to prevent invasion of introduced plants into the remnant riparian vegetation.

The landholder has expectations about improving the productivity of this site rather than managing it as a woodlot, for example, where the benefits would be largely environmental.

## Appendix 9: Case Study Reports – Pittong

### Site 9: East of Skipton, Morton Hill Rd

#### Description

The treated site is about 20 ha in area and drains into the Naringhil Creek, a tributary of the Woody Yaloak River.

#### Botanical Notes

This large site formerly carried extensive Spiny Rush (*Juncus acutus*) but after it's removal the site was surface drained and sown to Tall Wheat Grass (*Lophopyrum ponticum*) and Puccinellia (*Puccinella ciliata*). The system was closely grazed at the time of inspection and the cover of Tall Wheat Grass was 15-20% while Puccinellia was about 25% cover. Other common species are Sea Barley-grass (*Hordeum marinum*), Water Buttons (*Cotula coronopifolia*) and Buck's-horn Plantain (*Plantago coronopus*).

On the upslope side of the rehabilitated area, Yorkshire Fog (*Holcus lanatus*), Strawberry Clover (*Trifolium fragiferum*), Onion Grass (*Romulea rosea*) and other species have begun to invade the Tall Wheat Grass-Puccinellia pasture.



Project site – Puccinellia and Tall Wheat Grass sown together with surface drainage (Sep.07)



Project site – aerial view

#### Incentive Summary

- establishment of 20 ha salt tolerant pasture– TWG
- surface drains installed

Year treated: 04/05



Project site – ponded drainage water below treated area


#### Issues

A relatively large area of secondary salinised land has been successfully treated with TWG and surface drainage, boosting the productive capacity of a once marginal piece of farmland.

There is a relatively low risk of TWG invasion downstream, given that the treated area is part of the catchment area of the drainage depression rather than part of the drainage depression itself.


The landholder also has experience and knowledge about the management of TWG to prevent its spread.

## Appendix 10: Field Site Reports – Lismore - Derrinallum

Site no.	Location	Road Name	
10a	Derrinallum township outskirts	Glenelg Highway and railway crossing	


### Field notes:

TWG has been sown in this broad depression area south east of the Derrinallum township. TWG has been successful in raising the agricultural productivity of this site. The species is clearly highly invasive in the area, being capable of establishing dense swards in road reserves. Such road reserves are already fully occupied by exotic grasses (annuals and perennials) which indicates how competitive TWG is in such situations. It appears to be more drought tolerant (i.e. high physiological drought tolerance because of its salinity tolerance) than Phalaris (\**Phalaris aquatica*) for example. TWG is also very robust, the size of plants only being equalled by Phalaris. In this way it can overtop and outcompete subordinate species.

Site no.	Location	Road Name	
10b	NE Derrinallum township	Derrinallum-Vit Vite Rd	

### Field notes:

This site, while mapped as secondary salinity, may be a site of primary salinity or modified primary salinity. The vegetation dominants were indigenous: Australian Salt-grass (*Distichlis distichophylla*), Brackish Plains Buttercup (*Ranunculus diminitus*) and Annual Fireweed (*Senecio glomeratus* ssp. *glomeratus*). Brackish Plains Buttercup is rare in Victoria. Other significant rare or threatened plant species occur at this site. Other indigenous and exotic species included Shiny Swamp-mat (*Selliera radicans*), Salt Pratia (*Lobelia irrigua*), Plains Saltmarsh-grass (*Puccinellia stricta* var. *perlaxa*), Common Tussock-grass (*Poa labillardierei*) (Volcanic Plains form), Wiry Dock (*Rumex dumosus*), Swamp Fireweed (*Senecio psilocarpus*) (nationally vulnerable, EPBC-listed), Wimmera Rye-grass (\**Lolium rigidum*), Willow-leaf Lettuce (\**Lactuca saligna*), Creeping Cotula (*Leptinella reptans*) and Phalaris (\**Phalaris aquatica*).

Site no.	Location	Road Name	
11	Lake Logan	Mt Elephant Estate Rd	 <p>Lake Logan freshwater lake supporting diverse freshwater botanical species with no evidence of salinity</p>

**Field notes:**

Lake Logan has been mapped as affected by secondary salinity. No evidence of salinity was found in terms of indicator species. Lake Logan supports permanent freshwater or mildly brackish submergent, emergent and lake-shore aquatic or amphibious vegetation. Indigenous species included: *Ruppia* sp. (Tassel), *Stuckenia pectinata* (Fennel Pondweed), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Native Thistle (*Sonchus hydrophilus*), Annual Fireweed (*Senecio glomeratus* ssp. *glomeratus*), Swamp Fireweed (*S. pinnatifolius* var. *lanceolatus*) and Sharp Club-sedge (*Schoenoplectus pungens*).

Site no.	Location	Road Name	
12a	Tributary Browns Waterholes	Eight Mile Lane	 <p>Severely salt affected drainage line, recently planted to trees</p>

12b Browns Waterholes Eight Mile Lane



Brackish drainage line planted to trees

**Field notes:**

Extensive areas of recent tree planting were observed being targeted toward rehabilitating degraded creeks lines in the Mundy Gully and Browns Waterholes drainage systems. The sites visited appeared to range from severely degraded and salt affected to brackish drainage lines supporting a mix of native and introduced species. It is likely that the biodiversity values of the vegetation planted to trees was variously low (exotic pasture) to moderate or even high, depending upon the floristic composition and structure of the vegetation (partially indigenous and exotic vegetation). To what extent these are secondary salinity sites was not determined in the field. Given the geology (base and salt-rich Newer Volcanics) and the fact that much of the landscape was formerly treeless Plains Grassland (i.e. recharge areas probably little modified functionally) these areas may not be substantially different from the pre-settlement hydrological and salinity conditions. In planting trees on such sites the water yields need to be considered in respect of the terminal wetlands (streams or swamps) lower in the catchment. Does such tree planting deprive these wetlands of important environmental flows?