Natural Resource Management in Western Australia

The Salinity Strategy

March 2000

Government of Western Australia

Prepared by

STATE SALINITY COUNCIL

In association with community groups and government agencies

Natural Resource Management in Western Australia

The Salinity Strategy

March 2000

Government of
Western Australia

Prepared by

STATE
SALINITY
COUNCIL

In association with community groups
and government agencies

Foreword

In 1996, in recognition of the magnitude of the threat salinity poses to agriculture, rural towns and the environment, the Western Australian Government released the first Salinity Action Plan. It provided a blueprint for applying government resources in an integrated and effective way for salinity management.

The State Salinity Council formed by this initiative has reviewed the Salinity Action Plan and developed a strategy which gives greater focus to community based programs. Partnerships between government, community and industry will be needed to implement the strategies required to protect our water resources, biodiversity, regional towns and maintain agricultural productivity.

All levels of government accept the need for joint action on salinity management. For example, the Commonwealth Government's Natural Heritage Trust is important in funding community groups to plan for and take action against salinity on individual farms and catchments. The Western Australian Government makes a significant contribution through its agencies, but it is acknowledged that most of the resources for salinity management come from and will continue to come from the private sector.

It is appropriate that the community is well represented in any structure established to implement the new Salinity Strategy. Regional Natural Resource Management Groups are fundamentally important in ensuring salinity management strategies are developed by community groups in partnership with government agencies.

I congratulate the State Salinity Council, and its Chairman Alex Campbell, on the production of the new Salinity Strategy. It sets clear goals for the planning and implementation of activities by all stakeholders engaged in the fight against salinity.

Hendy Cowan

Hendy Cowan MLA

Deputy Premier; Chairman of the Cabinet Standing Committee on Salinity Management and the Natural Heritage Trust

Contents

A range of landcare treatments is being used on this Morbinning farm. Photo: Landcare Vision

Preface

In 1996 the Western Australian Government launched a Salinity Action Plan with a 30-year vision to address dryland salinity in the State. The State Salinity Council was formed in May 1997, representing key stakeholder groups with a role in salinity management. The original plan proved to be a robust base from which we could move forward and develop the present strategy.

In December 1998, in response to calls for the Salinity Action Plan to be more community-focused, a revised plan was released as a draft for public comment. This strategy has been further developed following considerable public input. Its release coincides with the restructure of the Salinity Council that will allow greater integration between government, industry and regional and local community groups, reflecting a broader approach to salinity management for the future.

Recent research shows that an enormous effort is needed to reduce the impact of salinity significantly. It will not only require large-scale planting of deep-rooted perennials, changing crop rotations and appropriate engineering works including pumping and drainage, but will also see most farmers completely changing their land use practices. We will not be able to control salinity without changing from the traditional farming practices of annual crops and livestock grazing to new types of farming across large parts of the agricultural area.

There is encouraging evidence from around the State that these new systems are potentially more profitable and sustainable, once established. However, there are high social and economic costs to be considered with these changes and the wider community will need to share this responsibility.

With 1.8 million hectares already affected by salinity in Western Australia, we have to accept that some land will be saline in the future and we have to live with this and learn to manage it. However, the effort we put in during the next few years will determine how much more land and resources will be affected and what levels of intervention are appropriate.

Management measures will also be required to help deal with the social effects of salinity. Impacts on rural families and communities must be acknowledged and assistance provided during the process of change.

There are crucial questions facing the Western Australian community, as there will be trade-offs as we develop and implement measures to address salinity. The restructured Council with regional involvement will take a leading role in tackling these difficult decisions.

The good news is that we now have a better understanding of appropriate control measures and can more accurately assess where these need to occur within each catchment in the region. As we enter the 21st century, we offer a vision of hope, that we will be able to manage salinity for economic and environmental benefits, and take advantage of new and evolving management practices for saline land.

During the past three years the community and Government have developed a strong working relationship which will be vital to manage salinity. I believe this strategy will provide a new impetus to help us achieve our goals for sustainable and profitable natural resource management in the future.

Alex Campbell

Chairman, State Salinity Council

Opposite: Planting to rehabilitate the headwaters of a stream, near Mt Barker.
Photo: Simon Neville – Ecotones/Water and Rivers Commission

Section 1
Executive summary

1 Executive summary

Salinity is the greatest environmental threat facing Western Australia – 1.8 million hectares in the south-west agricultural region are already affected by salinity to some extent. Projections show that without rapid, large-scale intervention, including significant changes to current land use practices, about three million hectares will be affected by 2010-2015 and six million hectares, or 30 per cent of the region, will be affected by the time a new groundwater equilibrium is reached.

This document explains what leads to salinity problems, and their impacts in Western Australia. It also sets out a strategy to manage salinity and outlines the tools to be used, in the light of recent research that indicated actions must be undertaken across a wider area, and more quickly than anticipated in the 1996 Salinity Action Plan.

The community needs to consider where it would be possible and/or economic to control salinity in the longer term, and for any given area whether we should try to reverse salinity (recovery), stop it from getting worse (containment), or learn to live with and manage it (adaptation).

This strategy builds on the 1996 Western Australian Situation Statement and Salinity Action Plan and the 1998 Draft Update Salinity Action Plan, and on new research that has been undertaken recently.

The impact of salinity

The area of salt-affected land has already had a serious impact on biodiversity, current and future water supplies, agriculture and regional infrastructure, including roads, rail, water and wastewater facilities, public and private buildings. The impact is potentially enormous if the area at risk is allowed to become saline. Without intervention, 450 plant species endemic to the region will become extinct, and three-quarters of the region's waterbird species will severely decline.

Up to $400 million per year will be lost in agricultural production by 2050. There will be increased flood risk in many areas, and sealed road life expectancy will be reduced by up to 75 per cent.

Salinity will also affect people. The magnitude of this effect is difficult to quantify but includes the cost to rural communities of declining population, loss of business (both existing and potential), the cost of rural restructure if farms become unprofitable, and increased health problems due to stress on families affected by change.

The strategy

This strategy aims to reduce the impact of salinity in the south-west agricultural region of Western Australia. It has as its goals:

- to reduce the rate of degradation of agricultural and public land, and where practical recover, rehabilitate or manage salt-affected land;
- to protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity;
- to protect and restore high value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the south-west region of Western Australia;
- to provide communities with the capacity to address salinity issues and to manage the changes brought about by salinity; and
- to protect infrastructure affected by salinity.

Each of these goals applies across the south-west agricultural region. However, the degree to which each goal is pursued will depend on the relative importance of the range of public and private assets under threat in individual catchments. Input at the regional level will help determine these priorities.

The proposed actions to achieve these goals are based on three fundamental principles:

- salinity needs to be addressed by treating the causes of the problem, focussing on managing recharge and rising watertables;
- developing practical and environmentally sound methods that mitigate the impact of salinity by managing the discharge; and
- the strategy needs to be implemented in a partnership approach between all stakeholders at the regional and catchment scale.

Strategic approach

A strategic approach is essential to manage salinity on the scale facing Western Australia. The key elements of such an approach are:

- working in partnerships that involve all stakeholders;
- analysing risk in different areas over time to allow appropriate priorities to be set;
- retaining native vegetation and protecting the remaining biodiversity values;
- adopting an appropriate mix of the tools available to manage salinity;
- helping the farming community to make the transition to more sustainable production systems and building their capacity to do so;
- addressing equity concerns that arise;
- promoting research and development to improve salinity management;
- planning to address shortfalls in actions where priority biodiversity and other public assets remain at an unacceptable risk, or are significantly affected; and
- developing continuous monitoring and evaluation of salinity management actions.

Tools to manage salinity

There is a range of tools available to manage salinity. Each catchment will need to select a combination of these to suit their specific needs and to meet their objectives. No one tool is likely to work in isolation and the tools used will need to be appropriately located in all parts of the landscape.

The Salinity Council believes significant changes to land management practices are required to achieve a moderate level of salinity control. It has been estimated that most of the 18 million hectares of cleared land in the south-west agricultural region will need to be covered by a combination of deep-rooted perennial shrubs and trees, phase farming (rotations which include a perennial phase) and alternative, high-water use enterprises alongside catchment-scaled surface water management and a broad spectrum of complementary engineering options.

Deep-rooted perennial shrub and tree cover will be achieved by protecting and enhancing remnant native vegetation, and by revegetating strategic areas for biodiversity and for commercial returns. The large area of revegetation required and the substantial cost involved means that commercial tree crops will be an essential part of this strategy.

Opportunities to use saline land and water productively will be developed further and promoted, where appropriate.

Community action to address salinity

The State Salinity Council, which represents community and government stakeholders, has been restructured to increase integration in salinity management. The regional natural resource management groups will be recognised and supported to develop salinity management strategies in the context of their broader strategic plans.

The whole Western Australian community is affected by salinity and will have to share the costs and the benefits of managing it. The State Government currently contributes about $40 million a year to salinity management, and the Commonwealth Government has also contributed significantly to programs in Western Australia. However, the largest investment has come from and will continue to be funded by private landholders.

The threat to biodiversity, water resources, agriculture and infrastructure means further investment is required through corporate funding, public contributions and new mechanisms for landholder contributions, possibly catchment levies.

Within each catchment, it is the community's capacity to manage vegetation, soils and waters that provides the potential for sustainable natural resource management. It is important that this capacity is given the best opportunity to develop, which means that we must address issues of equity, biophysical data and information availability, decision support systems and capacity building (including knowledge building, access to information, leadership development, network building and community involvement).

Monitoring and evaluation

Monitoring and evaluation should be carried out at the property, catchment, region and State scale and will involve all stakeholders. It will provide information to landholders, the community and government on:

- progress towards agreed goals for agricultural systems, water resources, natural diversity, infrastructure and capacity-building;
- longer-term biophysical trends and the likely impact of changes in land use management; and
- performance of landholders, community groups and government agencies in meeting their responsibilities and the objectives of their plans.

This strategy sets a direction in the face of incomplete answers. However, considerable progress is being made in the mapping of affected areas, the prediction of areas likely to be affected, and most importantly, the development of management systems. New actions to address salinity continue to be developed and refined. Managing salinity requires persistence because the problem will take a very long time to abate. There are no quick solutions and fundamental change is required in land use and management practices throughout the region. Continuing with just broadacre annual winter crops and pastures systems in their current format will not manage salinity.

Three other documents are also associated with this strategy:

- *Salinity actions*, which lists new actions recommended by the State Salinity Council, together with actions begun under the 1996 Salinity Action Plan and 1998 Draft Update;
- *Salinity: A guide for land managers*, which includes management options and initial contacts to help land managers plan activities at the farm and catchment scale; and
- *Summary of public submissions* on the 1998 Draft Update Salinity Action Plan.

The Salinity Council will prepare annual operating plans detailing current projects, budgets and monitoring and evaluation information. In addition, a series of technical notes and options papers will be developed on specific issues and updated as new knowledge comes to hand.

New initiatives are highlighted throughout this strategy.

Opposite: The stark impact of salinity on the Avon River at Yenyenning Lakes. Photo: Simon Neville – Ecotones/Water and Rivers Commission

Section 2
The impact of salinity

2 The impact of salinity

Most of the salt responsible for salinity in Western Australia originated in the ocean. Salt, mainly sodium chloride, has been carried inland by the prevailing winds and deposited on the land in small amounts (20-200 kg/ha/year) in rainfall and dust. The amount of stored salt in the soil profile is least in the high rainfall areas (generally moderate relief and well drained), and highest in low rainfall areas (generally flat and poorly drained).

Primary salinity develops naturally, mainly in areas where rainfall is insufficient to leach salts from the soil profile and evaporation is high. Over thousands of years, salt slowly accumulated beneath the south-west of Western Australia, causing changes in biological systems and landscape form and function.

Secondary salinity (which takes the form of either dryland or irrigation salinity) is the result of clearing native vegetation and replacing it with shallow-rooted crops and pasture that use less water, causing changes to the hydrology of the landscape. The indigenous vegetation of Australia is perennial and deep-rooted, well-adapted to surviving both floods and drought and effective in its use of water. Annual crops and pastures do not use as much of the incoming rainfall and this unused water either runs-off or infiltrates beyond the root zone and accumulates as groundwater (recharge).

Much of the land in the south-west agricultural region was prone to salinity prior to clearing. It has been estimated that the region has an average of about 2000 tonnes of salt stored below every hectare in the soil profile between the surface and the bedrock, with as little as 300 t/ha in uplands and as much as 10,000 t/ha in saline valleys. In many areas, this accumulation of salt has become mobilised with the rise in groundwater levels, emerging where water is forced to the land surface. This secondary salinity is the threat addressed in this strategy.

As saline groundwater comes close to the soil surface, salt enters the plant root zone leading to the death of native plants and crops and pastures that are not salt tolerant. Plants also suffer from increased waterlogging. Saline groundwaters discharge at the soil surface and are concentrated by evaporation, damaging soils on-site and down slopes, eventually draining into streams, rivers and lakes, degrading wetland habitats and water resources. Seepage areas and scalds are the surface expression of salinity, although salt can also be present in areas where only marginal reductions in yield can be seen.

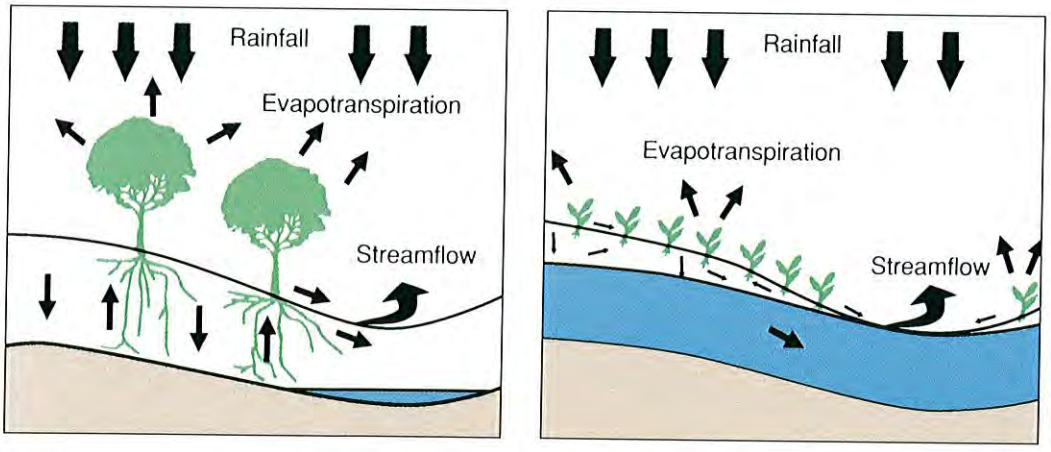


Figure 1: Typical changes in water and salt balances following clearing.

Most early settlement in the south-west agricultural region occurred in the valleys near water courses. These areas, including most of the towns in the region, are now in the areas at highest risk of salinity.

We live in a dry continent, yet fail to use annual rainfall to best advantage. This strategy sets out ways to make better economic use of this precious resource and correct the water imbalance that leads to salinity and waterlogging problems.

2.1 The recharge/discharge imbalance

The primary cause of salinity is under-use of annual rainfall and the relatively impermeable and flat nature of many Wheatbelt groundwater systems. Generally speaking, groundwater continues to rise at an average rate of 20 centimetres per year in the south-west agricultural region as it is recharged by rainfall. The rate of groundwater rise and the spread of salinity can only be slowed or reduced by either reducing the amount of rain that reaches the groundwater or finding ways to remove groundwater in an environmentally sound and practical way.

Land is considered saline when saline groundwater rises to within one metre of the soil surface. The expression of salinity varies with soil type, climate and land use. Coarse textured soils (for example sands or sandy loams) may produce a reasonable crop with the watertable at one metre, whereas a fine textured soil (clay or sandy clay loam) may not produce a crop with the watertable at two metres. Also in higher rainfall areas the additional leaching of salts by the winter rains will enable cropping over shallower watertables than in the low rainfall areas where leaching is not so effective. Thus saline land has a range of visible and not so visible characteristics. It is not all totally bare and encrusted with white salt.

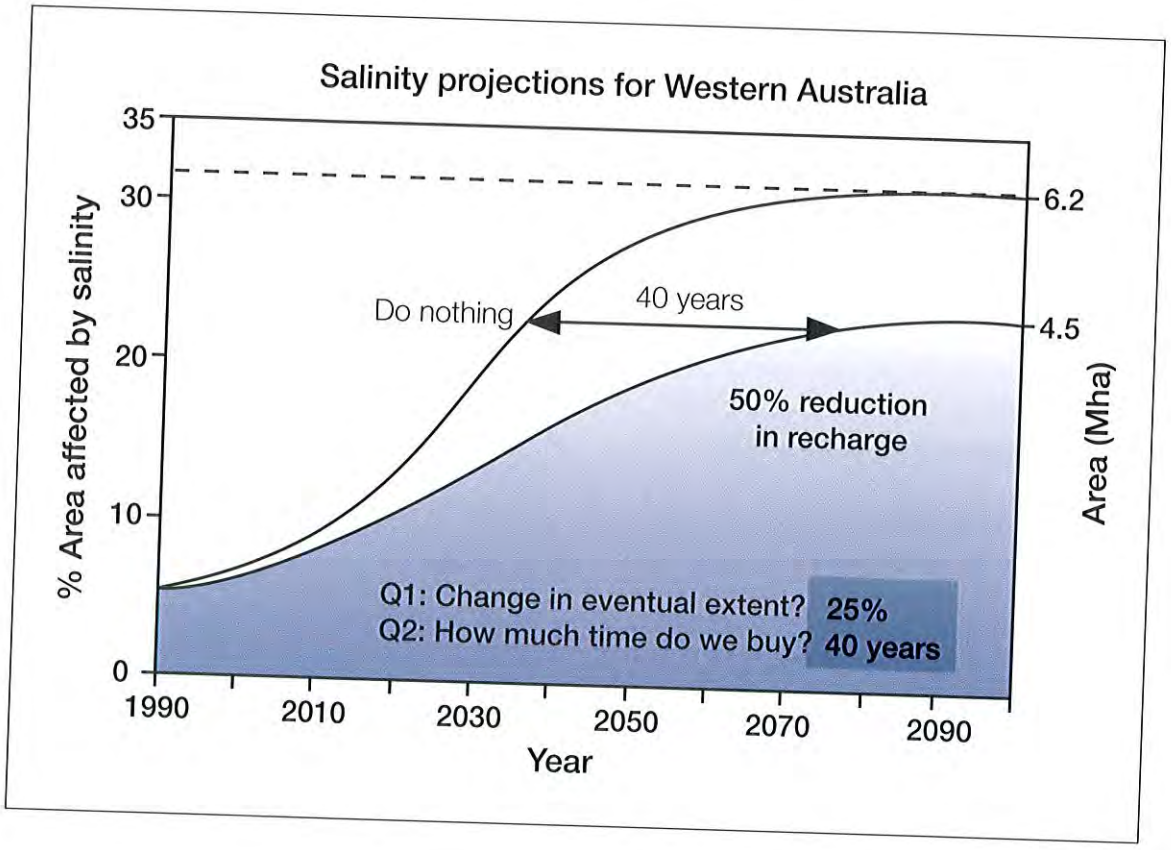
The effect of salinity on plant growth is exacerbated when the soil is also waterlogged. Plants can tolerate much higher levels of salinity in well-drained soils. For this and other reasons, such as reducing flood risk and protecting biodiversity, the strategy gives considerable emphasis to surface water management to reduce waterlogging.

As recharge and discharge to the groundwater system continue to respond to current land management systems, there will be a shift towards a new (but higher) equilibrium groundwater level. The estimated time to reach equilibrium varies between zones and catchments in the region but it could take as little as 30 years in the southern and western areas, to as long as 50 to 100 years in the east and north.

The landscape will not be uniformly affected, which makes it difficult to plan remedial action. Some areas will never be affected by salinity (while they could be contributing to recharge) and some areas, despite significant action, will go saline. However, we now know that remedial action is required over most of the region. This makes the scale of implementation much larger than the estimated 30 per cent of land currently saline or at risk. We need to act very quickly and to make significant changes to current land use practices across large parts of the south-west agricultural region, especially those that have little time until equilibrium is reached.

In 1999 the State Salinity Council asked scientists from Agriculture Western Australia, Murdoch University and CSIRO[1] to undertake an initial assessment of the impact that reducing recharge would have on the extent of salinity in the agricultural areas of Western Australia. They also estimated the impact on recharge rates of changes to farming systems being proposed in this strategy and already being implemented by some farmers.

1 The Salinity Council would like to acknowledge its appreciation of the following people for this work: Dr Richard George (Agriculture Western Australia), Dr Christopher Clarke (Murdoch University), Dr Tom Hatton and Dr Paolo Reggiani (CSIRO Land and Water).



Their scenarios showed that catchments responded differently to reductions in recharge. In dissected landscapes, the groundwaters were more responsive and lower levels of recharge control were required than in areas with flat landscapes. However, even in these areas, recharge reduction resulted in significant delays in the onset of salinity (25-100 years) "buying time" for many catchments. In unresponsive catchments (flat landscapes) recharge reductions in excess of 50 per cent are required to reduce significantly the final area that may become saline. This level of intervention is significantly greater than is currently being achieved.

This work showed that change needs to occur across catchments on a bigger scale and more quickly than had previously been considered. It is already too late to prevent some areas from developing high groundwater levels.

The scenario modelling is a generalisation and does not provide the picture for all catchments. Possible high intervention scenarios include:

- A Wheatbelt catchment could revegetate 30 per cent of the total area to woody perennials with phase farming introduced over the rest of the catchment, as well as appropriate surface and discharge water management. The woody perennials could be planted in different ways, such as in alleys across the contours, or at the break of the slope and near saline areas, and would include appropriately managed areas of natural bush. Changes in rotations could include warm season cropping and/or phase farming with perennial pastures
- Around 10 per cent of the catchment could be planted to a shrub with the *remainder of the catchment area* planted with two rows of trees or shrubs (for example oil mallees) at nominal belt spacings of 50 metres.

Cropping or pasture could continue between the alleys. The alleys could be spaced further apart if more rows of trees were added or a higher percentage of the catchment was revegetated.

Engineering options will form an important component in a number of catchments to protect high value assets, particularly surface water management but also including groundwater pumping and deep drains in some instances. However, they will need to form part of an overall strategy and their cost may be a limiting factor in many cases.

The research showed different responses to treatment between catchments, emphasising the need for prior investigations that lead to risk assessment, and site evaluations prior to works.

2.2 Biophysical impacts

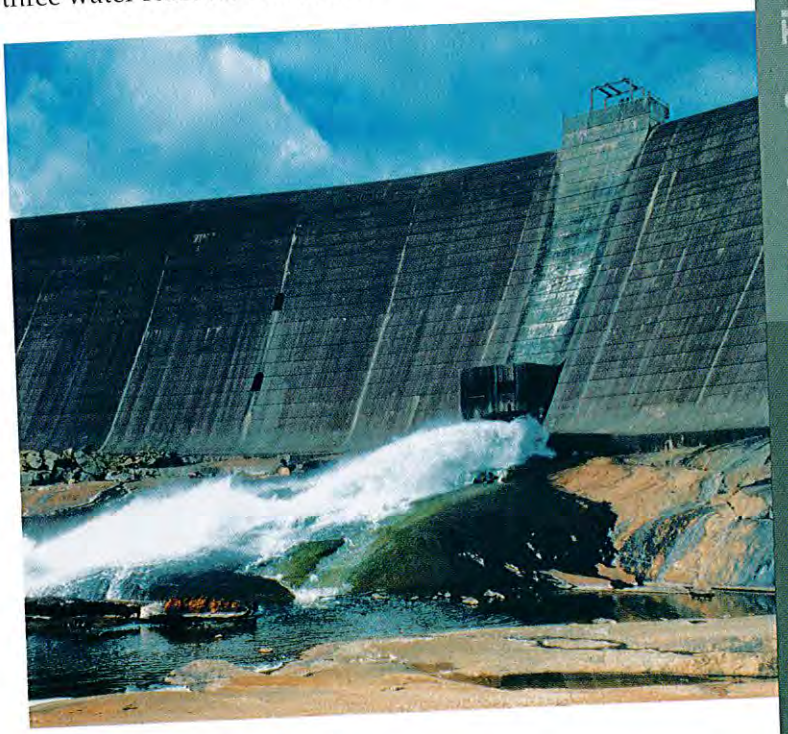
2.2.1 Water resources

Water is one of our most precious resources and potable water is in short supply. The salinity of many rivers in the south-west agricultural region has increased significantly over the years and is likely to continue to increase in many cases. For example the Avon River salinity is increasing at the rate of 100mg/L while the Frankland is increasing at 40mg/L. Where management practices have changed to reduce salinity, the increase has been controlled. For example the Collie River increase is close to zero. Stream salt loads are likely to increase five-fold over the next 50 years. As a result, many rivers and wetlands have become more saline with a corresponding impact on their aquatic and associated terrestrial ecosystems. Some surface water systems and fresh groundwater resources are becoming saline which could affect the availability of fresh water for rural and urban areas in the future.

More than one-third (36%) of the south-west's previously divertible surface water resource (suitable for domestic, agricultural or some industrial use) has become brackish or saline and can no longer be used. A further 16 per cent is of marginal quality.

Clearing controls were introduced by legislation on five catchments during the 1970s in response to increasing salinity and over $46 million has been spent on compensating farmers for not being able to clear their land in these catchments. Three of these (Helena, Collie and Denmark River catchments) have been developed for water supplies, and the others (Warren and Kent River catchments) are important future sources. These five catchments have the potential to yield almost 440 gigalitres per annum (one gigalitre is one thousand million litres) in total. This is equivalent to about twice Perth's current water supply. Without increased and continuing action, water quality of the Collie, Warren and Kent rivers will deteriorate and the potential of these water resources will be lost or become too expensive to restore.

More than $25 million has been spent on salinity management and research in these three water resource catchments.



Wellington Dam on the Collie River. Photo: Water and Rivers Commission

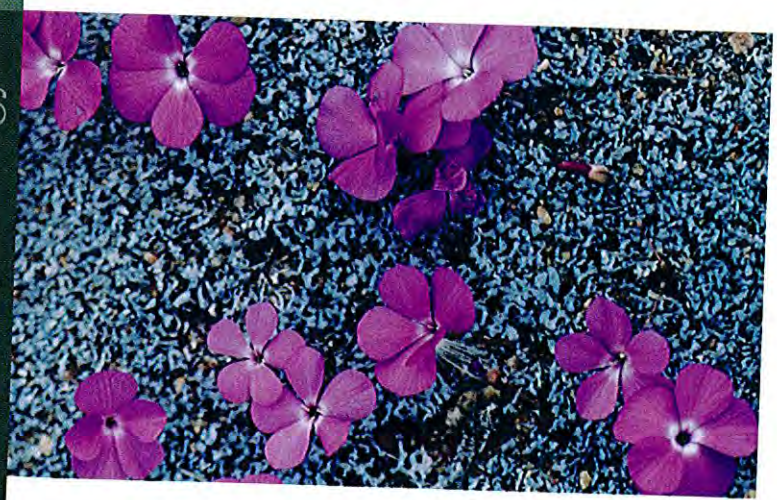
Replacement storages have been built for the Collie and Denmark rivers in the past eight years at a cost of $50 million. Costs of over $100 million will also be incurred in constructing a pipeline into the south-west, instead of using nearby brackish water sources for Perth.

Rivers other than those used for public water supplies are also affected or threatened by salinity. The full impact of salinity on riverine ecosystems is not well established, but includes a loss of fringing vegetation and decreased water quality. Wetlands are also significantly affected by rising watertables and salinity is causing major changes in ecological and social values.

2.2.2 Biodiversity

Maintaining biodiversity is essential for our future wellbeing. The agricultural sector, for example, relies on biodiversity to maintain soil health, absorb nutrients, allow pollination and help control pests. The pharmaceutical, fishing, pastoral and forestry industries also rely on biodiversity and ecosystem services to survive. Biodiversity also has an intrinsic value.

Salinity is driving the rapid and catastrophic collapse of existing ecosystems. As root zones come under the influence of saline groundwater, vegetation and soil fauna decline, habitat is lost, plant and animal populations and species decline, functionally important species are killed and the maintenance of ecosystem processes is compromised or destroyed.



A new species of Calandrina *discovered in the northern Wheatbelt as a result of the biological survey begun under the 1996 Salinity Action Plan. Photo: Department of Conservation and Land Management*

The impacts of salinity on natural biodiversity are most obvious in the lower parts of the landscape, and this will continue. The beds and banks of 80 per cent of the region's rivers and streams are seriously degraded. The degradation of wetlands is already severe and the relief of the region is so low that large areas are being affected by salinity almost simultaneously. Valley floors and wetlands contain plant species that are at most imminent risk of extinction, for example:

- **Flora:** The south-west agricultural region has a vascular plant flora of over 4000 species and approximately 60 per cent are endemic to the region. Of these endemic species, 450 occur low in the landscape and are under threat of extinction from salinisation and hydrological changes.
- **Fauna:** The region also has a diverse terrestrial and aquatic fauna, with high species diversity in areas low in the landscape, including naturally saline areas.

  Of the 61 more common waterbird species in the south-west, only 16 prefer strongly saline (more than 20,000 mg/L) or hypersaline (more than 50,000 mg/L) conditions. An average of five waterbird species use hypersaline wetlands, compared with 20 in saline wetlands and 40 in fresh wetlands containing live trees and shrubs. Death of trees and shrubs in many Wheatbelt wetlands due to salinity has caused a 50 per cent decrease in the number of waterbird species using them.

  Over 560 invertebrates have been identified in Wheatbelt wetlands during biological surveys to date, with 45 per cent restricted to fresh water (with salinity less than 3000 mg/L). If all wetlands in the Wheatbelt become saline (more than 10,000 mg/L), approximately 220 of these aquatic invertebrate species will disappear from the Wheatbelt.

These predictions of biodiversity loss are based on the results to date of the first comprehensive biological survey of the south-west agricultural region, which began under the 1996 Salinity Action Plan. The results of the survey, when completed, will be incorporated into the actions taken under this strategy.

Not only does salinity affect natural biodiversity, but also physical diversity of landscapes such as that represented by the loss of a variety of lowland forests, woodlands, shrublands and heaths. River pools and some estuaries are lost to sedimentation and natural discharge areas are degraded by prolonged periods of inundation. These in turn, detrimentally affect other values, including aquatic biodiversity and environmental services such as nutrient fixing, soil structure and function, and an ability to absorb waste and toxins. It has been estimated that, without remedial action, up to 80 per cent of small areas of bushland on farms and up to 50 per cent on public lands (including nature reserves) in agricultural areas would be lost over time.

2.2.3 Increased flood risk

A consequence of clearing of vegetation, rising groundwater levels and modification of natural river and stream systems is an increased risk of flooding. The increase in flood magnitudes and frequency in turn increases the risk of damage to buildings, roads, bridges, embankments, pipes, culverts and farmland.

Replacing native vegetation with crops and pastures has led to higher run-off rates for a given rainfall due to:

- lower interception and transpiration of water by crops and pastures; and
- waterlogging of the catchment due to rising watertables, which reduces rainfall infiltration rates.

The following factors also need to be considered:

- control measures such as drainage, unless properly designed, can increase surface run-off; and
- significant additional recharge of groundwater can be caused by floods – in naturally slow draining country (flat, low permeability) any recession of elevated groundwater levels can be further delayed, reinforcing the undesirable rising of the watertable.

Rain on waterlogged areas causes almost immediate run-off because infiltration is reduced or no longer possible. Waterlogging occurs when rising groundwaters reach the surface, generally due to a recharge imbalance following clearing of a catchment. Generally, the magnitude of the increase in surface run-off depends on the percentage of the catchment that has a waterlogged surface. While in many parts of the Wheatbelt the groundwater will not reach the surface in the valley for many years, there are areas where it is happening now and there are catchments where it will happen relatively quickly.

Modelling carried out on the Blackwood River catchment highlights this effect. The modelling indicates that when the groundwater levels reach the surface in the valleys and represent a significant area of the catchment, there will be increases in flood discharges of between two-to-four times previously observed flood magnitude levels. The critical issue is controlling the extent of waterlogging. If this is done with vegetation then it is likely that salt-tolerant plants will be required because of the salinity associated with the waterlogging.

Direct groundwater contribution to the magnitude of the flood is generally not significant compared to the surface run-off, as groundwater is slower to discharge into the stream and will peak days or weeks after the surface water peak.

In addition, backed up floodwaters can effectively sustain elevated groundwater levels as well.

Installing drainage to manage salinity and/or reduce waterlogging also has the potential to increase flood risk as it modifies the natural drainage system. Creating additional channel networks and a more responsive river by straightening, cleaning or training leads to increased velocities, reduced natural valley storage, shorter times of concentration and quicker flood response, higher flood magnitudes, increased erosion and consequent sedimentation. Any drainage modification must be designed in such a way that it does not concentrate storm run-off and thereby increase the potential peak discharge of the system.

However, well designed surface water management systems can slowly drain saturated soils between storms and manage surface water flows during storms by using retarding basins and other techniques.

2.3 Economic impacts

2.3.1 Agricultural productivity

Western Australia's south-west agricultural region produces agricultural goods worth more than $4 billion annually for local and export markets on about 18 million hectares of cleared land. About 10 per cent of this land is already affected by secondary salinity.

If effective management is not developed and implemented, the agricultural area affected by salinity is likely to double in 15 to 25 years, and eventually affect 30 per cent of the total area. This will have large implications for agricultural production levels, with resulting impacts on the social and economic structure of the State's rural industries. By 2050, annual losses from agricultural production alone will be $300 to $400 million in present day terms. These production losses would be reflected in lost capital value of farmland, estimated at $3 to $4 billion.

However, not all saline land will become unproductive. Salinity will affect land to any degree from minor levels of salt in the root zone (causing reduced production) to inundation (no production possible). Production, particularly livestock grazing, will be possible on some saline land (see section 5.1.3).

The increasing emphasis at the international level for "clean and green" production will also affect agricultural profitability if the impacts of salinity on the environment are not mitigated. Future export potential could hinge on how sustainably the natural resource base is managed.

Cereals and other agricultural products worth more than $4 billion are produced each year in Western Australia. Photo: Landcare Vision

2.3.1.1 Irrigation and high rainfall salinity

Although the focus of this strategy is on dryland salinity, irrigation salinity is already a problem in many irrigated areas, particularly in those that are poorly drained, either naturally or artificially. In Western Australia at present, irrigation salinity is most advanced in the south-west irrigation area, where poorly-drained soils are subject to summer flood irrigation, high salinity reservoir supplies and winter waterlogging. These factors, when combined with naturally saline and shallow groundwaters, lead to a decline in productivity. In one survey it was estimated that salinity caused a 50 per cent yield reduction in clover-dominant pastures on 25 per cent of the area. In another survey, up to 36 per cent of irrigated land had high and increasing salt levels.

Irrigation salinity also poses a potential threat to parts of the Ord River Irrigation Area.

Some parts of the Swan Coastal Plain (south of Gingin) are recognised as having a high potential to develop dryland salinity depending on land use. Salinity risk assessment, using soil-landform maps, indicates about 40 per cent of the land area in the southern portion of the Swan Coastal Plain has a moderate or high salinity risk, with production systems based on salt sensitive species at higher risk than those of lower sensitivity.

Overall approximately 20 per cent of the southern Swan Coastal Plain is estimated to be affected by shallow watertables and increased soil salinity to some degree and as a consequence, pasture growth may be reduced throughout the year or at critical times. These areas are also subject to severe waterlogging and inundation during winter and it is difficult to separate these related factors without field measurement.

2.3.2 Infrastructure

Rising groundwater levels are affecting regional infrastructure and transport systems in over 30 rural towns. A percentage of the State road network is either currently affected or at risk in the future with sealed road life expectancy being reduced by up to 75 per cent in areas with rising saline groundwaters. The cost to the community of salinity is increasing with the growing need for maintenance of public and private town buildings, recreational facilities, water supplies, parks and gardens, townsite remnant vegetation, roads, railways, drainage systems, and waterways. Farm infrastructure such as dwellings, fencing, farm roads and dams are also at risk. In addition, salinity may have an adverse impact on the quality of rural life due to the effects on landscape and visual amenity values.

Run-off that causes flooding and seasonal waterlogging increases recharge and can have a negative impact on townsites due to groundwater levels rising after such events.

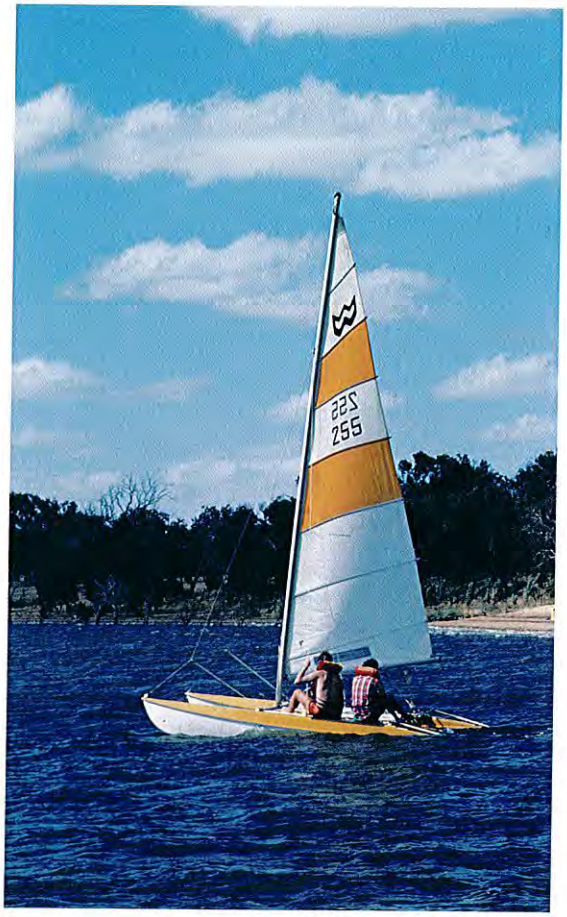
Many townsites are subject to additional recharge due to the importation of water via a water supply scheme. Watering of parks and gardens, septic systems and leaking storage dams can add between 16 and 52 per cent on top of average annual rainfall that needs to be managed. In the case of Corrigin, the introduction of scheme water at the expense of groundwater use contributed to a rise in the watertable of over 20 metres.

There are also significant impacts from run-off from roads and houses. About 30 per cent of any housing block is covered by roofs, paths and roads. Roofs recharge groundwater through soak wells and road run-off goes into roadside verges or into absorption basins or creeks. Concentrated water recharges preferentially and it is common for groundwater mounds to form under towns, with the potential to cause significant problems.

2.4 Social impacts

2.4.1 Individual and family impacts

Declining water quality, loss of agricultural productivity, fewer facilities and infrastructure, and a loss of landscape and visual amenity as a result of salinity will have profound social ramifications. Life in rural areas, which for many has been the way of life for generations of the same family, may be forced to change. There is a financial and physical burden in taking remedial action to address salinity problems. Maintaining the family's income can require increasing production from existing land or purchasing more land. Individuals and families will feel an extreme social impact if they are forced to move off the land.



Yachting on Lake Towerinning, south of Darkan. Photo: Babs and Bert Wells/Department of Conservation and Land Management

Adapting to these changes or coping with the pressure of an uncertain situation can put stress on individuals and families, which in turn can affect individual health and family stability.

2.4.2 Community impacts

Strong, adaptive communities are those that can count on the involvement of residents in civic, cultural, social and educational pursuits. As individual landholders feel the pressures caused by salinity problems, they are likely to have less time for community pursuits. The sense of community will begin to erode as involvement declines. If the economic impacts on farming are extreme and people move off the land, the population of some towns may decline. In the past, this has led to withdrawal of services, closure of businesses and decline in the overall quality of life in a community.

The rural landscape is seen by many residents as an amenity that improves their quality of life, and any loss of this amenity would affect the community.

2.4.3 Recreation and tourism

Water attracts people and rivers and lakes in particular are important locations for leisure activities. Changes in fringing vegetation due to salinity have decreased the appeal of these wetlands as recreation and tourism destinations.

This decline has important social and cultural implications for rural communities, particularly given that many of these areas have been used by several generations of rural people. The visual quality of country life is a marketing tool used in a range of tourism products, particularly chalets and farm holidays. Land degradation also would affect the likelihood of tourists and residents using particular areas for bushwalking, birdwatching, camping or other nature tourism pursuits.

Opposite: Belts of trees in an alley farming system. Photo: Agriculture Western Australia

Section 3
The strategy

3 The strategy

This strategy aims to reduce the impact of salinity in the south-west agricultural region of Western Australia. It has as its goals:

- to reduce the rate of degradation of agricultural and public land, and where practical recover, rehabilitate or manage salt-affected land;
- to protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity;
- to protect and restore high value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the region;
- to provide communities with the capacity to address salinity issues and to manage the changes brought about by salinity; and
- to protect infrastructure affected by salinity.

Each of these goals applies across the south-west agricultural region. However, the degree to which each goal is pursued will depend on the relative importance of the range of public and private assets under threat in individual catchments. Input at the regional level will help determine these priorities.

The proposed actions to achieve these goals are based on three fundamental principles:

- salinity needs to be addressed by treating the causes of the problem, focussing on managing recharge and rising watertables;
- developing practical and environmentally sound methods that mitigate the impact of salinity by managing the discharge; and
- the strategy needs to be implemented in a partnership approach between all stakeholders at the regional and catchment scale.

Priority has been given to the following actions:

To manage recharge	To manage discharge	To ensure a partnership approach
• Changing land use practices • Protecting, improving and adding to remnant native vegetation • Revegetation with commercial deep-rooted perennials, especially tree crops • Revegetation with native species • Catchment planning and management, including surface water management	• Protecting, improving and adding to remnant native vegetation • Revegetation with commercial deep-rooted perennials, especially tree crops • Productive use of saline land • Subsurface water management • Catchment planning and management	• Priority catchments to protect biodiversity, water quality, productive land and infrastructure • Community capacity building (locally-based professional support, training and knowledge networks) • State Salinity Council • Catchment planning and management

Opposite: Revegetation in Tin Dog Creek catchment, Dowerin. Photo: Agriculture Western Australia

Section 4
Strategic approach to addressing salinity

4 Strategic approach to addressing salinity

The magnitude of the challenge that dryland salinity poses in the south-west agricultural region requires a strategic approach.

Many catchments in the south-west agricultural region of the State are already significantly affected by salinity. Within each catchment, it is the community's capacity to manage vegetation, soils and waters that provides the potential for sustainable natural resource management. It is important that this capacity is given the best opportunity to develop, which means that we must address issues of equity, biophysical data and information availability, decision support systems and capacity building[2]. We also need to emphasise integration and partnerships.

Some lands and waters will need direct government support to protect high priority public assets. However, private landholders and communities have the largest role in managing community and private lands and waters. To do this successfully, the sustainable management of large parts of catchments is essential.

Monitoring rising water tables at Koolanooka. Photo: Agriculture Western Australia

The key elements of the Salinity Council's strategic approach are:

- working in partnerships that involve all stakeholders;
- analysing risk in different areas over time to allow appropriate priorities to be set;
- retaining native vegetation and protecting the remaining biodiversity values;
- adopting an appropriate mix of the tools available to manage salinity;
- helping the farming community to make the transition to more sustainable production systems and building their capacity to do so;
- addressing equity concerns that arise;
- encouraging research and development to improve salinity management;
- planning to address shortfalls in actions where priority biodiversity and other public assets remain at an unacceptable risk, or are significantly affected; and
- developing continuous monitoring and evaluation of salinity management actions.

4.1 Evolving natural resource management in Western Australia

The Western Australian Government is developing a State natural resource management (NRM) framework policy that will include as a key element the development and implementation of regional strategic plans. Salinity is one issue in the broader context of natural resource management. Through regional strategies linking into this strategy, regional natural resource management groups will contribute to the implementation of programs and projects that address salinity issues and ensure local relevance of State programs.

2 "Capacity" refers to the ability of a community or a group of people to pursue their own development. Capacity building is generally recognised as including knowledge building, access to information (and removal of barriers to adoption of that information), leadership development, network building and community involvement.

The importance of natural resource management in regional development is recognised in the State's Regional Development Policy. The policy includes strategies to strengthen the partnerships between government and community, increase knowledge and understanding of natural resource management options, and help ensure community groups can build their capacity to manage the natural resource.

This salinity strategy provides a blueprint for action through a partnership approach between the State Government and its agencies and landholder groups, landholders and the community. This partnership needs to be based on a clear understanding of the respective roles, responsibilities and interests of each party. This is particularly relevant in the consideration of respective contributions in any shared investment in salinity management to reflect best the balance between private and public benefits.

Regional groups are well placed to manage salinity issues at the landscape level, and it is primarily at the regional, catchment and farm scale where the impacts of management practices are felt and the responses best directed.

The partnership framework also incorporates industry and other sectors. The rural industry, including agri-business, must play a larger role in addressing salinity and in developing new and innovative agricultural products. Sustainable management practices underpin the productivity and profitability of these industries. Industry can play a valuable leadership role through developing codes of practice, developing environmentally-sound production systems and enhancing the knowledge and skills of their members in managing natural resources better.

4.2 Regional planning

A key issue in the management of salinity is effective and integrated planning at a catchment level that addresses the broad issues of land and water management, and economic, environmental and social concerns (including equity considerations).

Land use planning is important in salinity management. The Western Australian Planning Commission is involved in land use planning, including natural resource management, through the State Planning Strategy, regional planning strategies and regional schemes. Local governments are responsible for the preparation and administration of local planning schemes that regulate land use and development and address land use conflicts.

The protection, enhancement and repair of the environment and sustainable use of resources are critical to the State Planning Strategy. Regional planning strategies can ensure that salinity management is taken into account at a formative stage in the planning process. Regional strategies, for example, can identify existing and potential areas affected by salinity and recommend planning measures.

Local government planning schemes can also provide mechanisms to address salinity management through special control area provisions. These allow detailed land use requirements to be prescribed for a particular site or particular areas. Special control area provisions for salinity management in schemes could, for example, identify areas subject to salinity, facilitate their stabilisation, encourage revegetation and ensure development is undertaken in a way which brings about a reduction in salinity recharge.

A framework for the effective management of dryland salinity within the context of land and water resources requires:

- The involvement and ownership by the regional and local community in developing strategies and plans for land and water resources within their region or locality.
- The integration and coordination of economic, social and environmental objectives on a regional and State basis. This allows for the management of land and water resources within a catchment establishing a set of management goals and targets for dryland salinity.
- Setting priorities for the management of land and water resources.

- Helping community groups identify management options and supporting the actions of groups of land managers towards their shared goals.
- Monitoring the effectiveness of management strategies.

Strategies and targets need to be specifically defined at each level and be reflected by landholders in their property management plans. To achieve the best salinity management outcome, these different actions and plans need to be consistent with an overall regional strategic approach.

The State Government will work with and assist regional and catchment groups to develop their role and skills in setting regional goals and strategies to coordinate actions to address salinity and other natural resource management issues.

The Western Australian Planning Commission will address salinity management in regional strategies and promote measures to address salinity through regional strategies and planning schemes.

The State Salinity Council will be restructured to reflect the broader community and regional roles and responsibilities in salinity management.

4.3 Priority setting

An effective response to salinity at the catchment scale requires sound information, clear objectives, targets and priorities that are owned and supported by all stakeholders.

We need to consider where it would be possible and/or economic to control salinity in the longer term, and for any given area the stakeholders should consider whether we should try to reverse it (recovery), stop it from getting worse (containment), or learn to live with and manage it (adaptation).

Four key aspects should be considered when developing objectives and target outcomes for individual catchments:

- sustaining the land and water resources base, reducing further deterioration, and where possible, restoring land and water qualities;
- conserving natural diversity, protecting remaining natural areas and their flora and fauna, and restoring a representative range of natural environments on a regional scale;
- reducing the economic and financial losses to the individual, the community and the State, reducing the costs associated with losses in agricultural production, water resources, environmental values, and infrastructure; and

- equity of impacts on landholders across the catchment that may need some mechanisms to redistribute the economic hardship as distinct from the physical actions.

The relative importance of each of these aspects will vary depending on the public and private assets at risk and what is achievable in the individual catchments and districts, and priorities agreed between the Government, catchment groups and the community.

Knowing the best possible prediction for "what it is going to take" is vital for making an informed choice of the strategic goal for each catchment. For example, what are the environmental costs downstream for the possible interventions, and the costs and benefits expected, in choosing recovery, containment or adaptation as the response?

The Department of Environmental Protection will work with agencies and communities to develop environmental objectives and criteria for identifying priority environmental assets when planning salinity action at property, catchment, regional and State level scales.

The 1998 State of the Environment report identified priority environmental issues for each region as well as environmental indicators.

4.3.1 Catchment assessment

Individual landholders and groups of landholders are receiving salinity management support within several categories of priority catchments. These priority catchments, designated under the 1996 Salinity Action Plan, include focus catchments, mainly to protect agricultural land, and three types of recovery catchments to protect water resources, natural diversity and rural infrastructure.

The risk of salinity to these values, both geographically and over time, must be assessed objectively throughout the south-west agricultural region.

Once the risk has been assessed, advice will be required on treatments that might be adopted and their impact. All farmers in agricultural catchments need some appraisal of their risk, the generic treatments they might adopt and the impact of these treatments on groundwater levels. The most effective scale for this to be undertaken is at the catchment scale.

It is both urgent and vital that landholders have a better understanding of the salinity risks of each catchment so that remedial action can be implemented on a priority basis. It is already too late to save some areas but we do not yet have a clear understanding of the high priority areas that must be dealt with now to conserve high value resources.

At the same time as the environmental assessment is being conducted, a socio-economic assessment will also be carried out to identify potential social impacts in the catchment, and help develop ways to manage these impacts.

A rapid assessment of catchments throughout the south-west agricultural region to provide information to landholders will be undertaken within five years, to:

- provide a statewide assessment of salinity risk in terms of the areas, the environmental values and the infrastructure likely to be affected, and when they will be affected;
- cover all agricultural catchments where farmers are involved in the determination of their risk and the strategies they might adopt to either avert the risk, delay the onset of salinity (giving time for the development of new technologies) or adapt to increasing salinity; and
- identify social, economic and environmental impacts and develop mitigation strategies.

Left: A water quality monitoring site established by the Gabby Quoi Quoi Catchment Group and the Water and Rivers Commission. Photo: Landcare Vision

Preparing for an airborne geophysical survey in the Wheatbelt. Photo: Agriculture Western Australia

This process would work in tandem with the focus and recovery catchment activities and the Land Monitor project. The rapid assessment process will help to identify better the priority catchments in terms of both total public and private asset value and need for rapid intervention. It will provide early indications of appropriate remedial activity that could be undertaken in partnership between all stakeholders. Catchments completing the rapid catchment assessment will be provided with follow up support ranging from entering the focus or recovery catchment process to mentoring, depending on the prognosis for the catchment.

A pilot study is currently being undertaken in the upper Blackwood and western south coast as part of the National Land and Water Resources Audit (funded through the Natural Heritage Trust). Known as Salt Scenarios 2020, this project is determining the total costs of salinity and the cost effectiveness of available solutions up to 2020.

To undertake rapid assessments of catchments, the community and rapid assessment teams require data at scales that allow quick interpretation to a local level. Over the past decade, government agencies have been building the 14 key datasets required and the capacity to interpret each of them. With the completion of the Land Monitor project in 2001, accurate elevation data and salinity maps will be added to the list.

Only three datasets remain to be collected; magnetics, radiometrics and electromagnetics, known collectively as airborne geophysics. Magnetics determines the nature of the bedrock and radiometrics the nature of the soils. Electromagnetics measures a combination of the thickness of the soil and weathered rock layer, its salt content, and groundwater salinity, but currently cannot separate these factors without additional drilling and sampling, which reduces the cost-effectiveness of the technique. At this stage, airborne magnetics and radiometrics are considered more worthy of collecting for the agricultural area than electromagnetics.

Many airborne geophysical surveys have been undertaken in Western Australia, reducing the area still to be surveyed, and improving the likely spin-off from data acquisition in new areas. Magnetics and radiometrics are fundamental tools in mineral exploration and surveys for salinity risk assessment may provide other benefits. These datasets will allow interpretation of salinity risk and soil properties down to the farm level, significantly improving the scale and speed at which salinity advice can be provided.

However, complementary development work will be required to link the wide range of datasets through targeted research.

Water management plans will need to be developed for each catchment to consider the best means to manage both surface and groundwaters to prevent degradation and use excess water in productive ways. These plans should include identification and agreement from all stakeholders on what are and are not acceptable receiving points for any proposed drainage. Trade offs, where some environmental, social or economic values may be reduced, will need to be considered.

Water management is best planned on a catchment basis, having regard for regional strategies.

Planning at this scale allows coordinated and strategic delivery at the farm scale. It requires agreement by landholders within the catchment (including local government authorities and government agencies with land holdings) and by the government agencies responsible for the various aspects of land and water management. Agreement will be easier when the implications of implementing the management plan are better known.

Water management plans will consider a wide range of land and stream issues such as flooding, water erosion, waterlogging, inundation, in-stream processes (eutrophication, sedimentation) and recharge-discharge processes. Such plans will include:

- identification of the resource and its degradation hazards;
- identification and agreement on acceptable and non-acceptable water receival points;
- assessment of risk under current land use;
- assessment of risk with the predicted expansion of salinity in the catchment;
- modelling of earthworks and detention basin designs in the catchment to reduce risk; and
- advice on the options available for individuals to manage their water as part of the integrated plan.

The SS2020 project will be expanded to cover the remaining 15 million hectares of the south-west agricultural region, including an estimation of salinity risk and cost of salinity for each catchment, and the cost effectiveness of options within five years.

The results of the Department of Conservation and Land Management's biological survey of the south-west agricultural region will be examined in light of the results of the SS2020 project to help determine biodiversity conservation priorities.

Airborne magnetic and radiometric data collection will be undertaken over a further nine million hectares in the next five years.

Eight catchment assessment teams consisting of hydrologists, soils specialists, agronomists, economists, biologists, GIS analysts and extension specialists will be set up to undertake rapid catchment assessment in all catchments in the south-west agricultural region. This work will be completed within five years and undertaken on a priority basis.

Water management plans will be designed and modelled for catchments in the south-west agricultural region over the next five years.

4.3.2 Focus catchment support teams

Following a rapid assessment, catchment groups may become a focus catchment where a high level of planning and technical support and capacity building is provided for up to a year to help residents adopt land use practices for catchment objectives and improve their ability to manage change.

Focus catchments were introduced in 1996, with catchments joining the process on a voluntary basis through a partnership agreement with government agencies. The Government has provided technical and business advice and support through catchment support teams and Agriculture Western Australia's Better Business Program to help in advanced planning and provide site-specific advice for on-farm implementation.

The focus catchment program is being continually refined, especially as new datasets and decision support tools become available to the teams.

The focus catchment support teams will continue and be subject to periodic review.

4.4 Biodiversity conservation

Conserving biodiversity requires action on a number of fronts, including protection and management of native vegetation, watercourses and wetlands as part of an integrated catchment approach. Various strategies and programs throughout the State address biodiversity conservation. This Salinity Strategy focuses on selected key actions to conserve biodiversity values at greatest threat from increasing salinity.

4.4.1 Seed collection, storage and databasing

While in situ conservation of biodiversity is the primary objective, ex situ conservation can be used as "insurance" against extinction and to provide seed for the production and translocation of plants into safer sites. The Department of Conservation and Land Management's Threatened Flora Seed Centre was established for this purpose in 1992.

Accurate, up-to-date information on threatened flora populations is essential for effective management of current and potentially saline environments. There is incomplete information on many taxa as to whether they are threatened species or not.

The Department of Conservation and Land Management will establish and maintain a long-term storage facility for seeds of rare and threatened plant species located in saline environments.

Work will continue through a number of mechanisms including the Sustainable Seed Banks project run by Greening Australia (WA) to ensure adequate seed supply to satisfy large-scale revegetation requirements.

Further data will be collected and analysed on priority flora taxa of the south-west agricultural region that may be threatened by increasing salinity.

4.4.2 Protecting fauna from extinction

Many native fauna species require action to ensure they do not become extinct. The endangered Carnaby's cockatoo is a "flagship" species that illustrates the dependence of native fauna on landscape health. The cockatoo's preferred nesting site, the salmon gum, is now quite rare in the northern Wheatbelt due to land clearing for agriculture and secondary salinity.

Yellow eyebright is almost extinct in Victoria, Tasmania and South Australia. The largest known population grows in Western Australia's Lake Muir Recovery Catchment. Photo: Department of Conservation and Land Management

The conservation of Carnaby's cockatoo depends on the conservation of remnant eucalypt woodlands and the adjacent banksia heathlands in which it feeds, and the corridors of native vegetation that link the two types of habitat.

The protection of existing remnant vegetation and the encouragement of native revegetation are essential for protecting endangered fauna, such as the Carnaby's cockatoo, from extinction.

The Department of Conservation and Land Management will implement a program to save threatened species such as Carnaby's cockatoo in cooperation with landholders.

A database of threatened and priority fauna in saline areas of the south-west agricultural region will be completed.

4.4.3 Natural diversity recovery catchments

Recovery catchments, a key measure for biodiversity conservation under the 1996 Salinity Action Plan, are based on the identification of major, high priority public assets that are at risk from salinity and warrant significant, ongoing investment in their recovery and protection.

Recent modelling has shown that very high levels of intervention, which may include up to 80 per cent of a catchment being covered or farmed in a rotation with perennial species plus engineering options, may be required to protect and conserve key areas of biodiversity.

The Department of Conservation and Land Management will continue to implement a coordinated Natural Diversity Recovery Program. This program already targets the Toolibin Lake, Lake Muir-Unicup system, Lake Warden system and Lake Bryde-East Lake Bryde catchments.

The Natural Diversity Recovery Program will target at least six more catchments by 2005, based on biological survey findings.

4.4.4 Protecting other wetlands

In addition to the wetlands that will be protected under the Natural Diversity Recovery Program, the Water and Rivers Commission will coordinate the development and implementation of management plans for other high priority wetlands at risk from salinity outside the conservation estate (for example wetlands on private land or on land vested with local government). This will be done in partnership with the community and where appropriate, the management plans will include wetland catchments.

Although biodiversity and the level of risk from salinity will be key considerations in the selection of wetlands, other factors such as physical uniqueness, cultural and recreational values will also be considered together with the capacity of the community to support the development and implementation of the management plans.

The Water and Rivers Commission, in partnership with the community, will develop and implement management plans for high priority wetlands located outside the conservation estate.

4.5 Water resource recovery catchments

We currently have adequate water resources in the south-west to meet water supply demands into the middle of the 21st century. However, as demands for water grow, there will be an increasing requirement to manage water resources in such a way as to keep them within salinity levels suitable for the region's drinking water supply needs. Extensive rehabilitation work may be required to recover fresh water resources in the future.

Action has already been taken to prevent salinisation and restore water quality in five key water resource catchments of the Mundaring Weir (Helena River), Wellington Reservoir (Collie River), and the Warren, Kent and Denmark rivers.

Future management will concentrate on high water use farming systems based on integrated catchment plans including actions for ground and surface water management, waterway management, remnant vegetation protection, farm forestry, improved annual cropping and pasture and conservation plantings next to discharge areas.

The target for the Collie River inflow to the Wellington Dam is to have potable water by 2015. The targets for both the Kent and Warren rivers are for potable water at sites suitable for future dams by 2030.

Water quality in the Helena and Denmark rivers will be regularly monitored and recommendations made on requirements for action on salinity control.

The Water and Rivers Commission will:

- **arrange implementation of plans based on a cost-sharing framework that considers public benefit; and**
- **encourage and facilitate the fencing of remnant vegetation.**

4.6 Infrastructure protection

The State Government established the Rural Towns Program under the 1996 Salinity Action Plan.

The aim of this program is to help local government authorities develop strategies that will guide the community to address rising watertables in the catchment, establish water use plans for the towns and put education programs in place to promote "water wise" programs to protect assets. The program provides funding on a shared basis for detailed investigations, development of a salinity management strategy, planning and implementation of salinity and water control measures.

Buildings, roads, rail and water facilities are all at risk from salinity. Photo: Department of Conservation and Land Management

The Rural Towns Program includes:

- a structured program in which local councils can operate;
- coordinated delivery of strategy outcomes which are integrated with other recognised natural resource management projects;
- salinity management services provided by technical specialists; and
- up to 50 per cent funding subsidies for works approved as part of a Salinity Management Strategy prepared for the town.

The Rural Towns Program will service 30 towns for the next three years with additional towns supported progressively over the following four to 10 years.

4.7 Flood risk assessment

Increased flood risk from the development of groundwater discharge areas has major implications for infrastructure and communities.

A flood risk study for the Blackwood River assessed the potential increases in flood flows due to the full expression of waterlogging within the catchment. The predicted increase in flood flows was two-to-four times higher than recorded flood magnitude levels, but the modelled situation need not be reached.

An unfortunate aftermath of flooding is the surcharging, or the boosting of groundwater levels by the floodwaters. After the surface water has receded the groundwater will also tend to drain away, but the rate will be delayed by the generally flat terrain that influences the hydraulic gradient.

Further work will be undertaken to look at other catchments at risk, such as the Avon, Murray and Collie rivers. The main management approaches to reducing flood risk are:

- limiting the extent of waterlogging within a catchment by planting any vegetation that will survive and use water, and/or by using drainage; and
- managing surface run-off to limit flooding, recognising that the processes that increase the risk of flooding are already operating in many catchments.

The intent is to convert the waterlogged ground back to more natural ground to delay run-off when rain falls. This could be achieved by growing saltbush, for example, in a previously waterlogged area. If the top few hundred millimetres of soil can absorb rainfall it will offset the flood risk due to waterlogging.

There will also be situations where properly designed drainage can be used, but it is important that any drainage option does not add to the flood risk in itself. Any future drainage proposals will be assessed with this in mind.

Undesirable processes are already operating in many catchments, sometimes with well-intentioned but equally undesirable human interventions. There needs to be a combined approach to control and reduce waterlogged areas and improve flood mitigation features of existing natural and artificial drainage systems. In addition, any new drainage endeavours must be appropriately designed.

The informed approach to reducing flood magnitudes involves slowing run-off wherever possible, using on-farm surface water management, dispersed retarding basins that mimic the natural valley storage of mature natural rivers and limit training natural river channels or developing drainage networks. There is a need for better explanations of the processes at work and advice on how to combat the undesirable effects.

The Moore River in flood, 1999.
Photo: Water and Rivers Commission

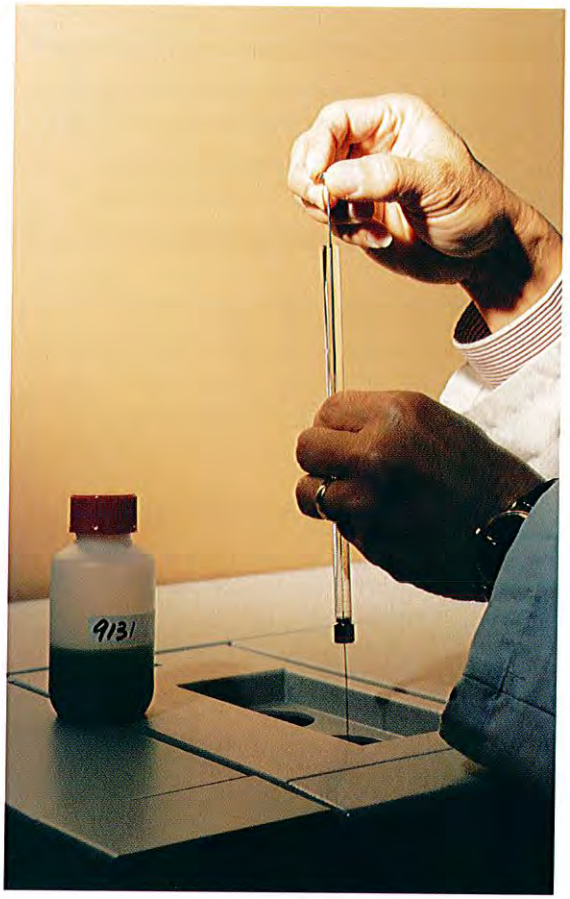
The Water and Rivers Commission will:

- **increase awareness of these hydrologic impacts by undertaking further study on the impact of waterlogging on flood risk and vice versa. This study will assess the increase in flood risk for the Avon, Murray, Collie and other southern rivers from catchment land use and the full impact of land clearing and waterlogging;**
- **provide advice on the optimum use of vegetation and/or drainage to control waterlogging;**
- **provide advice on drainage design to achieve flood mitigation.**

4.8 Research and development

Further research is needed to help refine existing activity and to help us move forward into new areas of opportunity. The high level of media and political interest in salinity has ensured an ever-increasing national source of funds for research in this area and provides an opportunity for this State.

Western Australia may attract much of this funding as we are experiencing the effects of salinity at an earlier stage than much of eastern Australia. Also, the level of awareness and understanding is higher here and provides a conducive atmosphere for the research sector. However, research activity often requires matching funds or in kind support which strain agencies' budgets and prove difficult for farm-based groups.



Testing eucalyptus oil content in different species of oil mallees. Photo: Department of Conservation and Land Management

The Salinity Council will continue to facilitate and encourage research activity and coordinating applications between agencies and private groups in order to optimise the benefits for salinity management in the State.

Government agencies will expand their capacity to host and attract research activity to this State.

Opposite: Morbinning Catchment Group members collect seedlings for landcare plantings. Photo: Landcare Vision

Section 5
Tools to manage salinity

5 Tools to manage salinity

There is a range of tools available to manage salinity. Each catchment will need to select a combination of these to suit their specific needs and to meet their objectives. No one tool is likely to work in isolation and the tools used will need to be appropriately located in all parts of the landscape. In addition, land use will have to change significantly across the whole agricultural area. Sources of further information about these tools are listed in *Salinity: A guide for land managers*.

Wherever possible, the tools described are economically beneficial to the landholder in the longer term. However, there are transition costs in establishing these new systems and delays in cash flow. This aspect is addressed in section 6.4, "Options for cost-sharing".

5.1 Land management practices

Current annual farming practices require significant change so that they either use more water, or they help to use saline lands or water in a productive way. Change needs to be effected across the landscape.

Deep-rooted perennials have a high water use potential, and are therefore the primary tool to control salinity. Their extended growing season and deep root systems provide the capacity to use more annual rainfall as well as exploit water available at depth within the soil profile. They provide an opportunity for income and diversification, while addressing salinity.

There is potential for the development of new and more productive rural enterprises providing funding is available to help with resource assessment, technical information, research and market identification, as well as associated transition costs. Benefits will accrue at both the regional and individual scale. While the primary target is salinity management, collateral benefits should occur in the longer-term through increased profitability and farm viability.

Financial incentives for investment in woody revegetation are needed, such as through a carbon offset scheme to provide carbon sinks for purchase by industry to offset carbon emissions.

Further emphasis must be put on the significance of the profitability of farming systems as an important component in finding and implementing solutions for salinity. It will be important to ensure that landholders have available to them the information they need to understand the options they have for reducing recharge, the likely impact of those options on recharge and salinity, and the practicality and financial implications of implementing them.

Developing integrated decision support tools that deal with these issues will allow landholders to make decisions for their own situation, in contrast to the general solutions that are desirable for a region or catchment.

5.1.1 Changing agricultural practices

5.1.1.1 Cropping options

A highly effective way of reducing recharge is the widespread implementation of profitable, practical farming systems that use more water than current systems. This will not be achieved by manipulating existing farming systems, but by developing new systems that include a considerable area of deep-rooted perennial species.

Recent measurements and models have shown that there is generally only limited potential to decrease recharge by modifying existing annual crop and pasture systems. The effectiveness of high performance annual crops and pastures in reducing recharge varies with soil type and climate and in the medium to low rainfall areas on finer textured soils a doubling of crop yield may only reduce recharge by five per cent (4mm out of an average of 20mm).

However, it is important to maximise water use of annual plants by aiming for:

- higher performance cropping and pasture systems such as those developed for the Wheatbelt and South Coast (for example wheat, lupin and canola rotations); and
- the selection of plants with a longer growing season and increased rooting depth (for example serradella cultivars).

Warm season cropping has the potential to offer more than increased water using capacity. Early trials show variable results in recharge reduction, but other benefits include the recycling of nutrients, breaking down of "hard pans", extending the rooting depth of following crops, assisting in future seasons' weed control and helping slow the chemical resistance of weeds. These benefits have attracted significant grower support. Warm season crops are under early stages of development in farming systems and need further extensive research, development and field trials. At present these systems are most suited to the southern agricultural area and to waterlogged areas, but are being trialed throughout the Wheatbelt.

The Western Australian No Tillage Farmers' Association is providing leadership in warm season cropping and high attendances at their seminars indicates a strong interest by farmers in these new systems. The Natural Heritage Trust and the Salinity Council have supported the work of the Association.

Further research, development and extension support will be given to optimise the potential of new farming systems and will be actively promoted by the Salinity Council.

The Western Australian No Tillage Farmers' Association is targeting warm season cropping over 15 per cent of the potential cropping area within five years.

The Grains Research and Development Corporation and the Land and Water Resources Research and Development Corporation have recognised the need to reduce recharge under productive farming systems and, through investments in the National Dryland Salinity Program, are funding significant amounts of work in this area.

The development of more salt-tolerant crops would delay the effects of salinity, providing extra time and income for implementation activity. However, the effects of waterlogging in the root zone would still need to be managed.

Tagasaste, a perennial fodder shrub.
Photo: Agriculture Western Australia

Lucerne pasture growing on a Borden property. Photo: Agriculture Western Australia

5.1.1.2 Pasture options

Perennial pastures, particularly deep-rooted lucerne, can also play a role in reducing recharge as a profitable farming system. The particular advantage of perennial pasture plants is that grazing industries able to use them are already in place. They could also form the basis of new products and provide the option of cattle production in areas previously considered as unsuitable.

The development of new farming systems based on perennial shrubs or trees and perennial pasture will require an innovative, holistic approach to research and development which relies on strong participation by farmers. Groups such as the Western Australian Lucerne Growers and the Saltland Pastures Association are currently promoting more extensive use of perennial grasses and herbs.

The potential for perennial pastures and fodder shrubs is high in the medium rainfall "wool belt", as is the potential for agroforestry systems. This presents an opportunity for a new timber-based industry to develop alongside a more intensive grazing system using a perennial pasture base. Such higher water use systems, incorporating commercial tree crops, need not be at the expense of traditional grazing, but as an addition to it.

5.1.2 Commercial farm forestry

Broad-scale planting of perennials is required to control salinity. Woody perennials will only be effective if they are strategically distributed across the agricultural landscape, and therefore efficiently integrated into the agricultural system. The large area of revegetation required and the substantial cost involved means that commercial returns from revegetation will be essential to achieve large-scale adoption. Initial transition costs may require community support.

Woody perennials range from shrubs to tall trees. Their longevity is linked with deeper, more extensive root systems and taller canopies, which generate a higher water use potential than perennial grasses, herbs and warm season growing crops. Farm forestry also offers the potential to incorporate sound biodiversity principles (for example preference for native species and more diverse mixtures of species in production systems).

Commercial tree crops have emerged, most notably bluegum in the higher rainfall areas, and others such as maritime pine and the fodder shrub tagasaste in intermediate rainfall areas.

The Department of Conservation and Land Management will continue to implement a major maritime pine program in the 400 to 600 mm rainfall region.

Oil mallee is under development as a tree crop for the low rainfall areas. A joint project between the Department of Conservation and Land Management and Agriculture Western Australia is examining the selection and development of multiple purpose species for large-scale revegetation.

Economic diversification requires the creation of new industries that inevitably have extended development and adoption periods. For example, the Oil Mallee Association and the Oil Mallee Company are actively working to develop a eucalyptus oil industry with by-products of charcoal and electricity generation. Trials of other commercial options include sandalwood, floriculture products, native foods, medicines and olives. Government and venture capital support is critical in establishing new industries, particularly for research and seed capital.

Commercial revegetation opportunities need to be given priority consideration in the low to medium rainfall areas. Native foods, floriculture and specialty timber commercial opportunities exist and are being tested at experimental levels by landholders and agencies.

Public investment in larger "commercial speciality clean and green" revegetation projects needs to be encouraged.

The 1996 Salinity Action Plan set a target of an extra three million hectares of trees and shrubs planted across the agricultural region over 30 years. Subsequent scientific assessment has shown that greater levels of intervention are required and this target needs to be revisited after community consultation and debate.

The State Salinity Council will pursue a target of more than three million hectares of woody tree crops in the south-west agricultural region, at an accelerated rate and will continue to review this target in the light of new information.

The Department of Conservation and Land Management and Agriculture Western Australia will undertake development of a range of new woody perennial crops and industries, which will focus on the commercial use of native species in low rainfall areas.

The Oil Mallee Association is targeting one million hectares of commercial mallee plantings by 2015.

Opportunities for commercial public investment in large-scale projects will be supported through business planning and feasibility studies.

Woody perennials such as bluegum, pines, tagasaste and oil mallees have each required many millions of dollars of capital to develop as commercial crops.

There are major problems in funding the development of new commercial woody plant species, products and industries. The investment required is large and inherently risky. This indicates a fundamental requirement for both government and private investment in the development phase of commercial woody perennial crops, especially in low rainfall agricultural regions.

Maritime pine planted as a commercial crop on already cleared farmland. Photo: Department of Conservation and Land Management

Oil mallee species growing at CALM's Narrogin nursery.
Photo: Department of Conservation and Land Management

Any interest in a promising prospect will be based, at least partly, on the salinity control benefit, a return that is not readily available to help motivate private enterprise. New prospects will not have an established industry lobby, and will have to face the problem of building up a sufficient resource base before commercial development can emerge. Furthermore, landcare and related funding programs often explicitly exclude commercial development projects, though it should be noted that the Natural Heritage Trust has contributed significant funds in recent years.

The potential for carbon credits and greenhouse emission trading, to be coordinated at national and international levels, would also add extra returns to revegetation options. It should be noted that transaction costs would preclude small parcels of vegetation and favours cooperative or corporate entities, such as the Western Australian Landcare Trust and the Oil Mallee Association. An investment in greenhouse plantings in high priority catchments with valuable public assets may well give a double return, of saving those assets by using more water while attracting greenhouse credits.

5.1.3 Using saline lands productively

While more land will be affected by salinity, there are increasing opportunities to use some areas productively. The Saltland Pastures Association believes that about one million hectares, or 50 per cent, of land currently affected by salinity could potentially be revegetated using saltland pastures or salt-tolerant trees and shrubs over the next decade. Additional work on the economics of the use of saline land still remains to be done. However, land that has become saline needs to be fenced and separately managed for both production purposes and biodiversity value.

Saltbush growing successfully on salt-affected land.
Photo: Landcare Vision

Recent studies by The University of Western Australia indicate that successful development of profitable enterprises for saline land would bring significant returns given the extensive areas affected by salinity now and into the future.

There will be five outcomes from productively managing saline lands:

- **improved economic outcomes for landholders with large areas of saltland;**
- **stabilisation of saltland, reduced erosion of degraded watercourses;**
- **limited local drawdown of saline watertables and reduced potential for flood risk;**
- **improved nature conservation; and**
- **improved visual and amenity aspects.**

Saltland in Western Australia presents a range of landscape opportunities (niches) with wide variation in levels of salinity, waterlogging and inundation, and in soil texture.

These different niches present diverse opportunities to develop new saline agricultural industries (for example saltland pastures, seed harvesting, wood for pulp, brushwood, essential oils and aquaculture).

Many landholders in the low and medium rainfall regions have been revegetating saltland with salt-tolerant annuals and grasses, herbs and woody perennials. The Saltland Pastures Association was formed in 1997 to help promote and advance this activity.

These activities are receiving renewed impetus thanks to the recognition that the inclusion of an annual understorey substantially increases productivity when grown in conjunction with salt-tolerant woody perennials such as saltbush species.

Saltland pasture adoption is expected to increase dramatically with the release of new short-season balansa clover varieties in the year 2000 and adoption of technology to increase productivity from these pastures.

The Saltland Pastures Association has already demonstrated great potential for this resource and is targeting one million hectares of productively-managed saline land over the next decade.

There are also a number of salt-tolerant trees and shrubs with potential for growth on marginally saline and waterlogged land in Western Australia, including *Eucalyptus sargentii, E. occidentalis, E. spathulata, E. loxophleba, E. camaldulensis, Melaleuca uncinata, M. thyoides, Acacia saligna* and *Casuarina obesa*. In fact, *E. camaldulensis* is the world's most used hardwood for pulp production. This offers a timber-pulp opportunity for saline lands in the 500 to 700mm rainfall zone.

Targeting different saline agricultural options to particular landscape niches is an important issue that will require continuing research, development and extension. In order to meet nature conservation outcomes, research and development should be focussed on native plants that grow locally on saline lands. These include a range of eucalypts, wattles, paperbarks, ti-trees, saltbushes and samphires. This is especially important in the south-west agricultural region given the high turnover of native plant species across the landscape. Species from elsewhere will have a reduced nature conservation benefit and a higher weed potential, although they may have significant roles for controlling watertables.

In deciding on the use of saline lands, account needs to be taken of the fact that naturally saline wetlands and their floodplains are diverse ecosystems with intrinsic value for nature conservation.

It will be important to ensure that farmers and other land managers can access the best possible advice on what can be done to manage salt-affected land and to examine alternative, innovative uses that may have a private and/or public benefit.

All salt-affected land is not the same, and some areas will not respond at all to treatment. Reducing waterlogging, for example, can significantly enhance production from slightly salt-affected land. Current knowledge needs to be assembled in the context of the different classes of salt-affected land and an information package developed.

Agriculture Western Australia will help landholders with salt-affected land by:

- **developing a system for classification of salt-affected land;**
- **developing an information package for management of salt-affected land;**
- **examining alternative uses for salt-affected land; and**
- **establishing eight salt-affected land demonstration sites.**

5.1.3.1 Productive use of saline water

A review of aquaculture operations interstate and overseas by Fisheries Western Australia and Agriculture Western Australia found a range of opportunities for commercial aquaculture in inland saline waters.

For example, in China, Chile and Taiwan minimal management techniques are used in the large-scale production of seaweed for food and chemicals.

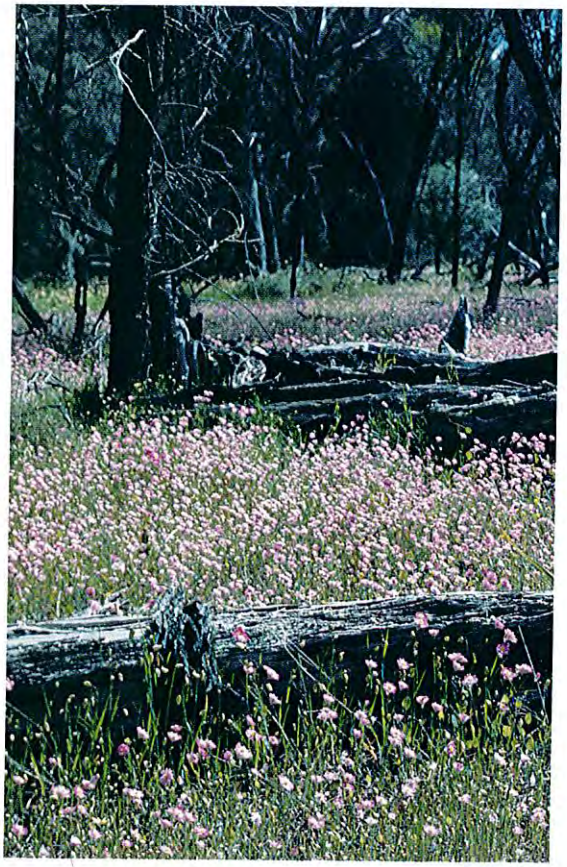
In this industry a range of seaweed species is grown in near stagnant, low salinity ponds. At the other end of the spectrum, carefully managed greenhouse tank systems in Israel are used to farm fish in water too salty for agricultural irrigation.

There is little commercial aquaculture using inland saline water in Australia, and currently few initiatives in Western Australia. Several research projects are in progress in New South Wales, Victoria and South Australia.

The initial work is using rainbow trout as a lead species. Trout has been farmed in Western Australia for over 50 years and it is the only species which has established commercial production in the State and which can tolerate a wide range of salinities. However, recent research by Murdoch University on black bream suggests that this species could also be commercially viable in saline water sources such as dams.

Care will be needed when introducing new species to ensure that they do not establish feral populations.

Fisheries Western Australia and Agriculture Western Australia will continue the Outback Ocean Project.



York gum and everlastings at Arthur River. Photo: Department of Conservation and Land Management

5.1.4 Irrigated agriculture

South West Irrigation (SWI) has been developing sustainable irrigation farming systems to increase their sustainability and alleviate irrigation salinity effects. A levy system has been implemented where irrigation farmer shareholders raise funds to undertake activities to reduce salinity.

South West Irrigation will undertake work on sub-surface drainage as a means of reducing salinity effects and increasing farm productivity; monitoring the quality of water flowing through the south-west irrigation area and undertaking salinity mapping to delineate and prioritise areas of salinity risk.

5.2 Native vegetation management and revegetation

An important component in any salinity management plan is to conserve the native vegetation that still exists in the landscape. This helps to save our natural heritage and develop sustainable systems of perennial agriculture. There is an urgent need for natural biodiversity to be promoted, preserved and integrated into Western Australian farming systems.

Revegetation in its many forms offers opportunities for all Western Australians to work together to help protect what remains of our natural heritage from the worst-case impacts of salinity.

5.2.1 Native vegetation management

Retaining native vegetation in good health is a first step in recharge control as it is easier to look after the plants that are already in the ground and using water than it is to revegetate. Remnants have the added bonus of being existing wildlife habitat. The ability of remnants to maintain a range of plants and animals may be improved by increasing the area of bushland or by improving its quality.

Native vegetation is vital for biodiversity conservation and particularly valued for salinity control where:

- individual remnants are large enough to reduce recharge at a catchment or sub-catchment scale; and
- smaller remnants occur on high recharge zones (for example deep sands and around rocky outcrops) or discharge zones (for example drainage lines, swamps and lakes).

Native vegetation is not only important as an ecosystem driver, it is also important in its diversity of native plants as well as being a habitat for a whole suite of invertebrate and vertebrate animals. Accordingly, the need to retain native vegetation in the agricultural areas is essential not only because of the part it plays in the hydrological balance but also because of its intrinsic importance as a habitat.

Native vegetation also contributes to water and soil conservation and provides an important genetic resource for development of new plants for commercial production. It is important as the strategic building blocks of landscape revegetation and repair. Remnant vegetation protection and management, and its integration with other vegetation strategies, will be a significant component of salinity control systems.

Successful flooded gum regeneration in the Blackwood catchment after fencing to exclude stock.
Photo: Water and Rivers Commission

The State Government has progressively tightened clearing regulations, with additional measures implemented early in 1999. Clearing remnant vegetation under normal circumstances is no longer acceptable given the issues of salinity, biodiversity, native habitat and global warming. However, it is recognised that there are equity issues associated with preventing further clearing and these are being addressed.

The Native Vegetation Working Group was set up by the Minister for Primary Industry to develop mechanisms that minimise the economic burden carried by individual landholders in the protection and retention of privately-owned bushland in agricultural areas.

The long-term value of remnant vegetation for salinity control and biodiversity conservation depends on management of a range of threats apart from salinity. For example, management of feral animals, weeds and disturbance events such as fire, and protection from dieback disease (*Phytophthora* species) in many areas, are essential to maintain values in the long term. Protective fencing, rehabilitation of degraded remnants and improved management will maintain or enhance water use.

The State Government will continue to protect and manage native vegetation on land it controls as well as providing advisory and support services to landholders conserving native vegetation. These services will include the Land for Wildlife Scheme, Remnant Vegetation Protection Scheme, voluntary conservation covenants and by working with Natural Heritage Trust programs such as Bushcare.

Additional measures to encourage native vegetation management and to address inequities associated with clearing bans will be addressed through recommendations of the Native Vegetation Working Group in conjunction with this Salinity Strategy.

5.2.2 Native revegetation

As well as protecting and managing native vegetation, revegetation with native species is also vital for salinity management and biodiversity conservation.
Revegetation has significant benefits for wildlife if it is well planned. Using native species where possible and including a variety of flowering trees and shrubs increase the value of such areas for a range of native animals.

Many of the revegetation methods implemented in recent years were developed in the south-west agricultural region. Farmers, their community groups, agencies and organisations have been active in laying solid foundations for the range of approaches and scales of implementation that we now know are possible.

Native fauna, such as the tammar wallaby, will be lost from the agricultural region unless action is taken. Photo: Babs and Bert Wells/Department of Conservation and Land Management

Revegetation and proper management of native revegetation have benefits in addition to biodiversity, including erosion control (wind and water), stock shelter, buffer zones and recharge management.

The reintegration of native species into agricultural systems on the required scale will require access to robust direct seeding technologies.

While some direct seeding technologies are available, further substantial research and development is required to develop these techniques.

Much of our native fauna will be lost from the agricultural region unless isolated remnants are buffered and joined by appropriate bush corridors. Revegetation in riparian areas such as creeks, rivers or wetlands should be undertaken with local native species, as an integral part of these bush corridors. In addition, native revegetation needs to include understorey plants to reconstruct natural habitats.

Imaginative approaches are required for the development of bush corridors. In some cases, it may be possible to develop corridors by widening and revegetating road reserves.

In other cases it may be possible to re-engineer saline agricultural farming systems so that revegetation of saltland and river systems conserves biodiversity and generates income.

Reintegrating native plants into farming systems will require the availability of major new seed resources. For many extensively cleared agricultural areas, it may not be possible to provide enough seed for revegetation from existing bush remnants.

Revegetation technology research and development will be supported, and delivered through partnerships between government, industry and community organisations.

The Salinity Council will investigate a targeted program of research and development including those low rainfall areas where direct seeding presently has poorest results.

Further research and development will be undertaken to determine the corridor requirements of different fauna species and the opportunities that exist for the development of corridors with dual roles.

A program for the establishment and management of seed nurseries of suitable local revegetation species will be developed in cooperation with relevant community organisations such as Greening Australia (WA) and local community groups.

5.3 Engineering options

High water tables have developed over much of the south-west and recharge continues to be significantly greater than discharge. For this reason, engineering options may be needed to complement agronomic and vegetation options. However, options must be implemented with full knowledge of their on-site and off-site impacts and practicality, and within the framework of a catchment plan.

Catchment hydrology has altered significantly since the land was cleared for agriculture. Some forms of drainage works have the potential to alter catchment hydrological characteristics further in some types of catchment, for instance by reducing flood detention capacity and increasing flood frequency, particularly if those forms of drainage are adopted as common practice throughout the catchment. In other catchments, drainage may have relatively insignificant off-site impact, or even reduce flood risk by creating greater water retention capability in the surface soils.

Under suitable hydrological conditions, engineering options can be useful in the protection or recovery of high value assets, such as areas of high agricultural productivity (including irrigation areas), areas of biological significance, wetlands, town buildings or other infrastructure.

Surface water control systems are already widely recommended, while deep drains, groundwater pumping, relief wells and syphons provide enhanced discharge, but need more care in their design and implementation.

For example, drains may become blocked with sediment and iron-fouling bacteria and create significant erosion risk and sedimentation if not well designed and installed. Engineering options need to be developed in the context of catchment plans and in association with other farming systems.

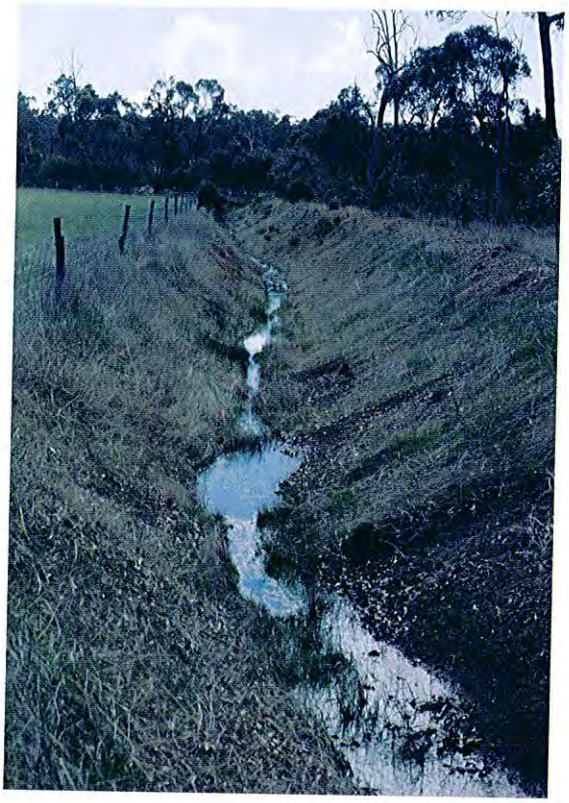
A new approach to engineering options includes a best practice environmental management package to help landholder groups develop catchment-based drainage proposals. Improvements will also be made to the statutory assessment process to give priority to proposals that are comprehensively and carefully thought out on a catchment basis and designed according to the following process:

- calculating the increase in catchment discharge of salt and water required to maintain or improve production and protect environmental and infrastructure assets;
- evaluating and selecting water management practices for the different areas in the catchment in order to meet both short and long-term objectives;
- considering the cumulative impacts (for example regional flooding) of all engineering proposals on the catchment;
- selecting the lowest risk engineering design; and
- demonstrating that all impacts on the environment downstream (for example nature reserves, wetlands, remnant vegetation, surface and groundwater) have been fully considered and will be minimised, monitored, and remediated if necessary.

There is a need to develop a new authorisation process to ensure that:

- engineering proposals are based on the processes and information package discussed in the technical note, so that they meet the Government's aim of integrating engineering options with other essential water management practices to increase water use and to reduce accessions to groundwater;
- all private and public stakeholders directly affected by such proposals are consulted; and
- the proposal improves the condition of relevant assets in the catchment with acceptable offsite impacts.

A process will be needed to refer proposals to relevant agencies for assessment where one area is sacrificed in order to save another area.



This open deep drain is stable, with no slumping and erosion. Photo: Water and Rivers Commission

5.3.1 Surface water management

Water is a resource that can become a problem without appropriate management. Water ponding on the soil surface and waterlogging within the soil profile inhibit plant growth, and encourage groundwater recharge. Directing water along grade lines using drains, banks or cultivation rows improves plant growth, reduces erosion and potentially recharge, particularly in wet years when most recharge occurs.

These systems are characterised as being over the whole farm/catchment, having particular emphasis on landscape water management, but can include discharge management in the lower parts of the landscape. Systems that harvest and manage water are critical. Examples of this are shallow drains built along contour lines that channel water into a series of dams and include several rows of trees or shrubs planted on the lower side of the drains.

These systems can lead to increases in production on the land between the drains and tree belts, as well as providing shelter for stock and birds and can often be the most cost-effective form of engineering works. A well-designed system will ensure there is no leakage due to low gradients, or overtopping and erosion.

Farming systems based on permanent raised beds are being tested and can produce significant yield increases on waterlogged land. These systems have been successfully applied to saline waterlogged land elsewhere but have not yet been used in this State.

Excess water harvested from a catchment can either be used for drought-proofing water supplies or to support new farm enterprises such as aquaculture, horticulture or summer irrigation, or will require careful disposal so that impacts on the environment or property downstream are within acceptable limits. The use of detention storages may help maintain catchment flow characteristics and aid in flood mitigation.

While management of surface water in this way is recommended for widespread adoption, it should be complemented by other strategies that directly increase water use and reduce discharge of saline groundwater.

5.3.2 Groundwater management

Groundwater management in discharge areas is distinguished from surface water management systems in that it targets removal of the permanent groundwater systems. Methods include deep drains that may be either open (constructed by an excavator) or closed (for example buried slotted pipe), pumping systems, relief wells and syphon wells.

5.3.2.1 Deep drains

Deep drains are constructed at depths of about one to three metres depending on site conditions. Deep open drains are most effective in permeable formations that resist slumping and erosion (for example limestone). Many agricultural soils have a low permeability (for example clays) or are unstable (for example loose sands) and therefore an evaluation of site responsiveness is very important before construction.

Sites with a low permeability have a very small zone of influence of the groundwater but may improve surface water management and salinity close to the drain.

Well-designed deep drains have a role in salinity management. When deciding if a deep drain is suitable for a particular site, landholders should:

- Assess the potential cumulative impact of the drain, including careful and ongoing monitoring and evaluation of the drain's effectiveness;
- Ensure disposal of drainage water offsite meets specific criteria, particularly with the risk of increased flooding and sedimentation downstream, and with impacts on ecosystems receiving water that is different in quality and/or quantity;
- Assess the potential for damage to other properties or reserves. Landholders have to accept a duty of care to ensure their management actions do not degrade other private or public assets. Currently there are inadequate mechanisms to deal with the cumulative impacts of drainage waters on adjacent landholders or on the environment.
- Ensure the drainage forms part of a comprehensive catchment water plan.
- Ensure the drainage design adequately provides for managing surface run-off, so as not to accelerate erosion or increase flood risk.

In some instances, water may be discharged into natural streams and salt lake systems if it can be demonstrated that the discharge will not affect current or future water supplies and will cause no significant environmental impacts, and that the discharge is acceptable to all potentially affected landholders and relevant agencies and statutory authorities.

Another option for disposal of drainage water may be storage on site in carefully sited, designed, constructed and managed evaporation basins. Sometimes this stored water may be used for other purposes such as aquaculture if the water quality is suitable.

Any drainage proposal should incorporate the cost of salt control.

A drainage review initiated by the Government will lead to the development of drainage design and assessment criteria by government agencies.

Deep drains must be considered within the context of an overall water management strategy, including flood risk management, to develop and implement longer-term solutions, and that is agreed to by affected landholders and relevant agencies and statutory authorities.

5.3.2.2 Groundwater pumping

This form of engineering option refers to bores drilled down to bedrock or into permeable aquifers and situated in low parts of the catchment with various forms of electric or compressed air pumps.
They are usually costly to install and maintain and are therefore most often suited to protecting high value assets. Their effectiveness is heavily dependent on soil permeability, which determines how many pumps and how much power is needed to achieve the outcome. Bore field arrays and collector systems can be quite extensive in some circumstances.

The disposal of water from these systems and the offsite impacts have the same constraints and requirements as discussed under deep drains. Groundwater pumping is usually used in conjunction with other tools, although like other drainage systems it may be appropriate to start with these options if the salinity risk is immediate.

Groundwater pumping is being evaluated at Toolibin Lake and in some rural towns.

A relief well installed on a Frankland farm. Photo: Water and Rivers Commission

5.3.2.3 Relief wells and syphons

This form of engineering option involves groundwater under pressure being discharged naturally from bores drilled to bedrock. Discharge through polythene pipes into waterways prevents erosion and these systems may be the most easily managed of the engineering options, however offsite impacts of saline water disposal still need to be considered.

Agriculture Western Australia and the Water and Rivers Commission are supporting the Gordon River Focus Catchment in an evaluation of this technique.

5.4 Social impact management

Various actions will ensure better management and mitigation of the social impacts associated with salinity:

- Structural adjustment should be instituted through a process of analysis and planning, and allocation of appropriate resources to carry out the changes required.
- Family and financial counselling should continue and be linked to programs that provide training in farm business skills.
- Community planning processes should be conducted at a local scale so that residents and landholders are able to identify future actions which need to be undertaken to ensure their ongoing economic and community development.
- Information must be provided to people who are likely to be affected so that they are able to make the best possible decisions. This information must be suitably presented for the audiences.
- The level of service delivery in the regions across a range of agencies must be monitored and alternative service delivery methods should be investigated.

The Salinity Council will commission studies to determine the social impacts of salinity and provide support and resources for existing social services to deliver appropriate financial, personal and family counselling.

5.5 The way forward

None of the tools summarised in this section offers the sole solution, rather they need to be used in an integrated manner.

Generally, it is most effective to plan and address salinity at the catchment scale. This is particularly important when actions in one area may have an impact elsewhere.

Where there may be impacts outside the catchment area, some decisions may need to be undertaken at the regional level. The regional natural resource management groups, through their regional strategies, will be in a position to help in decision-making at this level.

Revegetation under the Greening Challenge program, sponsored by Western Power.
Photo: Agriculture Western Australia

Opposite: Morbinning field day, a chance to share knowledge.
Photo: Landcare Vision

Section 6
Community action to address salinity

6 Community action to address salinity

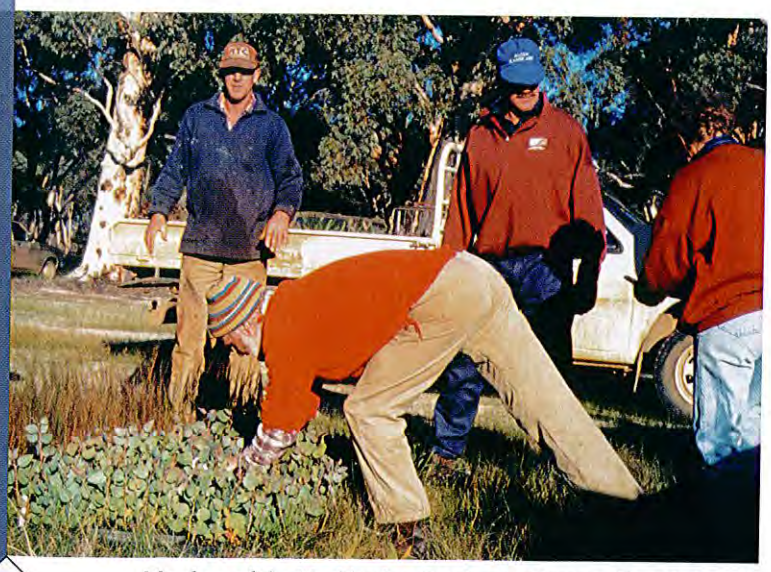
The present organisation of communities and governments means that economic, social, industry development and natural resources management issues are decided along sectoral lines, with responsibilities and decision-making at local and State levels based on industry or interest. Salinity management requires an integrated cross-sectoral approach on a catchment or landscape basis.

The regional and local communities' capacity to initiate and manage change needs to be enhanced and regional communities need to be empowered to develop and implement natural resource management strategies in an integrated manner.

The successful implementation of this strategy requires clear partnership between all stakeholders, including government, industry and the community at all levels. It is important that the efforts of individual landholder to manage salinity are part of the larger strategy at catchment, regional or State level.

6.1 State Salinity Council

The review process of the 1996 Salinity Action Plan identified strong community involvement as an essential component for future salinity and natural resource management in Western Australia.



Members of the Morbinning Catchment Group collect their bulk order seedlings. Photo: Landcare Vision

Through workshop consultation, a new structure and management arrangement has been put into place.

The State Salinity Council has a role in leading and supporting the community in addressing salinity. The Council is formed of representatives from both community and government stakeholder groups and provides a forum for interaction between these groups. The Council is an advocate for action on behalf of the community in its dialogue with government.

Dealing with salinity forces new ways of doing business in terms of strategic development and planning. A cross-sectoral approach is needed if activities are to be complementary. The works on the ground are mostly done by private landholders using their own resources, with some grant assistance, and by government (local and State) on lands they control and through programs they run. The new structure of the State Salinity Council has been developed to facilitate the involvement of all stakeholders in planning and prioritising activities.

All stakeholders need to be involved in the collection, assessment and sharing of information and experiences to build a salinity management strategy. Each stakeholder then takes from the Council the information and commitment relevant to their own responsibilities, having the assurance that it is compatible with other strategies. The structure and method of operation is indicative of the way in which salinity changes the way that society needs to deal with a landscape issue.

The role of the Council is to:

- provide leadership;
- provide strategic advice to the Cabinet Standing Committee on Salinity Management;
- coordinate decisions and activities between stakeholder groups; and
- monitor and evaluate the success of the Salinity Strategy.

The Council consists of representatives from the following organisations, with the Chairperson appointed by the Government. However, the membership of the Council is not fixed and may be varied in the future:

- Chairperson
- Avon Working Group
- Business in Western Australia, represented by Alcoa World Alumina Australia
- Conservation Council of Western Australia
- Environmental community group
- Environmental Protection Authority
- Greening Australia (WA)
- Indigenous representative
- Irrigation representative (initially from the South West)
- Lands and Forest Commission
- National Parks and Nature Conservation Authority
- Northern Agriculture Integrated Management Strategy Group
- Oil Mallee Association
- Pastoralists and Graziers Association
- Rural Adjustment and Finance Corporation
- Saltland Pastures Association
- Soil and Land Conservation Council
- South Coast Regional Initiative Planning Team
- South West Catchment Council
- Swan Catchment Council
- Water and Rivers Commission Board
- Western Australian No Tillage Farmers' Association
- Western Australian Farmers' Federation
- Western Australian Municipal Association
- Agriculture Western Australia
- Department of Environmental Protection
- Department of Conservation and Land Management
- Water and Rivers Commission

The Council in turn elects an executive from its membership, which is endorsed by the Cabinet Standing Committee on Salinity Management. The executive comprises:

- Chairperson (same as Chair of Council)
- One person with experience in primary production
- One person with experience in regional natural resource management
- One person with experience in local government
- One person with experience in conservation issues
- Three additional members (based on merit)

The Chief Executive Officers of Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection and Water and Rivers Commission sit on the Executive in an *ex officio* capacity as full members.

The Council and executive can co-opt people with expertise to help progress particular issues. (The Western Australian Planning Commission would be a good case in point. An appropriate relationship between the WAPC and the Council will be developed.) The executive will be empowered to manage salinity within the context of this strategy. A set of operating rules governs the operation of the Council, executive and other committees.

The Council will receive government funding support and will make arrangements with the agencies for secretarial and executive support.

6.2 Community and government partnerships

The structure and function of rural and regional community groups have been adapting to accommodate natural resource management and in particular salinity management issues during the Decade of Landcare.

South Yoting Catchment Group is one of more than 700 landcare groups in Western Australia.
Photo: Landcare Vision

Over the past 10 years groups of rural landholders have begun working together to achieve mutual salinity management and environmental goals. Over 700 catchment and landcare-related groups operate throughout Western Australia. They have been developing local strategies and plans and undertaking works in partnership with local and State Government agencies, some with support from community landcare coordinators.

The activities of local landholders and groups are important to the implementation of salinity management plans on individual farms and local catchments. Any State strategy will not succeed if action at the local level is not supported.

The capacity of these individuals and groups to achieve change is increasing through a learning process that occurs in the company of their neighbours. There is less risk for individual landholders in trying new approaches for salinity management if they have the involvement of their neighbours, readily available locally-based technical support and the opportunity to learn from other farmers' successes and failures.

Regional natural resource management groups have since evolved in recognition of the need for an integrated, coordinated and "systems" view of natural resource management issues.

They provide an umbrella network for the smaller landcare, environmental and catchment groups and open the possibility of regionally-developed and implemented strategies to address a variety of environmental issues. In the south-west agricultural region of Western Australia there are five regional natural resource management groups: The South Coast Regional Initiative Planning Team (SCRIPT), the South West Catchment Council (SWCC), the Swan Catchment Council (SCC), the Avon Working Group (AWG) and the Northern Agriculture Integrated Management Strategy Group (NAIMS). These groups provide the opportunity to develop effective partnerships between the community, industry and government at the regional level, providing the best means to address salinity.

Natural resource management groups must have increased access to information, skills in conflict resolution and group management in order to be most effective in managing land. In particular, such groups need financial support to identify and implement their strategies to protect natural heritage.

Several production groups also focus on salinity management through their activities. They include the Western Australian No Tillage Farmers' Association (WANTFA), the Saltland Pastures Association (SPA), the Oil Mallee Association (OMA) and the Western Australian Lucerne Growers (WALG).

The development and implementation of actions to achieve this Salinity Strategy will be undertaken through partnerships between all stakeholders, including community groups and individuals from both the urban and rural areas, industry, and Commonwealth, State and local government.

The Government will recognise regional natural resource management groups. Partnership agreements that clearly set out the roles and responsibilities of all parties to the agreement will be established between the regional groups and government agencies.

6.3 Shared investments

The issue of equity needs to be addressed because some landholders will be more affected than others. The whole Western Australian community will be affected and will have to share the costs and the benefits of managing salinity.

The issue of social change and industry adjustment in relation to dryland salinity is complex and more work is required in this area. It is the subject of current research and development under the National Dryland Salinity Program (NDSP).

Landholders have a duty of care to ensure that natural resource degradation does not occur as a result of their action or lack of action, and to undertake remedial works as required. As the greatest beneficiaries of any efforts to combat salinity, they should have a large investment in salinity activities. However, the issue of equity arises. Some landholders have already made significant investments and should not be penalised by being expected to continue to invest at the same level as those who have done little to date.

The equity issue also relates to the position of the landholder in the catchment, either from the perspective of having the greatest potential benefit from any remedial activities, or from the perspective of having to lose the largest area of land to existing activities.

Two main resource issues need to be addressed: the need to coordinate and prioritise investment to ensure maximum impact on salinity; and the need to ensure a continued investment in the long term. This in turn raises the issues of incentive and equity.

There are four key parties in any investment strategy for works on the ground:

- **landholders;**
- **general public;**
- **industry; and**
- **government (local government, State and Commonwealth).**

Gabby Quoi Quoi farmers growing their own trees and shrubs for revegetation. Photo: Landcare Vision

Any or all of these parties may be contributors to activities at the catchment or regional scale. The question is, how much should each party contribute and how can they be encouraged to make the investment?

The following points provide a general overview of the principles that should be considered when developing an implementation plan and considering contributions from relevant parties. These have been modified from a paper developed for the Standing Committee on Agricultural Resource Management (1998), *Principles for shared investment to achieve sustainable natural resource management practices.*

All natural resource users and managers have a duty of care not to damage the natural resource base. However, the landholders who first cleared the land were acting on best practice advice at the time and cannot be held accountable for these past actions. This exemption should not apply to those who continue to clear or exacerbate salinity in the light of current knowledge.

The Government will generally contribute to activities to a level sufficient to trigger further investment towards self-correcting, self-perpetuating natural resource management systems that operate effectively, providing the activities are technically sound, produce outcomes consistent with identified priorities and the benefits justify the costs.

In cases where the work being undertaken does not financially benefit the landholder(s) and there is no duty of care, it is appropriate for beneficiaries to provide some funding. Beneficiaries fall into two categories, and should pay according to the potential level of benefit that the activities will provide:

- *Direct beneficiaries* are landholders (public or private) whose potential income and/or capital value will be increased as a result of the activity.
- *Indirect beneficiaries* are those who will enjoy qualified benefits, such as improved biodiversity, recreational benefits, off-site agricultural benefits, etc.

Activities should generally be undertaken in a partnership between all stakeholders. However, it is accepted that salinity may be only one of a number of issues to be addressed by any catchment or regional plan and that investment, particularly by the landholders, may cover other issues as well.

Coordination of investment should be undertaken at the regional and catchment scale so that resources can be integrated and focused on the priority issues. Regional strategic plans will guide funding priorities at a broad level and catchment management plans should be the primary framework to guide investment at the implementation stage.

The provision of structural adjustment funds through the State or the Federal Government should be recognised as an investment in social equity for the whole of the State.

6.4 Options for cost-sharing

The Western Australian Government currently contributes about $40 million a year to combat salinity. However, the largest investment has come from and will continue to be funded by private landholders. Many landholders have already spent large amounts of money and effort on farming practices and landcare projects to benefit their own properties, catchments and public lands such as waterways and remnant bush. However, some landholders have not contributed significantly to date and, as this strategy has shown, a considerable increase in investment is required.

6.4.1 Commonwealth funding

The Commonwealth Government has also contributed significantly to date through earlier programs such as the National Landcare Program and the Federal Water Resources Assistance Program, and now the Natural Heritage Trust (NHT). The Commonwealth has helped raise awareness and set new directions, and these funding sources have significantly helped to develop strategies and implement on-ground works aimed at addressing landcare and natural resource management issues.

There is a compelling case for continued Commonwealth financial support for the Salinity Strategy. Western Australian urban and rural communities are expected to increase their commitment to help in natural resource management and salinity management and there is a good case for a post-NHT increase of strategic investment from the Commonwealth Government. There is a need for assistance with wider community issues such as conservation of biodiversity as well as the public benefit component of regional implementation activities. Western Australia is further advanced than the Murray Darling Basin in addressing dryland salinity issues and while catchment scale demonstration may be appropriate in the Eastern States, our more mature strategy warrants assistance to regional natural resource management catchment groups.

There are increasing opportunities for research funding through the National Dryland Salinity Program, the Land and Water Resources Research and Development Corporation, the Grains Research and Development Corporation and the Rural

Industries Research and Development Corporation. In addition there is considerable investment by organisations such as CSIRO, universities and farm production groups into various aspects of salinity management.

6.4.2 Corporate funding

In a recent survey by Landcare Australia Limited, 78 per cent of Australians said they would change products if they were linked to landcare. In contrast, only 11 per cent would change products if it would provide funding for sport, and three per cent for the arts.

Corporate funding has been and will continue to be an important component of this strategy. The Western Australian Landcare Trust offers companies an opportunity for tax incentives with sponsorship of landcare and other natural resource management activities.

The Alcoa Landcare Vision model provides a good example of shared investment between a company and landholders. Farmers, through their catchment groups, are supported by agency technical advice and benefit from external financial assistance. This model demonstrates that properly targeted external funding can achieve results. In addition to significant professional support, the six catchments in this project received $40,000 per year over five years, followed by $10,000 a year for a further five years. Members of each catchment group, averaging 15 per catchment, contributed approximately five times this amount during the same period.

Thus, each farmer in the group "received" around $2600 for priority catchment projects and contributed around $13,000 for each year of the project.

The likely development of carbon credit and greenhouse emission trading will also provide new industry funds for revegetation activities that have the collateral benefit of helping to address salinity problems. Carbon farming would form part of the future diversified agricultural systems. However, it should be noted that economies of scale will preclude most farmers trading in their own right and will favour cooperatives or corporate entities such as grower cooperatives or the Oil Mallee Association, which in turn would pass on the benefit.

There is already corporate investment in the bluegum industry through lease and share farming arrangements, following initial investment by the Department of Conservation and Land Management. There will need to be a concerted effort to extend these arrangements into other industries, particularly in the medium and lower rainfall areas.

6.4.3 Public contributions

The general public, particularly in urban areas, has contributed considerable amounts indirectly through taxes, to combating salinity. The threat to biodiversity, public amenities, water resources and infrastructure means more direct input is essential. This would form a shared effort between urban and rural Western Australia.

It is proposed that members of the public, and in particular the urban population, be encouraged to make voluntary contributions to aid in implementation activities. One option that will be explored is a small voluntary levy on a broad-based service.

Tammin's Alcoa Landcare Education Centre is the result of sponsorship from Alcoa Australia. Photo: Landcare Vision

Public funding for implementation activity needs clear reporting and monitoring mechanisms, so that there is confidence in the outcomes of the investment. It is proposed that the Western Australian Landcare Trust is an ideal vehicle to provide this independent role, with the Salinity Council being responsible for determining priorities and best use of these funds.

However, it is recognised that voluntary public contributions will not be sufficient by themselves, and that an on-going structured source of funds will also be required to help rural landholders with the public benefit aspect of their on-ground actions to combat salinity.

Public contributions to salinity through a voluntary levy, to be held by the Western Australian Landcare Trust and administered jointly by the Trust and the Salinity Council, will be investigated. The allocation of all funds collected through voluntary contributions would be reported publicly on an annual basis.

The State Government will establish a significant ongoing funding source for implementation activities aimed at combating or adapting to salinity.

A marketing strategy will be developed to raise the urban community's awareness of and participation in the Salinity Strategy.

6.4.4 Landholder contributions

Most salinity management funding will inevitably continue to come from landholders. However, new mechanisms are needed in order to address equity issues. The Salinity Council has developed an options paper that outlines different mechanisms available to catchment and regional groups to collect local contributions to implement local and regional plans.

It is expected that groups and individuals wanting to access public funds (as described earlier in 6.4.1) will have to demonstrate a considerable local contribution as well as having the proposed activities form part of a catchment or regional implementation plan.

Two specific options are outlined below. Groups will be encouraged to consider raising levies as outlined.

6.4.4.1 Catchment levies

An effective mechanism currently available to raise landholder contributions is through levies determined by Land Conservation District Committees under the Soil and Land Conservation Act and administered at local government level. Government should consider developing a mechanism to allow such levies to be raised at a catchment or regional scale, on the basis that the catchment or region would make the decision to raise the levy.

At present the Soil and Land Conservation Act allows contributions to be based on a percentage of gross unimproved value of the land, or as a flat or variable rate on a per property basis. In order to deal with the issue of equity, particularly where some landholders have already undertaken considerable work, provision should be made for other mechanisms, to be determined by the catchment or regional group setting up the levy.

One possibility that needs further development is to devise a system whereby each landholder is levied an amount that reflects management practices and high water use in that location. Landholder levies could complement a structured public contribution.

The Soil and Land Conservation Council will investigate the option of differential levies on landholders and will promote and encourage their adoption.

A support scheme will be developed and implemented by the State Government to help landholders in:

- **developing innovative land/water use systems;**
- **community capacity building; and**
- **planning and implementing catchment management projects.**

6.4.4.2 Land trading within a catchment group

Land trading would enable catchment groups to discuss the natural turnover of farmers from their area, and see if it can also be organised to allow for:

- specific land "niches" to attract new owners and land uses, including conservation buyers for bush but also possibly some more intensive industries;
- aggregating the cleared and non-saline land into viable properties, the larger areas of uncleared land into viable reserves and salinised land into viable areas to allow for proper management options;
- developing binding cross-boundary arrangements for managing and trading in the excess water; and
- constructively addressing the future of properties becoming non-viable due to salinity.

The Salinity Council will work with the Western Australian Planning Commission and regional groups in order to optimise the potential of market-based land trading solutions.

6.5 Capacity building

"Capacity" refers to the ability of a community or a group of people to pursue their own development. The Salinity Strategy targets capacity building activities to those key areas to do with people that will empower, motivate and enable them, through the provision of skills, resources, networks and information, to protect the State's natural heritage.

6.5.1 Solutions for managing the effects on people

The nature of communities and of people means that they are different, with different needs, varying perceptions and ideas of what will work. It is important that people who are affected by salinity are able to identify those impacts likely to affect them, and be involved in developing solutions to them. The role of the catchment appraisal teams will be integral to achieving this objective.

The layout of this alley farming system is clearly seen from the air. Photo: Agriculture Western Australia

6.5.2 Participation in decision-making processes

The salinity strategy relies on rural people embracing the need for change, whether it is in the ways they manage their land, or the role they play in making decisions for the future of agriculture and rural areas. People's willingness to take on additional responsibility or to try something new cannot be imposed from the outside. Participation in making the decisions – in deciding what needs to be done and how to do it – is integral in solving the problems associated with salinity. Decision-making support systems, research, or solutions for change must all be driven by input from people who will be affected by them.

6.5.2.1 Participatory planning

Farmers work in catchment groups, usually containing 15 to 25 properties. Participatory planning processes used by these catchment groups have led to a more common understanding by the group of landscape degradation processes and potential land use options.

During the planning process the catchment group moves from developing greater technical understanding of their own and their neighbours' farms and together build catchment knowledge. This shared knowledge base at the catchment level is then used to build individual farm plans that focus on cross-boundary actions to achieve salinity management outcomes at a catchment level.

A sense of community is developed by the catchment group members through this participatory planning process. The planning process becomes ongoing with continual resetting of their visions and goals.
The individual risk of trying new treatments is also reduced as experience and knowledge are shared.

Participatory planning processes are the fundamental basis of developing salinity management plans on a catchment and farm basis.

6.5.3 Communication and information

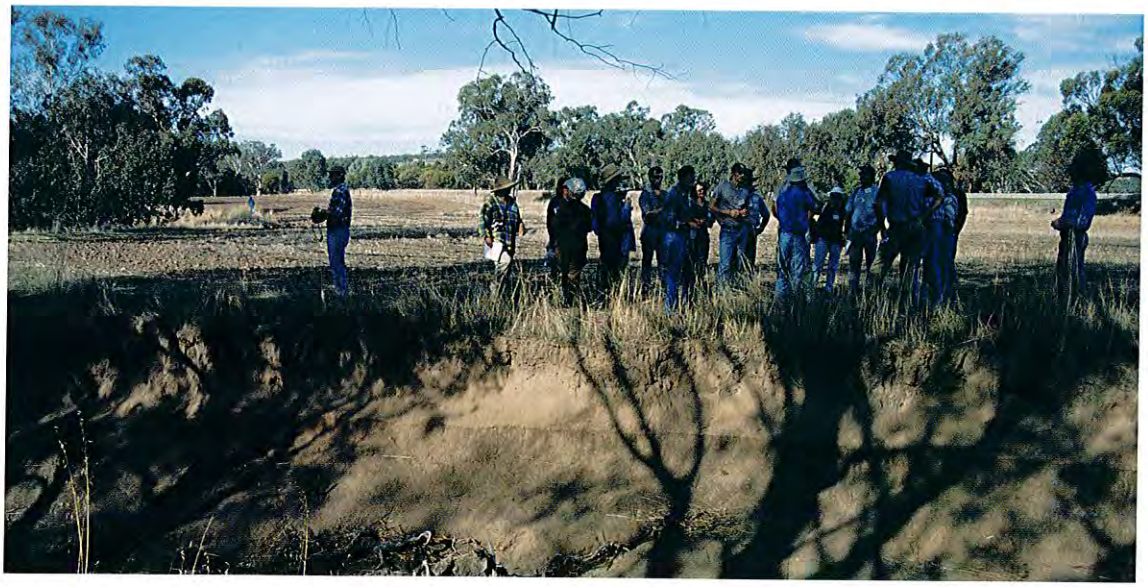
There are many communication and information services and processes already being used by some of the people affected by salinity. These processes include workshops, seminars, papers and videos. A great deal of research has been done into the uptake of information by farmers and rural people, and the findings should be applied to ensure that all users have access to the information they need, in a form they can use.

6.5.4 Adjusting to change in catchments

In the extreme case of salinity impact or where massive changes to land use over a catchment are required to manage salinity, some people may need to move off the land or radically change the land use basis of their income. This will require a process to analyse, plan and allocate appropriate resources for structural adjustment. Confidential rural family support services need to be developed and made available to each farming family.

6.5.5 Knowledge building

For people to be constructively involved in managing land resources, they must know about natural resource management and related economic and social issues, and have the skills to carry out the required work.



Volunteers at a Wheatbelt river restoration workshop. Photo: Water and Rivers Commission

Educational opportunities are already available, but resources must be provided to enable more people to gain the necessary skills. There is also a need to support and expand access to alternative forms of training delivery, such as use of the Internet and other telecommunications opportunities. There is a need for increased involvement of landholders in research and development within the framework of setting priorities and catchment assessment identified earlier in the Salinity Strategy.

Resources should be allocated through the use of new technology, for example, or information sharing forums.

6.5.5.1 Knowledge networks

A great store of knowledge, experience and information on salinity management is held by agencies, landholders and catchment groups in regional areas. This information can be based on science, experience or landscape data.

Most regional natural resource management groups have supported the development of knowledge networks linked to agency landscape data resources. Collecting, storing and managing salinity information for the use of landholders is important to accelerate the adoption of appropriate land management practices.

Community-based knowledge networks provide easily-accessible information. In the long term, landholders will use these knowledge networks, for example the South Coast Regional Information Centre (RIC), Avon Catchment Network and the Swan Catchment Centre, to rebuild their own management plans. They will also store and update their own farm and catchment plans through these types of facilities at the regional level. Salinity management knowledge networks will be supported at the regional level.

Building capacity in the community to manage salinity is a key strategy. To achieve this, improved training opportunities are required.

Several government agencies, educational institutions and other organisations involved in natural resource management provide a range of training courses relevant to salinity management and better linkages will be established between them. The scope of courses is wide and targets formal professional training through to very practical requirements in the community.

Formal training courses in the agricultural, environmental and natural resource management areas exist to train professional advisers. However, many advisers need further training as new techniques and methodologies emerge. There is also a growing demand from landholders for competent technical advice on implementing salinity control measures on a farm-by-farm basis. However, there are limited agency and private industry resources available to help landholders address their specific issues on a one-to-one basis. For this purpose, training of community landcare coordinators and technicians, bushcare workers, advisory personnel from agricultural service firms and prospective consultants from the farming community itself is essential.

The State Government will continue to recognise and support important industry groups such as WANTFA, WALG, OMA, SPA and regional plantation committees.

A concept gaining interest is the establishment of a network of experienced landholders or groups who are backed with some formal training and are acknowledged as a credible source of practical advice and support. This peer advice would complement and integrate with other sources of support.

A customised local course should be developed to equip practising farmers and groups involved in catchment management with the knowledge and confidence to make informed decisions on their own land and water management, and also the confidence and credibility to be consulted, and possibly employed, by other landholders.

Green manuring with sorghum, a warm season crop.
Photo: Agriculture Western Australia

It is proposed that educational institutions collaborate with the Salinity Council and agencies to develop the concept and establish the framework for such a course. The Melbourne University's Master TreeGrowers course has gained wide support from around Australia and it is anticipated that the proposed course could also attract national interest.

The Salinity Council will approach TAFE to coordinate, co-develop and implement technical courses for community landcare technicians.

Agriculture Western Australia will conduct courses on Salinity as a Landscape Problem throughout the agricultural area.

The Salinity Council will initiate a feasibility study, and subsequent development if appropriate, of a Master Land and Water Managers course.

6.5.6 Information provision and barriers to adoption

To be involved successfully in natural resource management, landholders must have good information about the types of support and government services available and how to access them, relevant details about their region, and advice on available management options and strategies. However, there are also barriers to adoption once information is available.

While much is known about the biophysical aspects of salinity, comparatively little is known about the impact of salinity on individuals and communities, and the barriers to adopting salinity control measures. The basic assumption is that landholders are motivated to do something about salinity and all they need is economic and locally relevant options for them to act.

Access to information is only one of the barriers to adoption of salinity management practices. Factors such as the economic state of the farm business, changing market requirements and specifications, family unit and landscape group decision-making processes, attitude to risk, resistance to change and other pressures make the decision more difficult.

A better understanding is required of how to help farmers' decision making on natural resource management and sustainability at the farm and catchment scale, and how associating with peers through membership of production groups and catchment groups may affect these processes. The Land and Water Resources Research and Development Corporation is funding national research in this area and the results will be taken into consideration by Council and research groups.

There is a need to look at what motivates the farmers who are investing now, and how they learn and make decisions. This has implications for communications, teaching and extension methods. Organisations that provide financial and advisory services to farmers also need to understand the implications of salinity for farm businesses and communities and the concepts of natural resource management and sustainability. Successful landcare works performed by farmers will eventually be reflected in the value of their properties.

6.5.7 Leadership development

Leadership within a community is a key factor in developing salinity projects and networks, and in involving others. Existing leadership programs have been successful in building the pool of leaders in regional areas, but more resources need to be dedicated to identifying leaders, especially among young people in regional areas. The concept of what constitutes a leader must also be expanded to include people outside established groups, and embrace different leadership styles.

The Rural Leadership Programs initiated by the Minister for Primary Industry will continue to develop leadership skills in the community.

6.5.8 Community involvement

Successful natural resource management relies on the participation of the landholders as well as the wider community. Communities must become collectively motivated and mobilised to act together to achieve aims and objectives they have identified. The involvement of communities in natural resource management is essential if the wishes and preferences of the community are to be respected in decision making. A great deal of work is being done in this area at present, but wider community recognition of the challenges facing rural areas through salinisation of land, and greater community involvement in implementing the solutions is needed. Effective community participation in natural resource management must continue to be developed through financial support of identified endeavours, good technical support and expertise, and the involvement of a wide range of people, including young people.

6.5.8.1 Indigenous interests and participation

Aboriginal people have a strong connection to the land and are concerned that issues such as salinity must be effectively addressed. They must be given the opportunity to participate in remedial measures to achieve sustainable land use management.

There has been Aboriginal representation on the Salinity Council's Reference Group and an Aboriginal representative will be a member of the restructured State Salinity Council.

6.5.9 Support and advisory services

6.5.9.1 Community coordinators

Facilitators and advisors such as Community Landcare Coordinators (CLCs), Bushcare, Rivercare, Land for Wildlife and revegetation staff, are now a major resource in many communities. They offer many opportunities to their communities to focus on resource management strategically at the landscape level. It is extremely important that all support staff work together to address the issues of the Salinity Strategy.

These trees have been strategically located to create a windbreak, as well as increase water use.
Photo: Agriculture Western Australia

For example, the Natural Heritage Trust Bushcare program has provided funds for the appointment by Greening Australia (WA) and the Department of Conservation and Land Management of Bushcare officers to help community groups with the development, implementation, monitoring and evaluation of Bushcare projects.
These Bushcare officers are based throughout the south-west and provide advice to community groups and landholders on remnant vegetation protection and revegetation.

Similarly, Rivercare officers are employed by the Water and Rivers Commission under the Natural Heritage Trust Rivercare Program. These officers ensure that the Waterways WA program is integrated with other natural resource management programs such as Bushcare and Landcare.

The Government provides support for CLCs, Bushcare, Rivercare, Land for Wildlife and other workers and their management committees.

These positions have been important in the development and implementation of activities that address both salinity remediation and broader natural resource management outcomes.

It is crucial that both Commonwealth and State Governments continue to fund community support services.

6.5.9.2 Private consultants

Western Australian farmers use the services of private consultants more frequently and for a wider range of services than in any other State. While they access financial, agronomy, chemical and animal husbandry services from the private sector, little use is made of resource management advice. There is an increasing number of consultants either specialising in this field or adding this service as a component of wider advice and this trend needs to be encouraged. The opportunity for new diversified industries and the increased capital values of land saved from becoming saline are powerful incentives.

Gabby Quoi Quoi farmers and the Land for Wildlife coordinator checking remnant vegetation.
Photo: Landcare Vision

Opposite: Monitoring water levels on a property planted with bluegums.
Photo: Department of Conservation and Land Management

Section 7
Monitoring and evaluation

7 Monitoring and evaluation

A successful monitoring and evaluation scheme for salinity action must be objective, widely understood, consistently applied and relevant to decision-making at all levels. At grass roots level, monitoring provides a focus for broadening community involvement in salinity action and the outcomes of plans and management responses. The process must be transparent and cost-effective, so that progress can be readily audited and evaluated and informed decisions made.

The monitoring program will provide information to landholders, managers, the community and government on:

- progress towards agreed goals for agricultural systems, water resources, natural diversity, infrastructure and capacity building;
- longer-term biophysical trends and the likely impact of changes in land use management; and
- performance of landholders, community groups and government agencies in meeting their responsibilities and the objectives of their plans.

Soil testing on a Wheatbelt property.
Photo: Agriculture Western Australia

Monitoring and evaluation should be carried out at the property, catchment, region and State scale and will involve all stakeholders. The information and awareness it generates is fundamental on many levels. As a part of initial catchment assessment, adequate data on hydrological status and rates of change are needed to develop accurate synoptic information on salinity status across a particular catchment. Monitoring and evaluation will enable us to gauge the success of property, catchment and regional level plans and activities, and their specific environmental, social or economic targets and outcomes.

Experience to date shows that on-the-ground monitoring provides many opportunities for broadening community involvement in salinity action, through meaningful contributions (through work effort or sponsorship) from young people, special interest groups, schools and community organisations as well as from the corporate and industrial sectors.

The Department of Environmental Protection is developing a list of indicators to monitor and evaluate the actions implemented under the Salinity Strategy. They include input and output measures and environmental outcomes for the strategy and for environmental management as a whole being undertaken against the background of salinity. The draft indicators are being examined by both Government and private enterprise and assessed for their ability to monitor and evaluate the needs of the strategy effectively and efficiently. The methodologies used and the costs involved with implementing a monitoring program for each indicator will also be defined.

An inventory of existing government salinity monitoring programs will be extended from a review of current resourcing for monitoring activities to anticipate the future levels of monitoring required and to examine all options for their funding.

A specific program of monitoring a sample of wetlands and their associated flora and fauna throughout the south-west agricultural region was put in place under the 1996 Salinity Action Plan and will continue consistent with the overall Monitoring and Evaluation Plan.

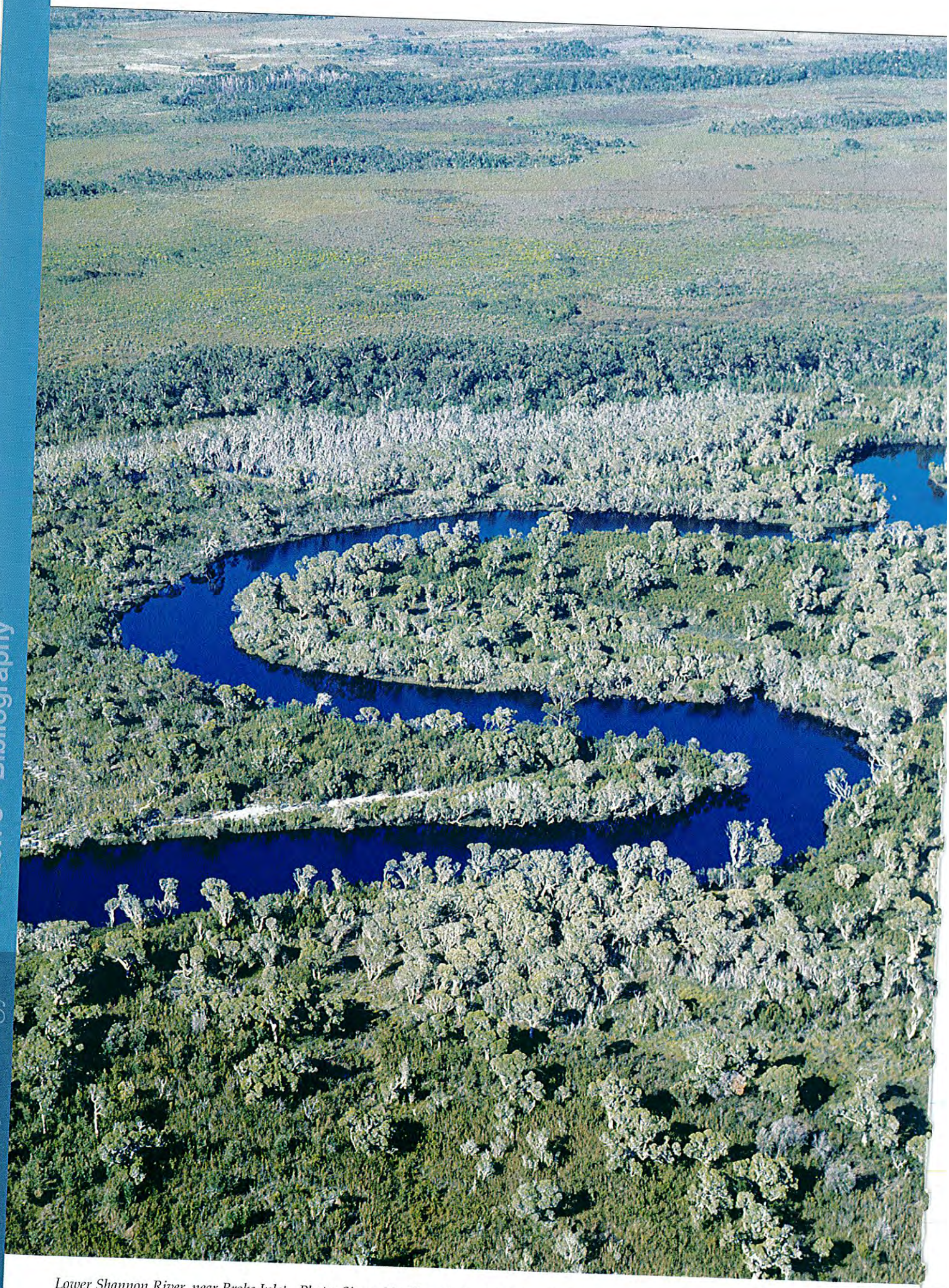
The Department of Environmental Protection will help agencies, regions and catchment communities to determine environmental objectives and criteria for salinity management, and to monitor their incremental achievement.

The monitoring and evaluation sub-committee of the Salinity Council will produce a Monitoring and Evaluation Work Plan.

The State Government will continue to support projects such as Land Monitor, Saltwatch and Ribbons of Blue.

Salinity Council and government agency support for farm monitoring tools, such as those developed by the Land Management Society, will be maintained.

Testing salinity levels at Cuballing.
Photo: Water and Rivers Commission



Lower Shannon River, near Broke Inlet. Photo: Simon Neville – Ecotones/Water and Rivers Commission

8 Bibliography

Barrett-Lennard, E.G. and T. Griffin, and P. Goulding (1999). "Assessing areas of saltland suitable for productive use in the Wheatbelt of WA: A preliminary assessment for the State Salinity Council", Perth.

Clarke, Christopher, Richard George, Paolo Reggiani and Tom Hatton (1999). "The effect of recharge management on the extent and timing of dryland salinity in the Wheatbelt of Western Australia: Preliminary computer modelling". Results of a six-week modelling study carried out for the State Salinity Council, Perth.

George, Richard, Christopher Clarke, Tom Hatton, Paolo Reggiani, Alan Herbert, John Ruprecht, Sally Bowman and Greg Keighery (1999). "The effect of recharge management on the extent of dryland salinity, flood risk and biodiversity in Western Australia: Preliminary computer modelling, assessment and financial analysis". Results of a two-week modelling contract carried out for the State Salinity Council, Perth.

Government of Western Australia (1998). Western Australian State of the Environment Report, Perth.

Government of Western Australia (1998). Western Australian Salinity Action Plan Draft Update, prepared by the State Salinity Council in association with community groups and government agencies.

Government of Western Australia (1996). Western Australian Salinity Action Plan, Perth.

Government of Western Australia (1996). Salinity: A situation statement for Western Australia, Perth.

National Dryland Salinity Program (1998). Management Plan 1998-2003, Canberra.