1. Introduction

1.1 Purpose of the Corangamite Soil Health Strategy

The Soil Health Strategy aims to guide investment in a range of actions that will protect and enhance natural and built assets in the Corangamite region from a number of soil-based threats or threatening processes.

The Soil Health Strategy (SHS) identifies specific assets that should be protected or enhanced, the various threats and the asset managers and other stakeholders who have been involved in its development and will potentially be involved in its implementation.

This introduction provides the background and current context of the strategy including concepts of 'soil health' as an asset, important natural resource and built assets that are under threat, features and characteristics of the Corangamite region and other topics that 'set the scene' for the strategy.

Strategy objectives

Principal objectives:

- improve the understanding of soil-based threats to private and public assets
- develop the logic and implement the processes that identify priorities for investment that meet Victorian and Australian government guiding principles
- identify suitable and feasible actions to address identified priority threats to assets
- formulate implementation guidelines and principles
- define and explore opportunities to create mutually beneficial partnerships with other strategic natural resource management plans, contexts and investors
- raise the profile of soil health management with specialists and the wider community in the Corangamite region
- develop a range of suitable targets to measure the effectiveness and success of implementing the SHS.

Soil health as an asset

In their natural, undisturbed state soils tend to be 'healthy', in that they support local life in various forms that is adapted to the characteristics of the local soil.

Activity – principally human activity in the pursuit of agricultural, forestry or urban development and their ongoing enterprises – tends to disturb or even degrade soil health.

Healthy soils support their natural local ecosystems. Disturbance disrupts these systems. In many cases, disruption leads, sooner or later , to unintended consequences for other natural assets – such as waterways, biodiversity, vegetation – or leads to impacts on built assets such as human habitation, roads, pipelines and other structures.

Unintended consequences of urban and agricultural development may include but are not limited to deterioration in water quality, secondary salinity, erosion or landslides. These consequences are referred to in this strategy as 'threats'. Elements of the natural environment and the built environment are referred to as 'assets', which may be impacted by the threats.

Maintaining soil health is one way to help protect natural assets – many of which are invaluable and irreplaceable if lost. Maintaining soil health – for instance, maintaining slopes in a condition that tends to lessen the risk of landslips or landslides – will help to lower the chances of rocks and soil falling into and probably contaminating downslope creeks. In this case, apart from the asset of farm land being lost, the asset of 'water quality' would be affected by stream contamination. Of course, landslides may also have effects on a range of built assets – for example roads, railways, urban or rural houses and buildings.

This strategy identifies a suite of soil-related threats and a range of natural and built assets in the Corangamite region that are at risk.

Once disturbed, soils are unlikely to ever be returned to their natural undisturbed state but actions to maintain and improve soil health have benefits that extend far beyond the individual public or private landholder, right through to the wider community in the region, the state and the nation.

This strategy, although focused on soil health, recognises that soil health is closely linked with river health, biodiversity, salinity, water quality and other issues outlined in the Regional Catchment Strategy (CCMA 2003).

Resources available for managing soil health in the Corangamite region include:

- partnerships between asset managers, investors and collaborators
- technical resources developed within public and private entities that link research and practice change – in some cases best management practices specific to soil-related threats
- effective and demonstrated outcomes from soil health projects implemented in the Corangamite region over recent years
- definition and understanding of the nature and distribution of threats in relation to assets.

History of developing the Corangamite Soil Health Strategy

The Corangamite Regional Catchment Strategy identified the need for a more strategic approach to soil health. As a result, the Corangamite CMA commissioned a Discussion Paper in 2003 that assessed the potential value of a soil health context for its investment decisions. Findings from this paper supported the need for a soil health strategy (MacEwan 2003).

Following the successful application for funds through the National Action Plan (NAP) for Salinity and Water Quality, the Corangamite CMA commissioned the development of a soil health strategy. The Victorian Department of Primary Industries (DPI) was commissioned to develop the strategy under the guidance of a Steering Committee and Technical Working Group (Appendix J).

With the support of NAP funds, the first draft of the strategy was developed from September to December 2003. During this period, the soil-based threats were identified and their severity assessed. This activity showed that there was little documented information for the majority of the threats that was specific to the Corangamite region.

During the September to December 2003 period, assets in the Corangamite region were identified and given some initial ranking. Soil and landform data (Robinson et al 2003) were used to classify the susceptibility of the region's soils to a range of degradation processes.

A land use impact model (LUIM) was used carry out a regional assessment of the likelihood degradation based on current land use practices (McNeill and MacEwan 2004).

Attempts were made to determine the risk that threats were posing to assets, but this activity was judged unsuccessful due to the limited quantity and quality of data.

Actions were also developed that would enable stakeholders to address the threats; management action targets (MATs) were developed, predicting the likely uptake of various management practices. An economic consultancy firm was engaged to carry out a benefit-cost analysis – mostly private assets, (for instance, agricultural production).

Funding was not granted to complete the strategy in the 2003/04 year. However, NAP funding was regained for further development of the strategy in 2004/05 and 2005/06. During this time, NAP funds were used to identify the distribution of erosion, landslides and acid sulphate soils. With additional information to hand, new processes were developed and a risk-to-asset analysis was conducted for many threats recognised in the strategy.

During the development of the SHS, it became clearly evident that a number of important actions needed to be taken without delay. Several are progressing well, even before this strategy is confirmed and released.

Some of these actions have helped build improved definition and understanding of the distribution and activity of threats. Actions that are currently underway include:

- mapping soil erosion and landslides in the Corangamite region
- developing Erosion Management Overlays for the City of Greater Geelong and Colac Otway Shire
- assessing the risk of acid sulphate soils in the City of Greater Geelong
- mapping soil erosion and landslide susceptibility at 1:25,000 for the Corangamite region
- delivering priority soil extension activities, such as field days, whole farm planning courses, accreditation of soil training activities and developing information packages
- stabilising erosion sites threatening priority waterways and other high-value assets.

1.2 Understanding the regional environment

Social aspects of the Corangamite region

The Corangamite region covers approximately 1.3 million hectares of south-west Victoria, with a human population of approximately 400,000 in 2006; population is increasing at around 5% per annum (Thomas & Collier 2002).

Nine local government municipalities lie within the catchment – the City of Greater Geelong, Surf Coast Shire, Colac Otway Shire, Ballarat City, Golden Plains Shire, Moorabool Shire, Corangamite Shire, Pyrenees Shire and the Borough of Queenscliff *(Fig.1.1)*.

Ballarat and Geelong are expanding, encroaching on surrounding rural areas. The spatial distribution of the population within the Corangamite region is changing, with significant expansion in the coastal areas as well as the Ballarat to Geelong 'corridor'. The northern parts of the Colac Otway and Corangamite shires have been suffering significant population decline. The population of farmers, who manage more than two thirds of the land in the Corangamite region, is at best stable, but more likely falling, particularly in the broadacre farming areas.

Figure 1.1: Municipalities of the Corangamite region

Climate in the Corangamite region

Climate in the Corangamite region is temperate. Rainfall is predominantly in winter and spring, and is greatest along the ridge of the Otway Ranges in the south (1500 mm – 1800 mm) and the Western Uplands in the north (1000 mm – 1100 mm). The central Victorian Volcanic Plain experiences much lower rainfall (500 mm – 600 mm), with the lowest rainfall recorded east of the Brisbane Ranges (400 mm – 500 mm) *(Fig.1.2)*.

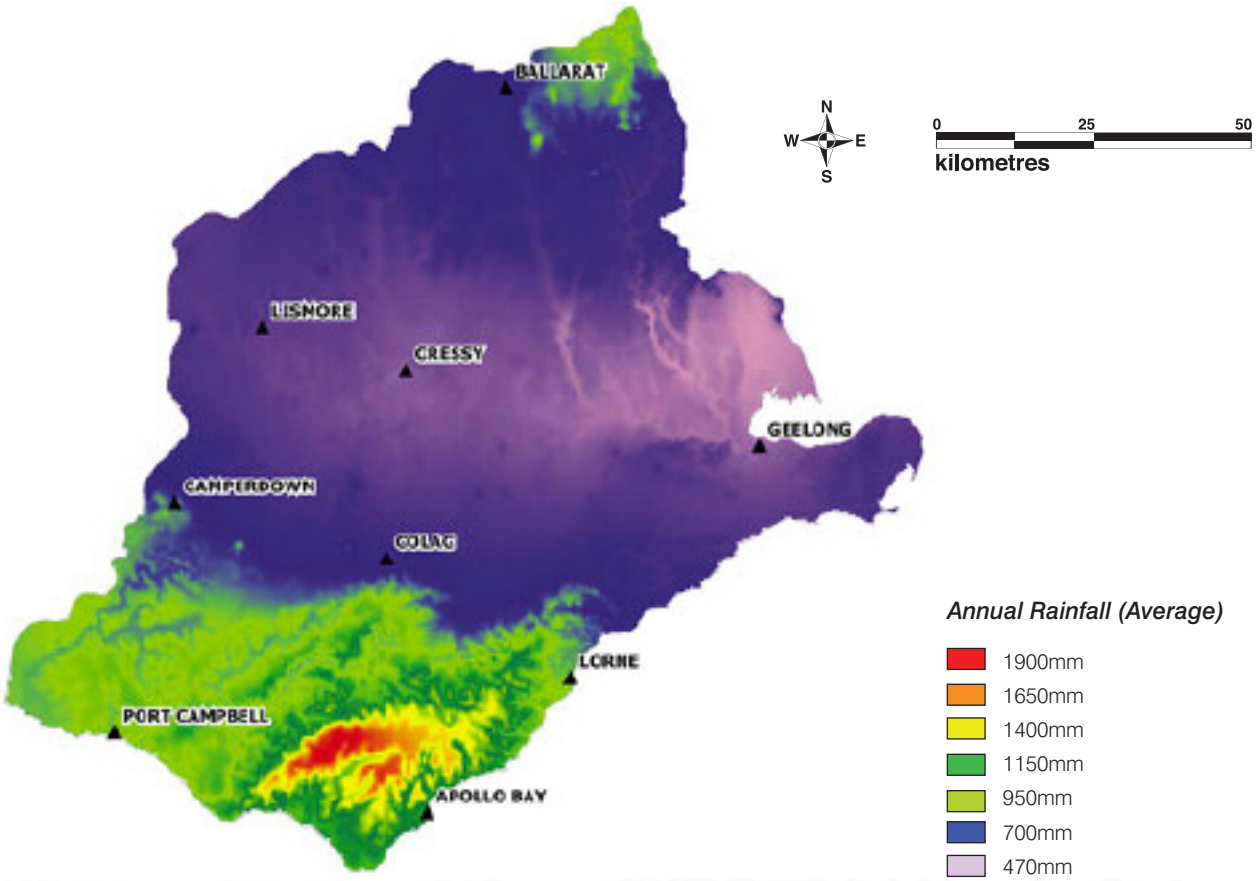

Figure 1.2: Annual average rainfall in the Corangamite region

Landforms and geology in the Corangamite region

The Corangamite region comprises some of the most spectacular landscapes in Victoria, including coastlines, volcanic features and lakes that are of international significance. These landscapes occur in a variety of geological settings.

The evolution of landscapes throughout the Corangamite region reflects the events of the geological past, which included mountain building, continental break-ups, vast periods of erosion, large changes in sea levels and climates and volcanic eruptions. The region is characterised by three major geomorphic divisions (Joyce *et al.* 2004), *viz*. the Victorian Western Uplands, the Victorian Southern Uplands and the Victorian Western Plains *(Fig. 1.3).*

1. Victorian Western Uplands

Dissected uplands form the northern highlands of the Corangamite region, which are characterised by a variety of interwoven landforms preserved by substantial uplift during the past 50 million years. Undulating hills and broad valleys characterise the landscapes formed on folded sedimentary rocks and granite plutons formed around 450 to 350 million years ago. Remnants of an ancient plain, formed about 40 to 30 million years ago, occur as caps of gravels sporadically distributed at various elevations. A remnant of the sands deposited during the retreat of the sea around four million to two million years ago fringes the southern bedrocks as a dissected tableland. Around the same time, volcanic eruptions filled the broad valleys to form elongate basalt plains and a variety of other volcanic landforms. The last remnants of this period of volcanism are the prominent volcanic cones of Mount Buninyong (745 m), Mount Warrenheip (741 m) and Tipperary Hill (743 m), which are now the highest elevations in the Corangamite region.

Three river systems drain the dissected uplands of the Corangamite region – the Moorabool River (east), Leigh River (central) and Woady Yaloak River (west). The waters in the Moorabool River are utilised for urban supply to the cities of Ballarat and Geelong, as well as a number of smaller towns. Both the Moorabool and Leigh rivers join the Barwon River system to the south, whereas the Woady Yaloak River feeds Lake Corangamite, a saline wetland of international importance and Victoria's largest permanent inland lake. Within this geomorphic province, increasing salinity, nutrients and turbidity are the dominant threats to the health of the waterways and water bodies of the region.

2. Victorian Southern Uplands

The southern portion of the Corangamite region is dominated by the Victorian Southern Uplands, which form the deeply dissected Otway Ranges, moderately dissected Barrabool Hills and low hills of the Bellarine Peninsula. All three landscapes have been formed by the uplift of structurally controlled blocks of lithic sedimentary rocks around 140 to 100 million years old (i.e. the Otway Group rocks). The Barrabool Hills and Bellarine Peninsula are smaller fault-bounded uplift blocks at lower elevations than the Otways.

The headwaters of the major river in the Corangamite region – the Barwon River – drain the northern slopes of the Otway Ranges. The Barwon River is an important urban water supply for the City of Greater Geelong. The Gellibrand River, Aire River and other smaller waterways drain the Otway Ranges to the sea.

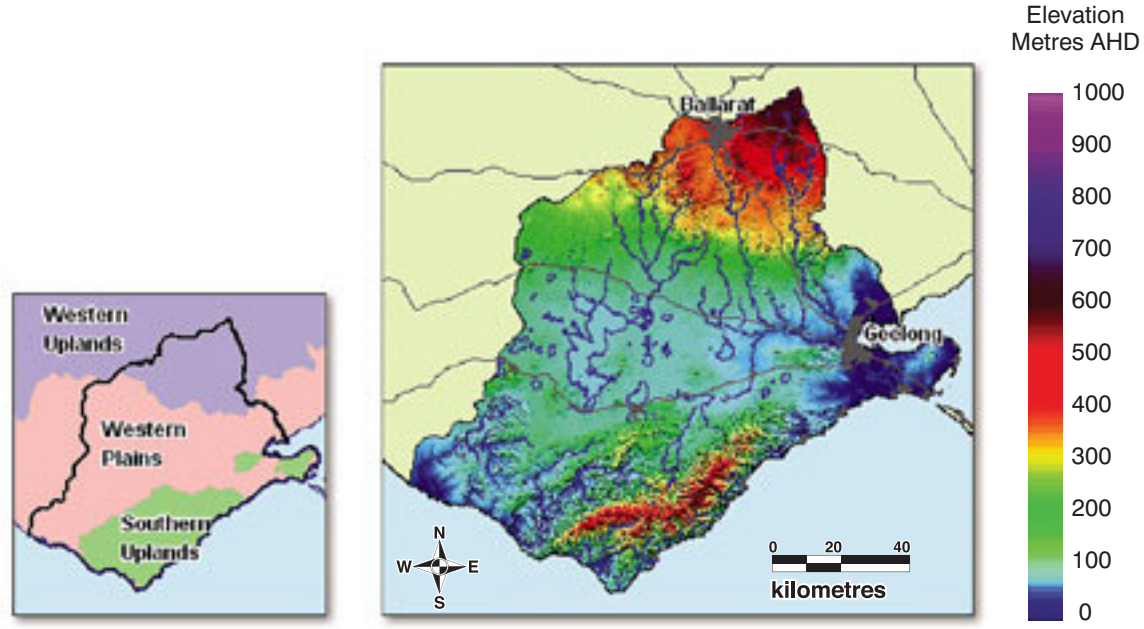

Figure 1.3: The three major geomorphic divisions (Joyce et al. 2004), and the elevation of land throughout the Corangamite region

3. Victorian Western Plains

The central Corangamite region lies within the Victorian Western Plains, the largest of the three geomorphic units which comprise undulating plains formed on both volcanic and sedimentary rocks. Volcanic plains make up the majority of the geomorphic unit, apart from the south-western portion, where dissected sand plains around two to four million years old overlie marls (geological unit), which is approximately 25 to 15 million years old. The volcanic eruptions commenced around four million years ago, forming plains of basalt, and concluded around 50,000 years ago with stony rises and scoria cones as more recent features. Exposures of the underlying Pliocene Age sands occur in places not covered by the volcanic eruptions or where the landscapes have since been dissected. Lakes and wetlands are the most important assets of the Western Plains, with the largest being Lake Corangamite.

Soil types in the Corangamite region

Soil types in the Corangamite region reflect the great diversity of their geological origins, landforms, climate, age and degree of weathering. Soil type, topography and local climate tend to exert a strong influence on land use. Soil types were mapped as part of the Land Resource Assessment (LRA) investigation carried out by Robinson *et al.* (2003). They identified and mapped over 200 soil-landform types in the Corangamite region.

Soil types in the Corangamite region can be simplified according to eight basic geology units *(Fig. 1.4)*. A description of soil properties and land use types in these geological units includes:

1. Palaeozoic sedimentary rocks

These are older soils that generally exhibit naturally low levels of plant nutrients. Together with underlying dispersive subsoils, they are susceptible to gully and tunnel erosion. These soils are generally used for conservation, grazing and forestry, with limited areas of crop production in flat terrain.

2. Palaeozoic granitic rocks

These are older soils that have shallow depth of topsoil, poor structure and lower levels of fertility. The areas where these soils dominate are mostly dedicated to conservation, forestry and broadacre grazing. These soils are prone to a number of soil threats, particularly water erosion.

3. Cretaceous sedimentary rocks

Soils developed on these rocks vary from shallow stony soils and brown gradational soils in the Otway Ranges, to clay loams and brown duplex soils of the Barrabool Hills. The soils are used for forestry, grazing and dairying, with conservation as the dominant land use. Highly susceptible to landslides, tunnel erosion and gully erosion, these soils are also prone to nutrient decline and waterlogging.

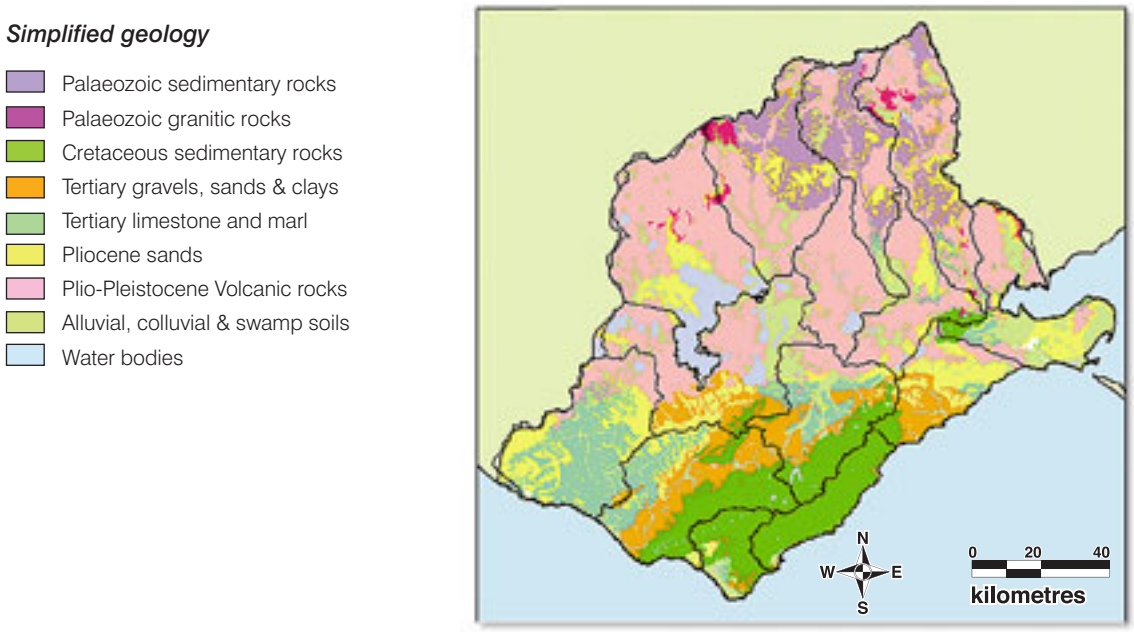

Figure 1.4: Simplified soil types in the Corangamite region, based on soil parent materials

4. Tertiary gravels, sands and clays

These soils, developed on gravels, sands, silts and clays, exhibit the most variability of the geological units. They range from grey sand soils through mottled gradational soils to sodic duplex soils with ironstone hardpans. These soils are highly susceptible to all forms of erosion by water and are nutrient deficient. They support all land uses, with forestry, grazing, dairying, cropping and conservation being dominant.

5. Tertiary limestone and marl

The soils developed on the limestones and marls are mostly gradational soils, with some dark well-structured soils on the limestones. They are dominated by dairying and grazing and are prone to waterlogging, compaction (pugging) and landslides.

6. Pliocene sands

The soils of the sand plains and gently undulating landscapes vary in their sand, silt and clay content. They vary from gradational sandy loams to sodic duplex soils to podsolic soils developed on iron cemented 'coffee rock'. These soils mainly support cropping, forestry, grazing and dairying. They are prone to water and wind erosion, nutrient decline and acidification.

7. Plio-Pleistocene volcanic rocks

The volcanic soils are the most widespread and variable soils in the Corangamite region. Some of these areas have arguably the most valuable agricultural soils in the Corangamite region, such as the krasnozems found predominantly, though not exclusively, in the north-east of the region *(Fig. 1.4).* These soils are characterised by high natural fertility, great depth, good structure (stability, water infiltration rate and aeration) and are generally devoted to rotational potato cropping. If left bare of ground cover over winter, they can also be subject to sheet and rill erosion.

On the broad volcanic plains, these soils vary from duplex soils with heavier subsoil layers which are more prone to waterlogging, to the shallow, stony, well-drained gradational soils of the stony rises and volcanic cones. These soils are generally used for broadacre cropping, grazing and dairy farming.

8. Alluvial, colluvial and swamp soils

Small areas of alluvial, colluvial and swamp soils include the calcareous sandy soils of coastal dunes, sandy and clay loams of lake-bordering lunettes, grey gradational soils of river flats and black organic heavy clays of swamps. Many of these soils have developed with impeded drainage and are often sodic, saline and prone to waterlogging. Sandier coastal and lunette soils are susceptible to wind erosion and nutrient decline.

1.3 History of land use and its implications for soil health

Land use in the Corangamite region

The Corangamite region supports a diverse range of land uses. The large urban centres of Geelong, Ballarat and Colac are supported by many smaller towns, villages and hamlets dispersed throughout the region. Peri-urban areas are generally found close to the larger regional centres.

The Corangamite region supports many categories and types of agricultural and horticultural enterprises, including wool production, lamb, beef, dairy, cereal crops, oilseeds, row crop vegetables, viticulture and intensive animal production.

There are a number of conservation areas, particularly along the coast in the Great Otway National Park. Forestry is conducted on public and private land. There are a number of mining enterprises in the region *(Fig. 1.5).*

Significant events for soil health management

Soil health management in Australia, Victoria and more locally in the Corangamite region has gone through a number of phases since European settlement. Listed below are selected milestones in the history of soil health in Victoria in general and the Corangamite region in particular.

1. Land clearing for farming, timber and fuel production, gold mining and other land uses in the late 1800s and early 1900s brought rapid reduction in the quantity and quality of vegetative cover in the region. During this period, hoofed animals were introduced and wetlands were drained for agricultural purposes. A significant change in the condition of soil and water resources was caused by these activities (EWR 2006).
2. Soil nutrient decline across Australian soils was recognised late in the 1900s. Nitrogen and phosphorus deficiency were recognised by 1900. In the 1930s and 1940s, many trace element deficiencies were identified. Mineral fertilisers were developed and distributed, enabling large tracts of land previously nutrient deficient for farming, to be devoted to agriculture (EWR 2006).
3. In Victoria, severe soil erosion in the 1930s and 1940s resulted in the establishment of major, state-wide soil conservation programs. The Soil Conservation Authority (SCA) replaced the Land Conservation Authority in Victoria and was a body corporate under the Soil Conservation and Land Utilisation Act 1949 (1958).

4. Improved management of vegetative cover on farm land, resulting in a reduction of erosion, occurred from the late 1940s as a result of the use of subterranean clover and improved grazing management techniques in rotation with cereal crops accompanied by the widespread use of superphosphate fertiliser (EWR 2006).
5. Land appraisal techniques and concepts of land capability were introduced in the 1950s.
6. Rabbit control programs, including the release of the myxomatosis virus, occurred in the 1950s, significantly reducing soil erosion hazards and enabling more effective rehabilitation of rabbit warrens.
7. The Soil Conservation and Land Utilisation Act was introduced in 1958.
8. Whole farm planning concepts were promoted in the 1960s (EWR 2006).
9. Techniques with beneficial soil protection attributes (minimum tillage, trash retention, chemical weed control) were introduced in the 1980s (EWR 2006).
10. In 1983, the SCA was merged into the Department of Conservation Forests and Lands.
11. Secondary salinity management programs were introduced in 1985.
12. Integrated catchment management concepts were put into practice in the late 1980s (EWR 2006).
13. Understanding of acidification problems through investigations occurred in the 1990s (EWR 2006).
14. The Catchment and Land Protection Act was introduced in 1994.
15. In Victoria, ten catchment management authorities were formed in the late 1990s. These authorities have developed regional catchment strategies, setting the framework for other, more specific natural resource based sub-strategies (including soil health).
16. The soil extension program was introduced into the Corangamite region in 2000. DPI delivered this program for the Corangamite CMA. Activities have focused on raising the Corangamite community's awareness and capacity to treat soil threatening processes. The program was implemented on a demand-based approach.
17. The concept of asset-based approaches to investment in natural resource management was developed and introduced in 2002.
18. The Minister for the Environment endorsed the Corangamite Regional Catchment Strategy in 2003.

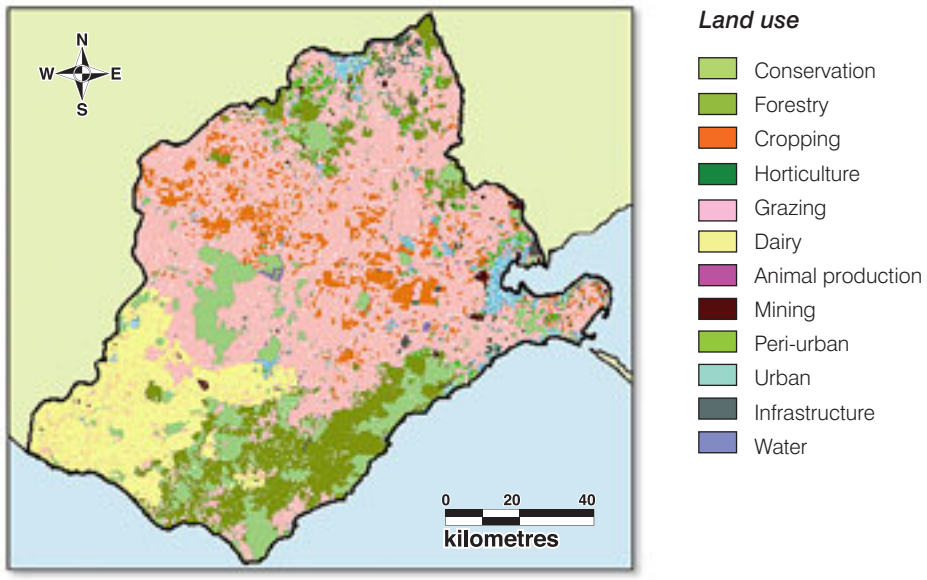

Figure 1.5: Land use in the Corangamite region

1.4 Linkages to national, state and regional contexts

This Soil Health Strategy focuses on the Corangamite region. As a regional document, the strategy links to Victorian and Australian strategies and fits within the broader framework set by their foundations, logic and direction. The Corangamite Soil Health Strategy aims to dovetail into and in as many respects as possible, work closely with the wider state and national strategies, gaining more effective natural resource management outcomes all round.

National contexts

Although there are no specific strategies linked to soil health at a national level, there are several that relate to other, closely related natural resource management (NRM) issues. Specifically, this Soil Health Strategy has a close and a direct association with:

- Commonwealth legislation, e.g. *Environment Protection and Biodiversity Conservation Act 1999; Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- Commonwealth policy, such as the National Strategy for Ecologically Sustainable Development
- the National Action Plan for Salinity and Water Quality
- Managing Natural Resources in Rural Australia for a Sustainable Future: A discussion paper for developing a national policy.

State contexts

A soil health framework for Victoria, 'Victorian State Soils Framework Draft' is currently being developed by the Victorian Department of Primary Industries. This will contribute to a broader understanding of soil health within DPI, across agencies and in the wider community. It aims to identify the key principles about soil health that include but are not limited to:

- improved understanding of soil health and its attributes
- better informed investment decision making for DPI and other providers
- better management of soil as a primary asset in farm business and industry sectors.

The draft Soils Framework suggests a legislative context that will enable investments in soil issues to be directed by an assessment of needs and potential benefits. The framework may also help to coordinate farm management principles across a broad range of agricultural enterprises and industry sectors.

A number of other Victorian frameworks and strategies also relate to the Corangamite Soil Health Strategy. These frameworks are not necessarily soil specific, but relate to soil health:

- *Victorian Archaeological and Aboriginal Relics Preservation Act 1972*
- *Catchment and Land Protection Act 1994*
- *Conservation, Forests and Lands Act 1987*
- *Environment Protection Act 1970*
- *Flora and Fauna Guarantee Act 1988*
- *Planning and Environment Act 1987* Victorian Planning Policy Framework; Municipal Strategic Statement – Local Planning Policy Framework
- *Victorian Fisheries Act 1995*
- *Water Act 1989*
- Management of Victoria's Ramsar Wetlands – Strategic Direction Statement
- Victorian Salinity Management Framework
- Victorian River Health Strategy
- Victorian Biodiversity Strategy
- Victorian Native Vegetation Management Framework 2002
- Victorian Pest Management Framework
- Waters of Victorian State Environment Protection Policy (SEPP).

Regional contexts

The Soil Health Strategy is a sub-strategy of the Corangamite Regional Catchment Strategy (RCS) *(Table. 1.1)*.

The RCS sets the broader framework for natural resource management sub-strategies in the Corangamite region.

The RCS:

- has been developed in partnership with the Victorian and Australian governments and the Corangamite community
- provides a focus for on-ground actions and investment in land and water management within the region
- follows the principles of community involvement through partnerships with regional stakeholders and the integration of activities across policy development, investment, program implementation and outcomes.

The development of strong partnerships with these existing catchment programs offers huge potential for the Soil Health Strategy (SHS) to add value to current and future soil health initiatives. Greater catchment benefits can be achieved by working together than by working alone.

Essential to the process of working together is an understanding of other catchment programs and the identification of areas where mutually beneficial outcomes can be achieved. *Table 1.1* describes the objectives of each strategy in the Corangamite region and how they link to the SHS.

Document	Main Objectives	Links to the Corangamite Soil Health Strategy
Regional Catchment Strategy (RCS)	Direct NRM in the region and coordinate integration between strategies.	Provides an overall context for the SHS to link in with other regional strategies to provide multi-benefit outcomes.
Research and Development Strategy (RDS)	Identifies research and development needs of all NRM issues that fall under the RCS.	Outlines the soil health-related research and development requirements to be considered in the SHS.
Salinity Action Plan (SAP)	Aims to maintain those primary and wetland salinity areas recognised as an asset to biodiversity, and reduce the risk of secondary salinity through recharge and discharge management.	Both the SHS and SAP aim to address secondary salinity. The SAP will be the primary strategy addressing secondary salinity. The SHS will integrate with the SAP and may address high-risk areas outside SAP target areas. The SHS will assist the SAP to address the risk of secondary salinity.
River Health Strategy (RHS)	Protect the health of waterways, including water quality, riparian vegetation etc.	The SHS aims to address those soil-based threats posing a risk to water quality for priority waterways identified in the RHS.
Water Quality Strategy (WQS)	To monitor and understand water quality trends in waterways.	The SHS aims to understand the relationship between soil-threatening processes and water quality, and to set up monitoring sites that help investigate the impact of erosion and other threats to water quality.
Wetlands Strategy (WS)	Protect and enhance significant wetlands.	The SHS aims to implement actions to address soil-based threats posing risks to wetlands.
Native Vegetation Plan (NVP)	Protection and enhancement of native vegetation and biodiversity values.	The SHS aims to address soil-based threats posing a risk to significant vegetation.
Weed Action Plan (WAP)	Controlling weeds in priority areas.	The SHS aims to maintain soil health to increase its resilience to the introduction of noxious weeds.
Rabbit Action Plan (RAP)	Controlling rabbit populations in priority areas.	The SHS needs to work with rabbit-control programs to ensure that disturbance by rabbits does not compromise on-ground remedial works to control soil movement.
Landcare Strategy (LS)	Support for stakeholders implementing actions.	Developing partnerships with Landcare groups to improve soil health management is essential for the success of the SHS.

Table 1.1: Soil Health Strategy linkages with other natural resource management initiatives in the Corangamite region