South East Drainage and Wetland Strategy 2019

Government of South Australia
South East Natural Resources Management Board

Government of South Australia
South Eastern Water Conservation and Drainage Board

Acknowledgements

Sincere thanks to the members of the Drainage and Wetlands Strategy Subcommittee, composed of members of the South East Natural Resources Management

Board and South Eastern Water Conservation and Drainage Board, for their expertise, enthusiasm and advice. The development of the Strategy was supported by technical input from key staff of the Department for Environment and Water who freely contributed their extensive knowledge about the landscape, wetlands, water management, drainage and regional issues and priorities.

Glossary

The Strategy - South East Drainage and Wetlands Strategy

SE - South East

SE NRM - South East Natural Resources Management

SEWCD - South Eastern Water Conservation and Drainage

SEAFG - South East Aboriginal Focus Group

MDB - Murray-Darling Basin

MOU - Memorandum of Understanding

NRM - Natural Resources Management

EPBC Act - Environment Protection and Biodiversity Conservation Act 1999

DEW - Department for Environment and Water (SA)

MAR - Managed Aquifer Recharge

Foreword

We are proud to present the South East Drainage and Wetlands Strategy to guide management of surface water in the region. The South East Natural Resources Management(SE NRM) Board and South Eastern Water Conservation and Drainage(SE WCD) Board have come together to prepare this strategy, with knowledge and input from the community.

We heard from the community about the importance of retaining water in our landscapes to recharge groundwater and for water dependent ecosystems. Wetlands are a big part of our region's identity and we value their diversity, the habitat they provide for wildlife, and their beauty.

We also heard from landholders about the big issues they face with inundation of their land and impacts on economic productivity. Having a lot of surface water to manage would seem an enviable problem to much of Australia; but when water is in the wrong place at the wrong time, managing it to support agriculture and the environment can be complex.

The South East has always been home to landscapes that are sometimes dry and sometimes wet. The climate is expected to get drier in spring which may reduce inundation issues, but there may be more intense rainfall events. This will create different challenges for the drainage network and maintaining wetlands, and we are planning for these changes.

The Strategy will guide management at a regional scale and in local catchments. It will be implemented through the management of the drainage network and by both Boards pursuing opportunities to address strategic priorities and working with landholders to manage water and restore wetlands. This strategy will help us to get the balance right in managing surface water for the future, and we look forward to working together with you to implement it.

Fiona Rasheed
Presiding Member SE NRM Board

Frank Brennan
Chair SEWCD Board

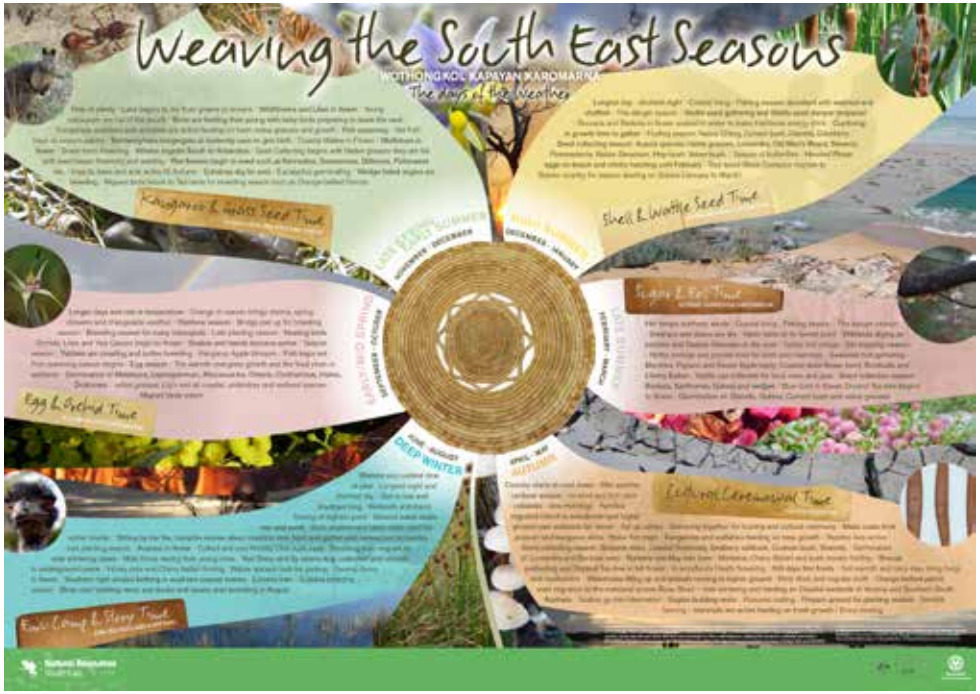
Cultural values of water and wetlands

For Aboriginal people, freshwater systems are the lifeblood of Country. Water, the land and all living things are spiritually and physically connected.

For us, if didn't have water, we would have nothing. Plants wouldn't grow, animals wouldn't be able to survive, there would be no food for us, birds wouldn't be able to nest in the water, we wouldn't be able to get out there and get all that. For us to not to have water would be a terrible thing. Uncle Cyril Trevorrow

To us it's like a supermarket, you go into Woolworths and buy everything, we go to a water hole and get fish, meat, duck eggs, vegetables - you have everything there at the waterhole. Uncle Major Sumner

It was lovely to go out and get all that wild tucker. Aunty Valda Brennan



The South East has been referred to as the Kakadu of the south, providing food, medicines and other resources supporting rich diverse Aboriginal cultures and healthy lifestyles. Our ancestors modified surface water flows and pools to trap food and farm the landscape. As shown in the Weaving the SE Seasons Calendar, Aboriginal cultural values are intricately linked to all aspects of the region:

Water is life. Uncle Kingsley Ahang

It means so much to us in way of health and food. We didn't have cars to drive into town and stock up. In those days we depended on water for our survival. Kangaroo, emu, ducks, swan eggs, all sorts of things important to us because that's our source of food. Aunty Gwen Owen

Today Aboriginal spiritual connections and cultural obligations to country remain strong. Where there is access, community members still visit wetlands, waterways and sites to connect to country and totems. They still hold stories about the landscapes – about creation, animals and languages.

Craitbul was a giant Hero of the Boandik Tribe. He was very tall, but he was still very afraid of an evil spirit named Woor. All Craitbul wanted to do was live in peace with his wife and two sons where he could be far away from Woor. They built a home at the top of Mount Muirhead and cooked fish in a special oven they built. They lived peacefully for a long time until they heard the cry of a Bullin bird, which was a warning that evil spirits were around. So the family moved from where they were and hid amongst some rocks. When the sun rose they gathered food and walked to Mount Schank to find a sheltered place, where Woor wouldn't find them. However once again they heard the Bullin bird, which scared them enough to move again. This went on for many nights and Craitbul and his family continued to dig other ovens elsewhere, but for some reason water came up from the bottom of the ovens and put their fires out. This occurred four times (the Valley Lake, Blue Lake, Browne's Lake and Leg of Mutton Lake). Finally Craitbul and his family moved higher and higher to a cave near the top of a mountain. Here no water spurted up, no Bullin cried and life was peaceful once more.

(Brunato 1975)

Aboriginal communities worry about the decrease in both water quantity and quality through the landscapes since settlement. They are worried about the changes to physical environments and water regimes. The changes to water flows have affected populations of plants and animals. For example, there used to be far more ducks than swans, and now swans are more dominant. Pest species, drainage, vehicles and development can also impact on the cultural values of wetlands, coastal lakes and native species.

During drought, the swans didn't nest, for two or three years we couldn't go out and collect swan eggs, because swans were not nesting due to lack of water. This was a bad because I couldn't take my kids out on the water like my dad took me on water to collect eggs, it was a sad thing because I couldn't teach my kids for a few years. Now water is back I have since taken my kids out on the lake walked through the water and reeds collecting eggs teaching them our cultural beliefs our cultural habits. Uncle Cyril Trevorrow

Look after your water, your lakes. Don't let people pollute it.

Aunty Valda Brennan.

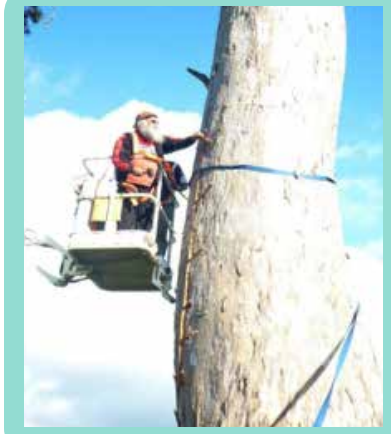
When governments ask us how many mega litres, and gig'a litres we need, I think it's a horrible question. For us, water was there all the time, we didn't have to rely on pipes to bring it down to us.. I think making sure everything is healthy and strong, and making sure there is always water in our water ways, this is a better thing, rather than to say we need this much!

Uncle Cyril Trevorrow

The South East Aboriginal Focus Group and the Ngarrindjeri Regional Authority continue to work to identify cultural values of Country. It is important to recognise that talking about the extent of loss of wetlands in the landscapes of the region, can sometimes be difficult. These discussions can inadvertently raise feelings of grief for what has been lost. This puts a spot light on our shared custodial responsibility to try to restore and maintain water in the landscapes.

The message from the South East Aboriginal Focus group is: Our role in land management is to bring back the landscapes so that the creation stories can be told in their right context. We are keen to work with the SE NRM and SEWCD Boards, and the community to:

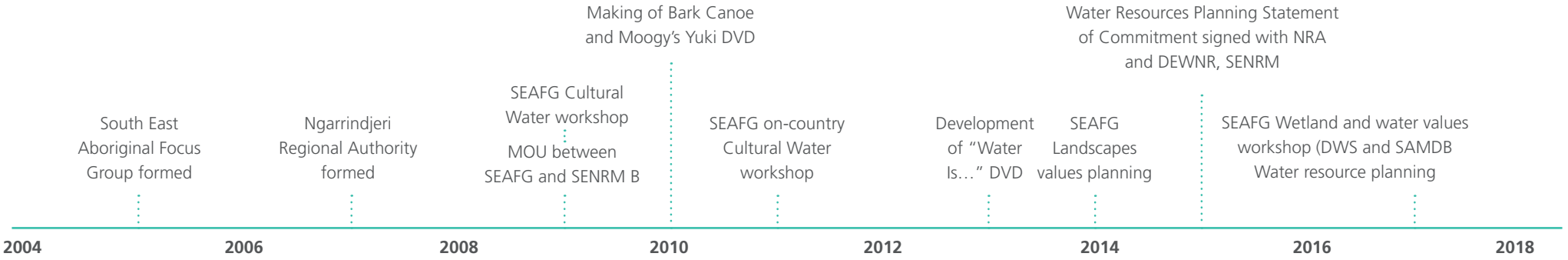
- Restore wetlands and water flows
- Include Aboriginal input and knowledge in decision making about priorities for wetland watering and in restoration works
- Maintain water quality (e.g. rush seedlings won't establish when the salinity is too high)
- Use Aboriginal waterways assessment as an approach to share knowledge of regional Aboriginal sites and stories.
- Support the community to value the importance of healthy wetland systems in supporting other land uses (e.g. agriculture)
- Be included in other issues that relate to water in the future.



Moogy's Yuki project 2010

NRSE supported the making of a traditional style Yuki (canoe) from a ***Eucalyptus camaldulensis*** or River Red Gum tree on the edge of a wetland in Kalangadoo.

This project taught the making of the Yuki, highlighting cultural connection to wetlands from a cultural science and cultural economic perspective.



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Part A

Regional Overview

Why do we need a strategy?

The South East region stretches from the southern lagoon of the Coorong to the Victorian border and supports diverse agricultural industries built on a base of rich natural resources. Productive soils, a mild, wet climate and abundant groundwater support the many businesses, communities and wetlands of the region.

Abundant water on or near the surface is a defining characteristic of the region, reflected in the many wetlands and the green pastures strewn across the landscape.

The regional landscape has been altered substantially as it has been developed. Drainage and the diversion of surface water are now widely used to support transportation and productivity and to manage the impacts of water on the low lying parts of the region in wet seasons. Deeper drains, in the more saline north of the region, were designed to help manage the impacts of salinisation.

Drainage has had a profound impact on the availability of water in the landscape. Prior to drainage, around 50% of the region was seasonally or permanently flooded wetland habitat. Now less than 6% of the original wetland extent remains and most of that is in poor condition. Those wetlands that remain in good condition are important for tourism and recreation and are some of the most visited and iconic features of the region. These significant wetlands, and those that are degraded, require active management to restore or maintain their values.

Today the 17,000 wetlands of the region and primary production sit side by side in a drying landscape, both dependent on and impacted by the availability of water and our management of it.

Community values and concerns about managing surface water

The SE WCD and SE NRM Boards have heard from the community in workshops and surveys about how they value water and its management. The following points are raised consistently:

- people strongly value wetlands, both the well known ones and those on their own properties
- in localised areas that are regularly impacted, farmers are concerned about the impact of flooding and waterlogging on productivity
- people see fresh, good quality surface water as a valuable natural resource that should be retained in the region to support regional values, including wetlands and to recharge groundwater
- the climate is getting drier over time and there is concern about the impacts of reduced rainfall on water availability.

Surface water is water, still or flowing, on the surface of the land, including water in drains, wetlands and creeks. Surface water can come from rainfall or be groundwater that has expressed at the surface.

The region has never had a comprehensive region wide strategy to guide management of surface water and wetlands. Over the decades, much has been learnt about surface water management and wetlands, and management practices have adapted. Recognising this, the SE NRM Board and the SEWCD Board have collaborated to produce the South East Drainage and Wetlands Strategy. The Strategy pulls together information from many sources promote a common understanding of the issues faced and how the management of surface water and wetlands can be improved.

The Strategy will:

- set over-arching objectives and long-term outcomes for surface water management in the region
- identify opportunities for improving our management of surface water to make the best use of water
- describe the threats and challenges that need to be addressed in each catchment
- provide a framework for landholders, organisations and community to follow to help them understand and manage threats to wetlands
- guide the SEWCD and SE NRM Boards to make decisions about, and set priorities for, surface water and wetland management.

A landscape shaped by water

The South East region is basically a limestone plain, which slopes gently down from the Victorian Border, over the Naracoorte Range and on towards the west and the north, punctuated in the south by volcanic cones and sinkholes.

Across most of the region there is not enough fall to create channelised creeks and rivers. The exception is in the Naracoorte Range where there are a small number of very important natural creeks.

The Tatiara, Nalang, Morambro, Naracoorte and Mosquito Creeks all contribute substantial volumes of surface water to the region from their catchments that cross the border with Victoria.

The most notable physical surface features that influence surface water movement are the low parallel dune ranges that were deposited over the past 700,000 years as the sea level successively rose and then retreated. Figure 1 shows the elevation change across the region with the dune ranges and interdunal flats. On average the interdunal flats have a fall of only 1m every 2 kilometres (east to west).

Historically, in wet years, surface water flowed slowly to the west until it hit a range. Water pooled along the eastern side of each range, forming broad swamps. In wet years these swamps overflowed onto extensive floodplains that directed water to the north towards the Coorong.

Map 1 shows the major dune ranges across the region and the historical patterns of flow pre-drainage. In the South East groundwater and surface water are integrated parts of the regional water system, in constant exchange with each other.

Groundwater resources, at or close to the surface, underpin agriculture, viticulture, dairy, production and manufacturing industries, and also support the ecological, social and tourism value of wetlands and swamps.

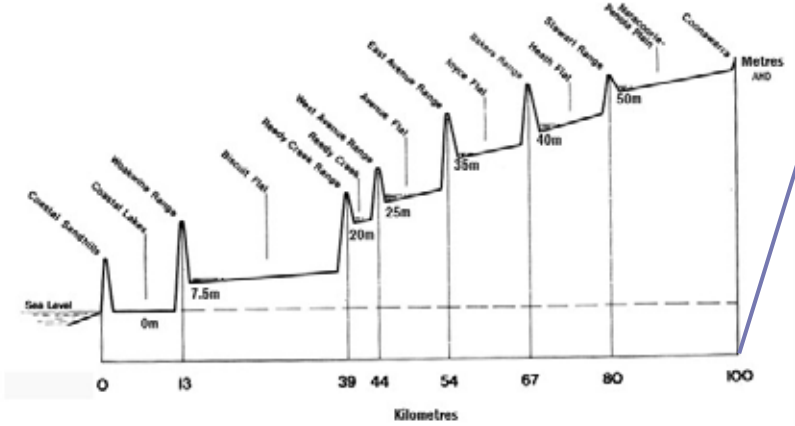
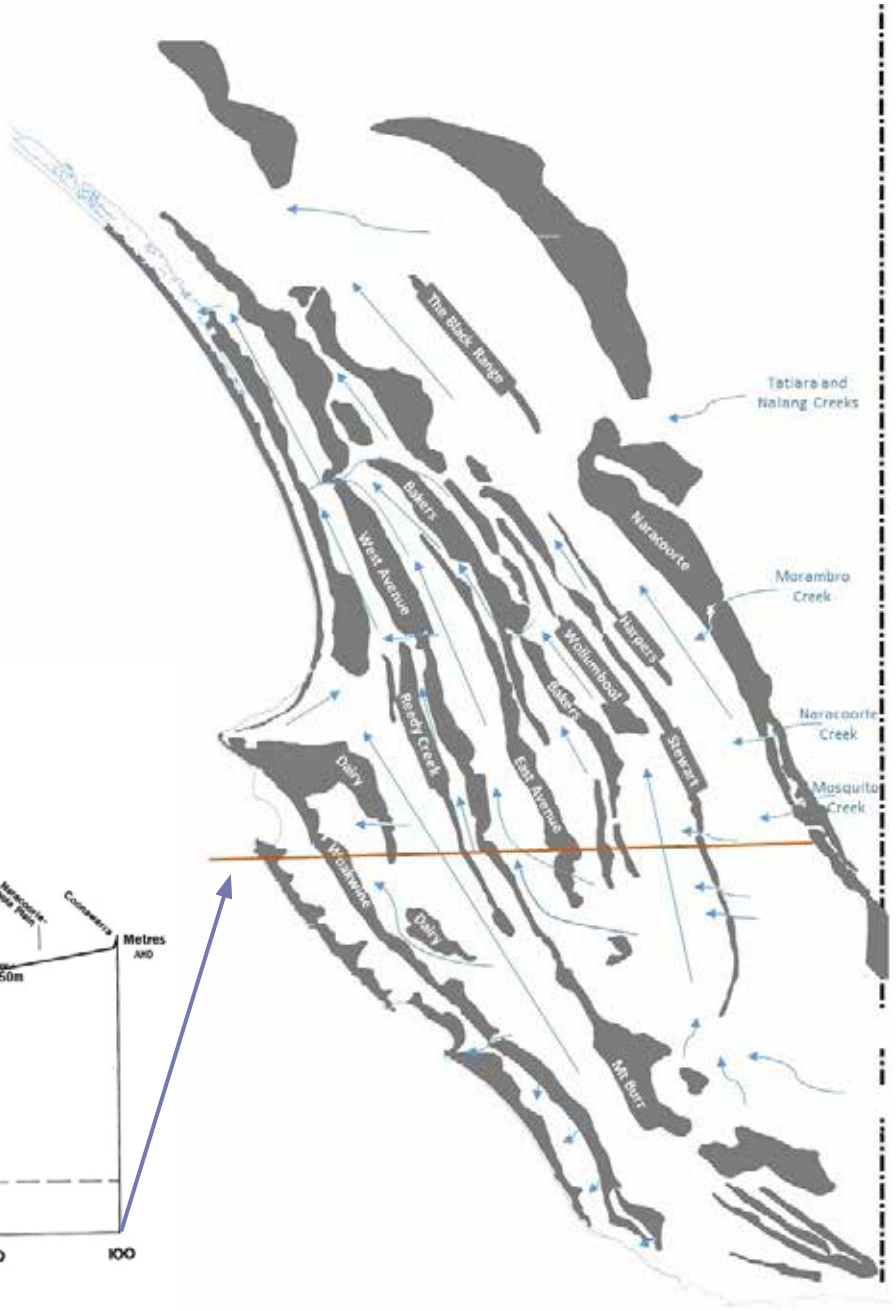


Figure 1 Elevation transect: coast to border

Adapted from (Roe et al, 1980)



Map 1. Major ranges and flow paths: pre drainage

A long history of drainage

Almost as soon as Europeans arrived, the first drainage works commenced in the Lower South East. Major works sought to breach the dune ranges so that water could flow more directly to the sea.

Reports by early Europeans give an idea of how wet the landscape was.

Mr Hanson (Secretary to the Public Works Commissioner) in 1863:

"The character of the country is very peculiar, no large river exists and there are not high mountains to form a watershed and force the drainage, by a strong fall, into any particular channel. The consequence of this is a number of lakes, lagoons, and swamps which in the winter are of considerable depth and in the summer, by evaporation and soakage, are nearly dry." (Roe et al, 1980)

Mr Goyder (Surveyor-General) on the same trip observed:

"After a moderate rainfall the water forms into a series of lakes connected occasionally by shallow channels…until a certain depth has been attained, after which the valleys are transformed into wide parallel sheets of water, with channels in their deepest parts, flowing in the direction of the outlets..." (Roe et al, 1980)

Drainage commenced in the early 1860s near Millicent and Port MacDonnell, and the majority of public drains in the mid to lower South East were constructed between 1949-1972, largely to remove waterlogging for agricultural productivity and transport accessibility.

Drainage in the central and northern parts of the region occurred primarily through the 1990s-2000s as part of the Upper South East Dryland Salinity and Flood Management Scheme. This scheme was initiated to address flooding, salinisation of agricultural land, and to improve wetland condition.

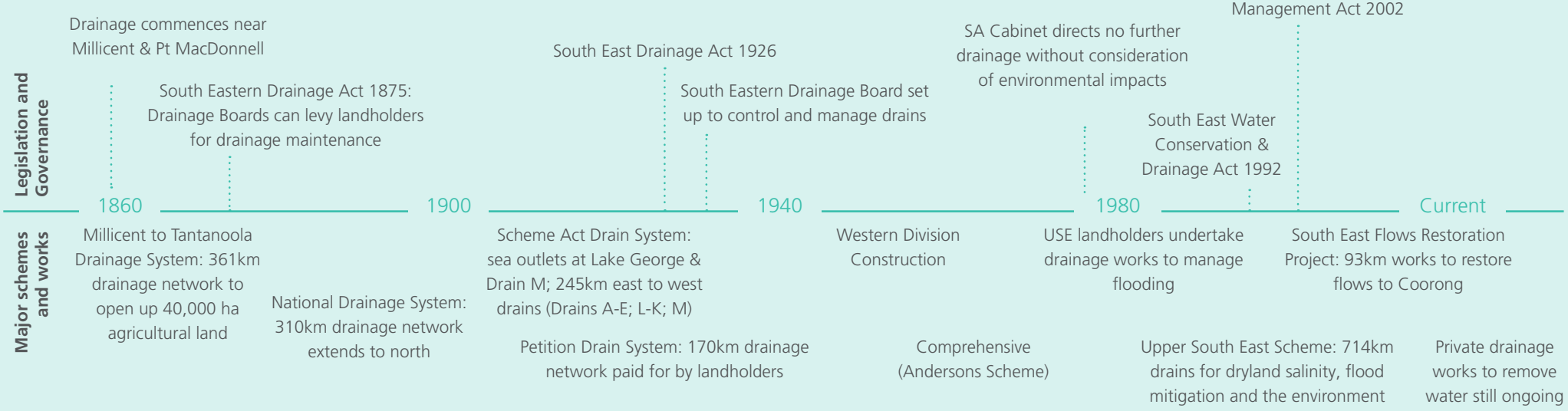


Figure 2 Simplified timeline of drainage schemes and governance

Rainfall in the South East

Rainfall trends

Rainfall is the key climate variable that drives the amount of standing surface water and flow in the region, it is incredibly important for maintaining wetlands and for replenishing groundwater resources.

Long term averages are a useful indicator of trend, but looking at more recent rainfall patterns gives us a more relevant climate basis for decision making.

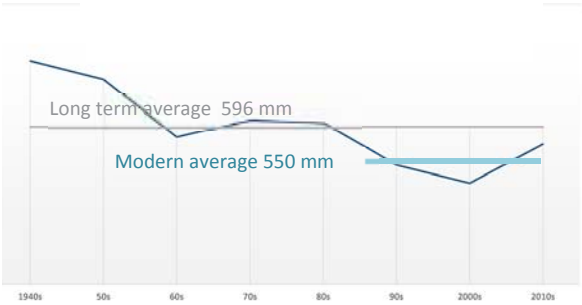


Figure 3 Rainfall (mm) average by decade for Lucindale.

For example, the Lucindale weather station (Bureau of Meteorology) in Figure 3 shows the long term (1940-2017) annual average rainfall is 596 mm, but the modern average (1978-2017) is 550mm.

Lucindale is used for illustrative purposes as it is a centrally located station, but a similar pattern is seen across almost all of the weather stations in the region. Declining trends are more pronounced in the north of the region with rainfall declining every decade between the1980s and the end of the 2000s at most weather stations, as shown in Table 1.

Table 1. Annual average rainfall (mm) across the region

	Decade Average (mm)					Long term average	Modern average	Millennium drought	By 2030 forecast
	1940s	1980s	1990s	2000s	2010s	1940-2017	1985-2017	2001-2009	projec-tions
Keith	470	473	463	433	425	466	436	443	442
Frances	547	537	523	459	511	527	506	453	495
Lucindale	688	609	527	510	581	596	550	496	562
Millicent	795	721	662	720	746	732	705	708	680
Mount Gambier	777	695	697	695	740	711	712	717	660

Wet vs Dry

In the South East, the extremes of wet and dry years have the most impact on water availability in the landscape. And extremes are pretty common, in fact an average (or normal) year occurs roughly only 30% of the time. Figure 4 shows the pattern of dry, average and wet rainfall years for Lucindale.

A dry year is a year where annual rainfall is >10% below average, a wet year is >10% above average and normal years occur in between.

Dry periods, or droughts occur where more than three dry to average years occur together but cumulative rainfall remains more than 10% below average. The late 1990's and the millennium drought are key examples of dry periods.

In the 40 year period, 1978 -2017, in Lucindale:

- 12 dry years (yellow)
- 15 average years (pale blue)
- 13 wet years (dark blue)
- 1992 was a very wet year
- 2006 was a very dry year
- during the millennium drought 2003, 2004 and 2007 were average years but there were no wet years at all
- 2000 was the only wet year between 1992
- and 2010
- a generally wet period from the late 1970s until the early 1990s, except for a very dry year in 1982.

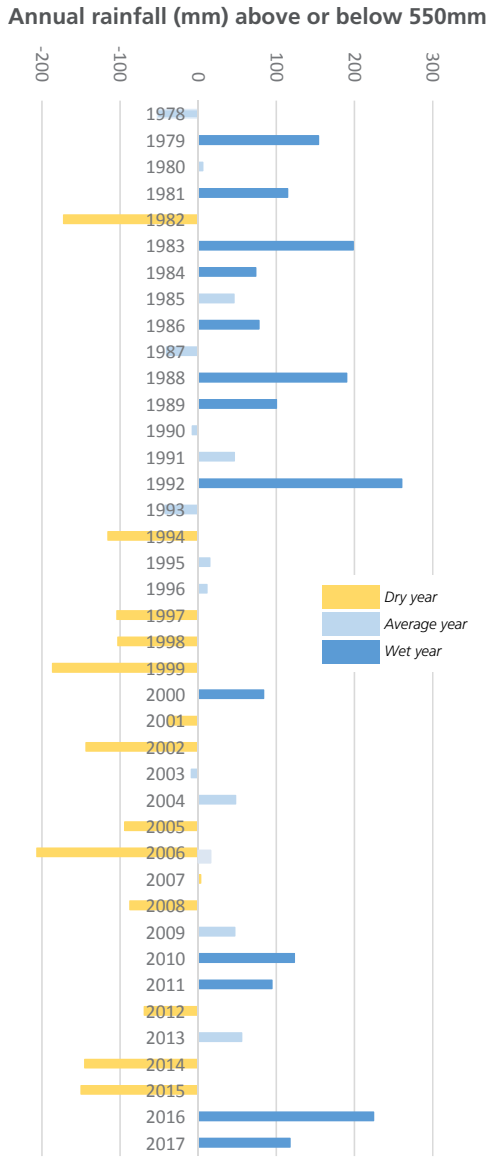


Figure 4. Rainfall patterns at Lucindale

The South East: sometimes wet, sometimes dry

The amount of surface water in the landscape varies from year to year, and it is challenging to predict in advance if a year will be wet or dry. Therefore management has to be adaptive and responsive as seasonal conditions develop.

Wet conditions

Rainfall is consistent and heavy through winter and spring (sometimes kick-started by heavy summer and autumn falls).

Eventually the soil profile is wet through so excess rainfall becomes run off or sits in low lying parts of the landscape.

Challenges

Management options are limited by the design capacity of infrastructure and drainage infrastructure is intensively managed to meet demands of primary producers.

Drains flow to full capacity for a period of months. Their design capacity may eventually be exceeded.

Localised flooding/waterlogging is a challenge for primary producers in low lying areas for weeks or months.

Wetlands and drains are full so water moves very slowly.

Large volumes of water are diverted to the sea.

Opportunities

Most wetlands are full, frogs call and breed, and puddles in paddocks become nurseries for ducks, swans and brolgas.

Flushing flows through wetlands remove salt, rejuvenate plants and promote breeding of many species.

There will be good quality water available to divert to the Coorong, if required, or to other wetlands on the drainage network.

Aquifers are recharged.

Average conditions

Rainfall is moderate and consistent throughout winter and spring. An average year following a wet year may still result in substantial run off if the landscape is very wet.

Localised flooding of low lying agricultural areas may occur and drains may reach full capacity in spring.

Challenges

Management decisions must constantly balance making best use of water with demands for drainage service over winter.

Many wetlands will not get sufficient water from local sources in an average year, and water may not be available long enough for many species to finish breeding or raising their young.

Water quality is likely not to be optimal in the Upper South East for at least part of the year as drains carry saline groundwater.

Opportunities

The moderate amount of spring flow that occurs is important for maintaining wetlands and is managed carefully to satisfy demand at priority sites.

There are no large scale flooding issues unless a large amount of rainfall falls in a very short period of time.

Dry conditions

Low rainfall across the region results in very low, or no flow. The cross-border creeks have very little flow, if any, and any pools dry completely or become stagnant.

The landscape is very dry and only deeper wetlands and drains receiving permanent groundwater inputs are wet and some of these may dry back a lot.

Challenges

Soil moisture levels drop so groundwater weirs are shut to hold available water in drains and improve soil moisture near drains.

Managing small refuge pools that are becoming drier and more stagnant is difficult, refuge pools are important in dry periods to sustain populations of local fish species.

Terrestrial plants will establish in former wetland habitats if prolonged dry periods occur.

Water in drains and wetlands becomes more saline due to evaporation.

Opportunities

During dry periods, there is widespread drying of the landscape, which may make areas that were formerly too wet for activities like cropping, temporarily accessible.

Cleaning and maintenance of drains can be undertaken when they are dry.

Who manages surface water?

Private landholders and the community play a key role in managing wetlands, lakes, drains, creeks, floodplains and surface water on their properties. Many wetlands occur on private land and are highly valued and actively managed by landholders.

All landholders have a duty of care to make sure that their water management activities do not cause harm to other landholders and the environment. Landholders need approvals to construct or alter private drains, dams, creek crossings, levees and other activities in watercourses or floodplains.

The South Eastern Water Conservation and Drainage Board plays a key operational role in surface water management as set out in the South Eastern Water Conservation and Drainage Act 1992, including:

- managing and maintaining the public drainage network to support productivity and water dependent ecosystems.
- providing advice and issuing licences for private drainage works such as drains and flood levees.

The SE Water Conservation and Drainage Board sets out its short term strategic and operational goals in its Management Plan every three years.

The South East Natural Resources Management Board plays a significant role in developing policy and planning tools for water management as set by the Natural Resources Management Act 2004, including:

- developing the Regional NRM Plan that guides water management in the region
- developing Water Affecting Activities policies for management of activities
- developing Water Allocation Plans that manage use of prescribed water resources. Water Allocation Plans in the region are largely focused on prescribing groundwater.

The SE NRM Board also supports the management of surface water and wetlands by:

- providing advice and issuing permits for Water Affecting Activities (dams, creek crossings, excavating soil or removing vegetation in or near watercourses and wetlands).
- providing advice about wetland management and supporting projects to conserve wetlands.

The SE NRM Board sets out its short term strategic and operational programs in its Business plan every three years.

The only surface water resource that is prescribed in the region is Morambro Creek. Morambro Creek was prescribed to manage increasing diversion of water from the creek to address increasing salinity in the adjacent Padthaway groundwater resource.

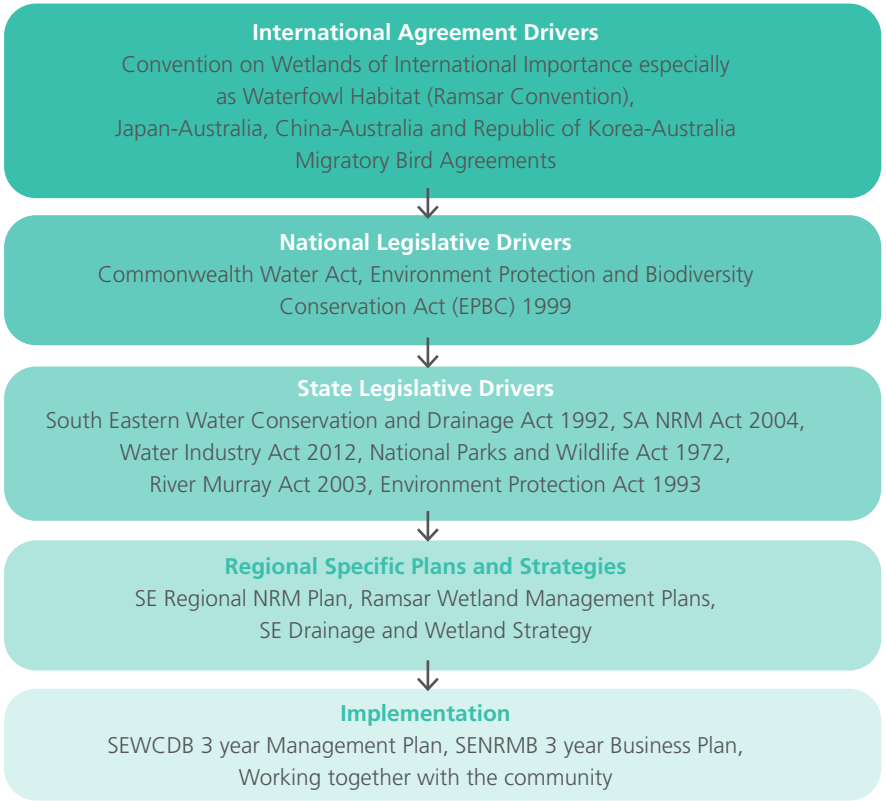
Our **neighbouring NRM regions** in Victoria, the Wimmera and Glenelg Hopkins Catchment Management Authorities, play an important role in working with us and landholders to help manage flow down the cross-border creeks and the Glenelg River.

The **South Australian Government** manages a large number of wetlands in parks and reserves, including all three South East Ramsar sites. State legislation provides protection for wetlands, water quality and species.

The **Australian Government** enhances the management and protection of internationally significant wetlands listed under the Ramsar convention. The Environment Protection and Biodiversity Conservation Act 1999 also provides for the protection of threatened species and ecological communities occurring in wetlands. The Australian Government provides significant funding to support these matters.

Local Government District and city councils manage creeks and wetlands in towns and, via planning documents, can influence the impacts of development on wetlands. Local government maintains a key connection to the community.

Figure 5. Legislative and planning framework for managing surface water



How much surface water is there?

Surface water inflow

The influence of wet years on flow is, as expected, very high, with flow down the cross-border creeks in wet years being at least four times larger than in average years. Table 2 shows the variation in creek flows under different rainfall conditions.

78GL is the largest volume of water ever recorded in one year (2016) at the Struan gauging station at the bottom of Mosquito Creek before it enters the Bool and Hacks Lagoons Ramsar site. Map 2 shows the mean cumulative annual flow and discharge volumes in average rainfall years.

Table 2. Flow volumes recorded down the cross border creeks

#	Station	Flow Volume recorded (Mean annual flow volume GL)			
		Dry Yr	Average Yr	Wet Yr	Max recorded
A	Mosquito Creek	1	9	39	78
B	Naracoorte Creek	<1	1	11	29
C	Morambro Creek	0	1	5	14
D	Tatiara and Nalang Creek	<1	1	7	24

Major surface water discharge sites

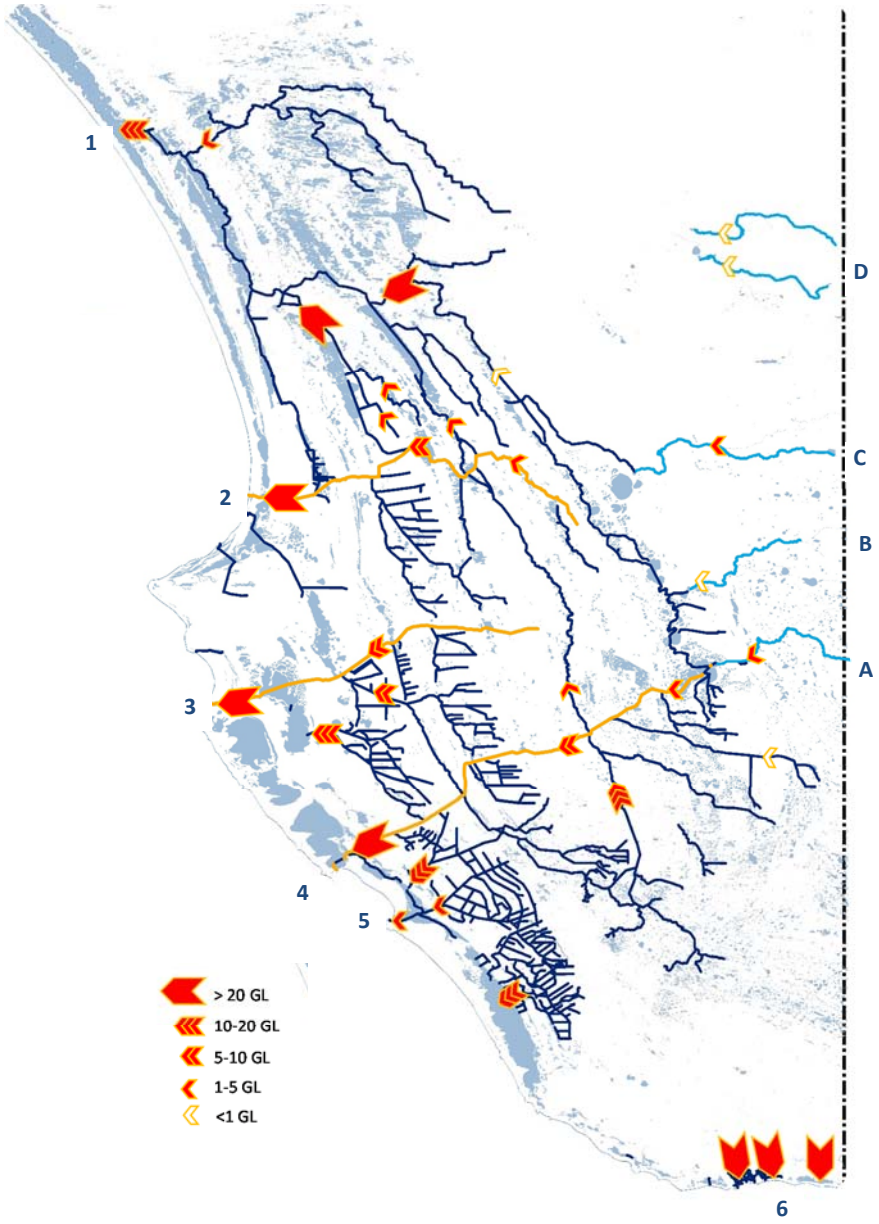
There are a number of large and small drain systems that discharge to the sea. Most drains are discharging a mixture of surface water and groundwater. The influence of groundwater is clear in drains that are discharging even in dry years. For example, the Lower South East spring wetlands (#6 on the map) are heavily driven by groundwater expressing under pressure, and maintain relatively constant discharge regardless of rainfall.

Most of the large drains that discharge to the coast are regulated somewhere along their length so flow behaviour is also influenced by decisions about when to release, divert or hold water

Table 3. Flow volumes discharged to sea from major ocean outlets

#	Station	Flow Volume recorded (Mean annual flow volume GL)			
		Dry Yr	Average Yr	Wet Yr	Max recorded
1	Salt creek to Coorong*	10	14	25	45
2	Blackford drain to sea*	11	21	39	60
3	Drain L to sea	19	58	82	204
4	Drain M to Lake George (to sea)	4	10	49	186
5	Lake Frome Outlet drain to sea	2	8	47	47
6	Lower South East Karst Spring systems (collectively) to sea	98	100	100	135

*based on pre-SE Flows Restoration project diversion from Blackford drain to the Coorong



Map 2 Flow and discharge volumes in an average year

Infrastructure used to manage surface water

Public drains

The largest drains are public assets managed by the SEWCD Board. Public drains are establishedon drainage reserves that run through the landscape. There are just over 2500 km of publically managed drains in the region.

Large drains designed to carry surface water away from agricultural land are often broad but relatively shallow in the upper parts of their catchments. To maintain a gradient that allows for flow, these tend to become deeper in the lower parts of the region where they often intercept groundwater.

Many of the larger regional public drains carry groundwater for at least part of the year. In the Lower South East, these drains carry fresh groundwater and may discharge constantly or seasonally. In the Upper South East drains often run parallel to water courses and are deeper, designed specifically to leach saline groundwater from the root zone of adjacent pastures.

Public drains are fed into by local drainage works and are used to move water around on a regional scale, either through the ranges towards the sea or north towards the Coorong.

Private drains

Private drains are small scale, local influence drains, developed and managed by landholders. There are now far more kilometres of private drainage lines than public in the region (3000+ km). The scale of public drainage works in the region is shown in Map 3.

Most private drains discharge into public drains and influence the carrying capacity of the drain. In wet periods when public drains are at full carrying capacity management options are constrained.

A permit from the SEWCD Board is required to develop private drainage works. The SEWCD Board seeks to balance individual landholder needs with the ability of the system to handle more flow and the potential impacts on downstream users and the environment.

Landholders are also concerned about dewatering of the landscape and seasonal management seeks to retain water where infrastructure allows, over late spring and summer.

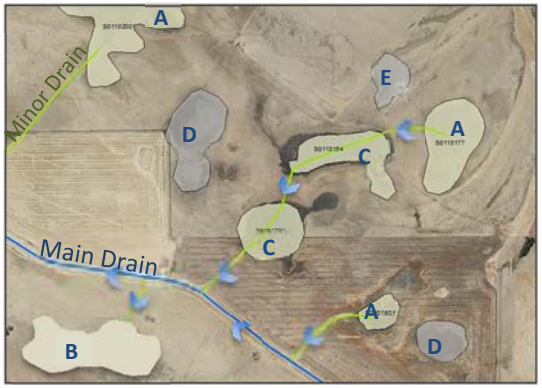


Figure 6. Drains and wetlands

Wetlands and drains

Wetlands on private land can also be supported by water diverted from public and private drains.

Many are managed under agreement with the SEWCD Board.

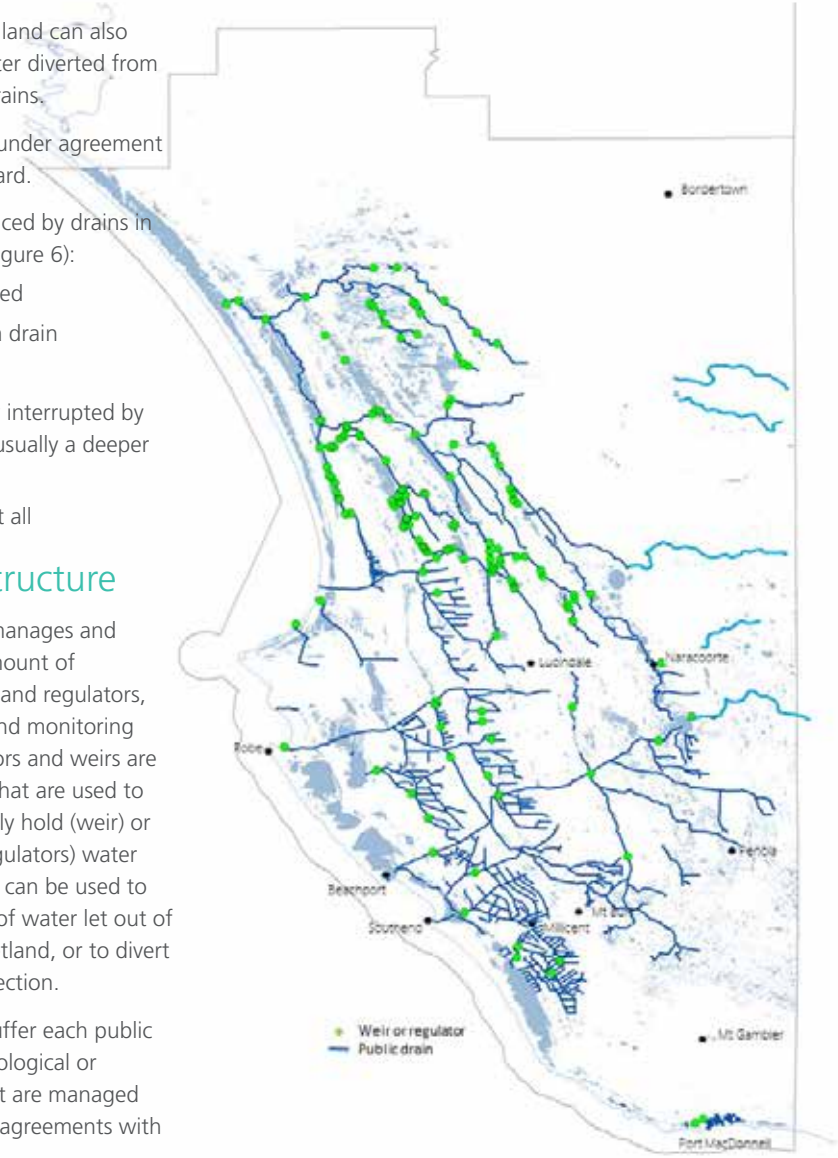
Wetlands are influenced by drains in several ways (refer Figure 6):

- **A** are directly drained
- **B** fed water from a drain
- **C** both A and B
- **D** water availability interrupted by a nearby drain (usually a deeper drain).
- **E** not connected at all

Other Infrastructure

The SEWCD Board manages and maintains a large amount of infrastructure, weirs and regulators, bridges, crossings, and monitoring equipment. Regulators and weirs are structures in drains that are used to partially or completely hold (weir) or hold and release (regulators) water in drains. Regulators can be used to control the amount of water let out of or into a drain or wetland, or to divert water in another direction.

Drainage reserves buffer each public drain, many have ecological or economic values that are managed under management agreements with the SEWCD Board.



Map 3 Surface water management infrastructure

Surface water and primary production

Agriculture is an important industry in the South East

The relative value (ABS 2016, ABARES 2019) of different land-based primary production activities are:

- Livestock (slaughtered) $603M
- Broadacre cropping $178M
- Livestock products (wool, dairy etc) $124M
- Hay $75M
- Forestry $321M (harvested log values only)
- Vegetables for human consumption $125M
- Grape production $85M

The region's drainage network was developed largely to manage:

- local flooding and waterlogging of low lying pastures and crops (Lower and Upper South East)
- the impacts of rising saline groundwater (dryland salinity) on production (Upper South East only)
- difficulties with travel and the transport of goods and people

To reduce flooding and waterlogging

During wet years and very wet seasons, there are widespread issues with waterlogging and flooding of agricultural land across low lying parts of the region.

When this happens, drains are managed to remove surface water as quickly as possible. The ability of drains to carry water is limited by the fall of a drain, its ultimate destination and its capacity. Most drains are designed to cope with no more than a one in ten year event although carrying capacity does vary depending on the purpose of the drain, how it is maintained and how much water is diverted into it.

Some large wetlands, like Bool Lagoon, are used to catch large volumes of flows during extreme rainfall events to mitigate the flooding effects on nearby properties.

Drained water is generally diverted to the large west-flowing drains that breach the ranges, and discharged to the sea. Some water is diverted directly into wetlands to help with flood management. The end point for disposal of water is an important consideration in surface water management decisions

To help manage salinity

In the northern parts of the region, the larger, deep drains of the Upper SE program were designed to intercept saline subsurface water rising to the surface. The aim was to prevent dryland salinisation of the land and protect high value wetlands.

Drains designed to catch saline groundwater generally run north to south, parallel to the watercourses of the Upper South East. They intercept subsurface groundwater flowing east to west.

Saline water in drains is diverted north to naturally saline wetlands, including, eventually, the southern end of the Coorong.

Many wetlands of the watercourses of the Upper South East have become more brackish as fresh surface flows from the south have been diverted.

Managing the salinity of water in wetlands to prevent further changes in wetland function and condition is an important function of the surface water management network.

Management priorities:

1. Maximise short-term drainage of productive land adversely impacted by flooding in wet periods (within the limits imposed by the landscape, infrastructure and resourcing)
2. Retain more local water in local areas
3. Ensure that water removed from one area does not have a negative impact on downstream values or assets
4. Manage flood storage wetlands to provide capacity to capture flood waters within agreed management levels.
5. Divert saline groundwater in drains to suitable discharge points
6. Manage any seasonal freshwater in groundwater drains to make sure it gets to the right wetlands at the right time
7. Balance the disposal of brackish to saline water into previously freshwater systems against the reality that no other water is available.

Refer to primary production strategic framework - page 22

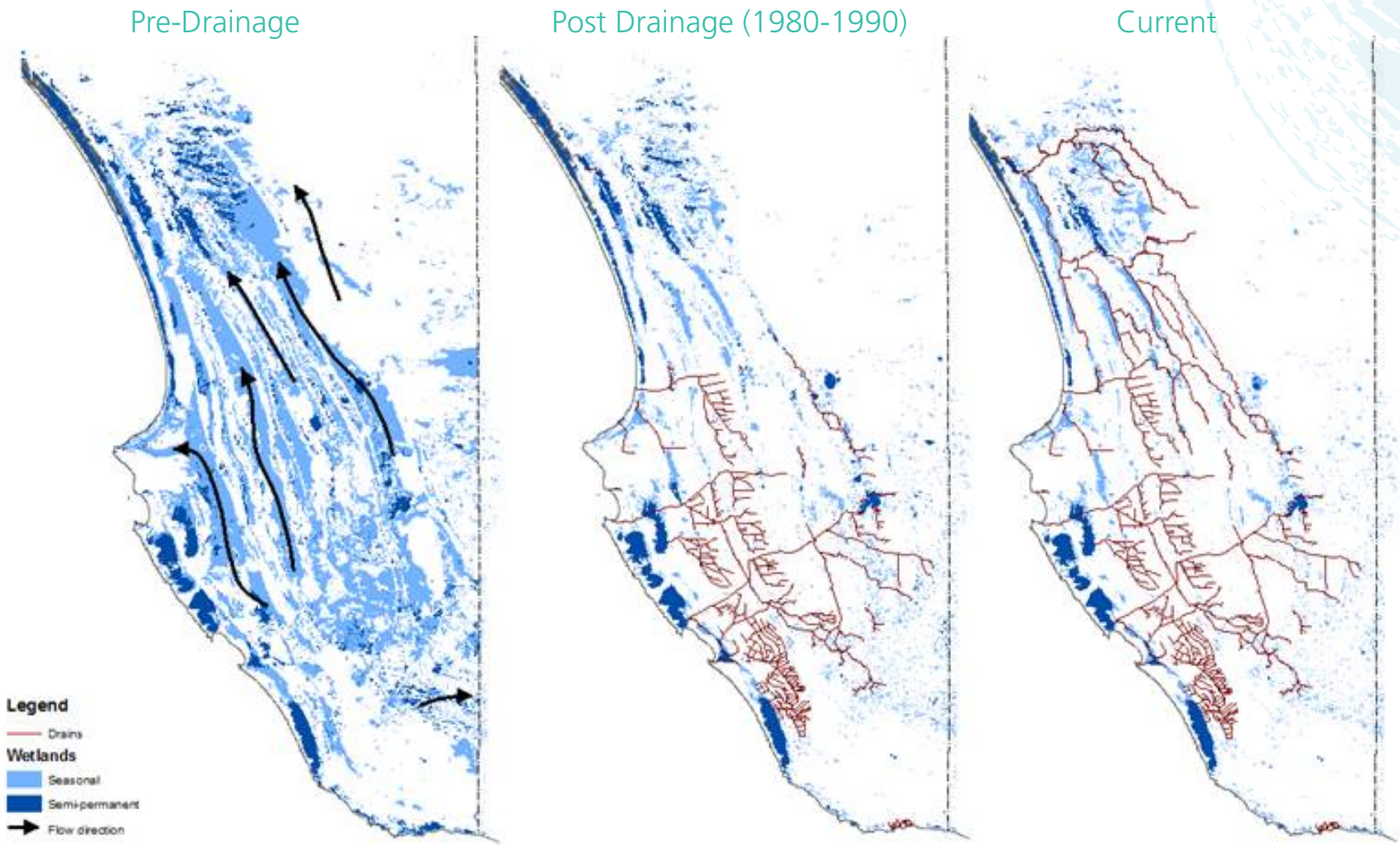
Management challenges

- **Lack of fall:** draining water from relictual floodplains which are very low lying is difficult when there is not much fall, these areas are naturally the wettest part of the landscape
- **The cost of infrastructure:** drains and regulators are expensive to construct and maintain
- **Limited resources** for maintenance, replacement and cleaning
- **The carrying capacity of the water course or drain:** drains have very variable carrying capacities. When the amount of water exceeds the capacity of a creek or a drain there is flooding of floodplains.

Changes to surface water over time

Prior to the development of the region for agriculture, surface water and its patterns of movement shaped the 17, 000 plus wetlands that covered over half of the region. The remnants of wetland basins still pepper the region, a legacy of a time before development changed the availability, quality and natural movement of surface water.

The maps below show the progression in changes in surface water extent over time.



Map 4 Change in wetland extent and flow paths over time

Wetlands of the South East

The wetlands of the South East are an essential part of the region's character.

They draw tourists from near and far and are valued by residents for recreation, their beauty and the biodiversity they support.

They also provide other services. They are efficient filters of water, removing nutrients and other pollutants, and they are natural holding places for water, keeping water in the landscape so that it can slowly recharge groundwater.

Beyond these values, the remaining wetlands of the region are rare wild places in a heavily cleared and developed landscape. They support species that are rare and threatened and they are recognised on the international stage for these unique values.

The Ramsar wetlands, Bool and Hacks Lagoons, Piccaninnie Ponds Karst wetlands and the Coorong and Lower Lakes, are protected under international convention as internationally significant sites.

The wetlands of the South East are also nationally important, in a dry continent, the permanent wetlands of the South East provide for the survival of species in danger of extinction as other habitats become drier. Migratory birds favour our wetlands, some traveling from other states, many from other countries.

The region has been heavily cleared, drained and developed for agriculture and forestry and, as a result, both the extent of wetlands and their condition has changed drastically.

Where are the wetlands?

There are over 17,000 mapped wetlands in the South East and they extend right across the region from north to south and east to west. Map 5 shows the current mapped wetland extent. Many of these wetlands are in substantially altered condition, having been converted to grazing, cropping or forestry and having had their natural hydrology changed by drainage, groundwater declines and reduced rainfall.

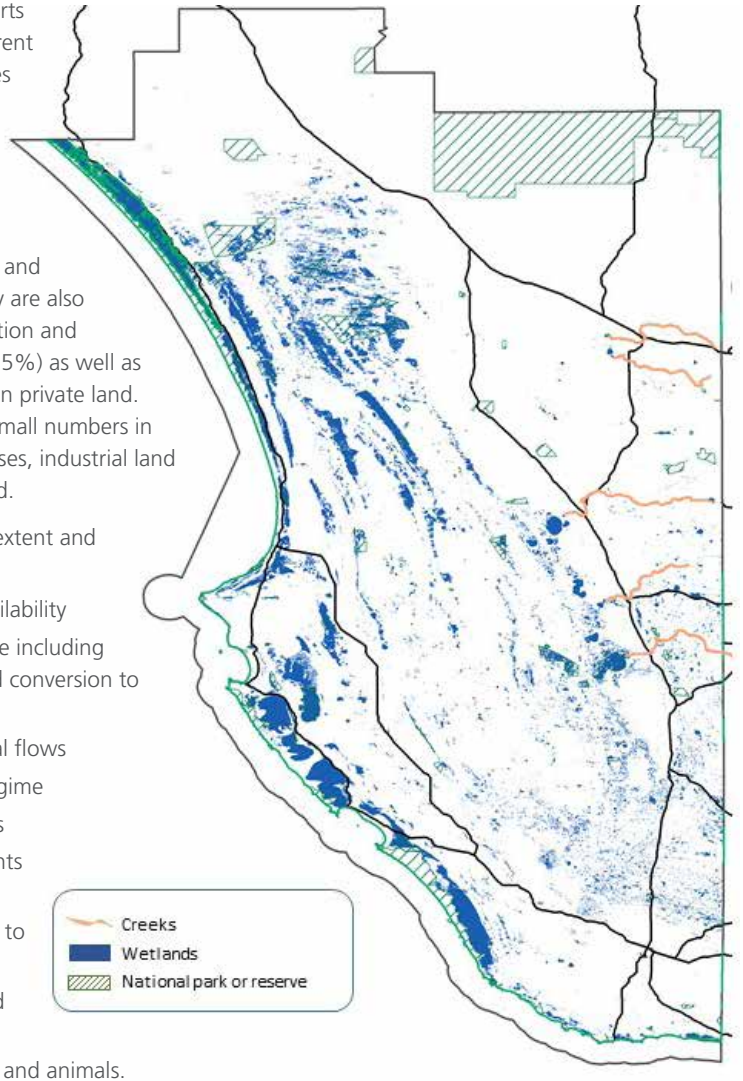
Wetlands are areas that are covered with water, flowing or still, for a long time or a short time, that supports native species for any part of their lifecycle.

Wetland values and priorities: For the purposes of the Strategy, High value wetlands are those that have a significant identified social or ecological value. For more information on how values are assigned to individual sites please refer to the Technical Supplement.

Wetlands in different parts of the region have different characteristics and values and are subject to different threats. Most wetlands in the region are embedded in land used for grazing (64%), agriculture (4%) and forestry (16%), and they are also represented in conservation and native forest reserves (4.5%) as well as in remnant vegetation on private land. Wetlands are found in small numbers in town-sites, on golf courses, industrial land and on other crown land.

Key threats to wetland extent and condition include:

- changed water availability
- physical disturbance including direct drainage and conversion to other land uses
- interception of local flows
- changed salinity regime
- increasing nutrients
- loss of species (plants and animals)
- loss of connectivity to other ecosystems
- climate change and reduced rainfall
- aquatic pest plants and animals.



Map 5 Wetland basins

The South East, with its unusual topography, soils, climate, geology and groundwater has the right ingredients for not only lots of wetlands to form but also for lots of different types of wetlands.

In this region, wetlands can be saline or fresh, or omething in between. They can be completely dependent on groundwater or only get local rainfall, they can be shallow or deep, big or small. They can be permanent or only get wet for a few months every year. They may even dry out for years during drought.

Some wetlands are static basins disconnected from other wetlands and some are creeks or basins on watercourses that were once connected by flowing water.

Understanding how wetlands function helps us to manage threats. In the South East, wetlands are classified into groups by their hydrology, depth, size, water source, water quality, the landscape they occur in and their vegetation.

At the broadest level, most of the wetlands of the region can be classified as swamps and marshes, lakes or creeks. Less common categories are also found, including estuaries and artificial wetlands. Of the artificial wetlands, only drains and the habitats they support are considered in the strategy.

Creeks and Rivers

Due to its flat nature the region supports very few creeks and rivers.

- The Morambro, Tatiara and Nalang, Naracoorte and Mosquito Creeks are the most easily recognised. They flow from Victoria onto the flats via the Naracoorte Range.
- Eight mile Creek, Maria Creek and Henry Creek are examples of smaller systems that existed naturally prior to drainage that have now been channelised and incorporated into the drainage network.
- The Glenelg River, and its estuary, found on the Victorian/South Australian border, is located largely in Victoria with a small section that crosses into the region.

Estuaries

Estuaries are areas where flows from the land meet ocean flows.

- Many fauna species breed in estuaries. They are especially important for fish species that spend part of their lifecycle in the ocean and part in fresh water wetlands.
- They are typically associated with creeks and rivers but also with drain outfalls.
- The Glenelg River has a naturally very long estuary, which passes through the region for a short part of its length. Once, the river estuary was connected to the Piccaninnie Ponds system with freshwater flows making their way from the Ponds, via Freshwater Creek, across the border and down to the river.
- Drains with sea outlets are likely to be functioning as small, high flow estuaries.
- The Coorong is the largest estuary in the region.

Lakes

Many of the region's most iconic and recognisable wetlands are lakes. Lakes are particularly important for tourism and recreation.

Lakes in the South East:

- are usually relatively deep (over 2m), large and more likely to be permanent
- are highly dependent on groundwater
- have open water habitat, and may be fringed with sedges and rushes or trees and shrubs
- provide important habitat for birds, including ducks and waders. Lakes with exposed mud flats, whether fresh, brackish or saline, are important feeding sites for the wide diversity of migratory waders that travel from their summer nesting grounds in the northern hemisphere every year.

There are approximately 60 lakes in the region. They are often large so account for around 20% of the wetland area in the region. The different types of lakes have the following characteristics.

- Close to the coast, lakes have formed in hollows between dunes, and may be fresh to saline. Examples: Lake Bonney, Lake Eliza, Lake George, Lake St Clair and Robe Lake
- Further inland, a small group of significant freshwater lakes are reliant on surface water flows from the cross border creeks and groundwater. Examples: Cockatoo Lake, Lake Ormerod, Lochaber Swamp, Bimbimbi Swamp and Jaffrays Swamp.
- Some of our most iconic wetlands, the volcanic lakes and sinkholes speak to the geological legacy of the region. Examples: the Blue Lake, Valley Lake, Lake Leake, Lake Edward, the Little Blue Lake and Hells Hole.
- Salt lakes are different from the freshwater lakes found in the south of the region but are ecologically important in their own right. Examples: Paranki Lagoon, Butchers Gap and the ephemeral wetlands of the Coorong National Park.

Because of their reliance on groundwater, the key threat to most lakes is groundwater level decline but many are also impacted by drainage, the diversion of surface water and increasing pollutant levels.

Many coastal lakes are also at risk of changed hydrology due to sea level rise, storm surge and infiltration with sea water.

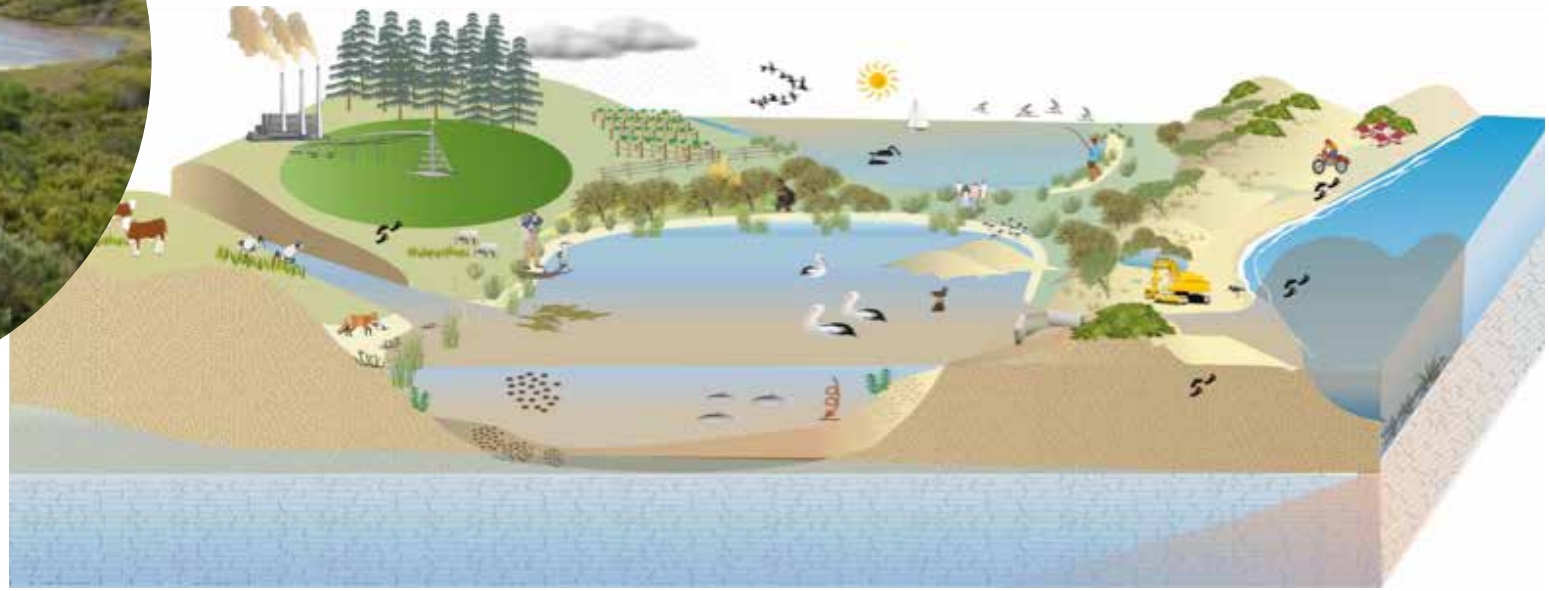


Figure 7. Coastal lake conceptual model

Swamps and Marshes

Swamp and marsh are terms used for shallower wetlands with aquatic plants growing all the way across them, either shrubs, reeds, grasses or aquatic plants, often fringed by dense stands of Melaleuca or mature Red Gum, Buloke or Stringybark woodlands. They are not deep enough to support open water habitat.

Swamps and marshes:

- are rarely permanently wet, usually they naturally dry out for periods of months
- can be large or small - the vast majority in the Lower South East rely on fresh water, whereas there are a large number of naturally saline swamps in the northern parts of the region
- occur all across the regional landscape and are heavily influenced by local rainfall and run-off but many are also very dependent on groundwater
- are often influenced by drainage. Some, like Lake Hawdon South, and Bool and Hacks Lagoons are receiving environments because of their large size and ability to hold large volumes of water.

There are over 17,000 swamps and marshes across the region and there is a lot of variety in the types found. Some of the more common types are discussed below.

Deep Freshwater Swamps and Marshes

- Relatively large, deep (up to 2m) and semi -permanent swamps of the central and southern flats, reliant on fresh groundwater and local surface water inputs. Examples: Lake Frome, Lake Hawdon South, Deadmans Swamp, Green Swamp, The Marshes, and wetlands of Honans, Kangaroos flat, Trail and Topperwein Native Forest Reserves.
- Seasonal swamps of the watercourses, formed on the broad interdunal flats between ranges with extensive floodplains that were connected by freshwater flows during wet periods. Examples: swamps of the Marcollat, West Avenue, Bakers Range and Tilley Swamp watercourses.
- Peat swamps of the coastal zone, underlain by peat formed under permanently wet conditions over long time periods by fresh, alkaline groundwater expressing at the surface or through the ranges. Examples: Eight-mile Creek Swamp and Picks Swamp.

Freshwater Meadows

- Very small (<2ha) and very shallow (20-30 cm deep) annual wetlands that are very common across the eastern parts of the region.
- These 'puddles in paddocks' coexist with grazing land across the region and support many unusual annual flowering species, giving a meadow like appearance.
- Important for nesting waterbirds including ducks, swans and brolgas.

Saline Swamps

- Shallow vegetated swamps of the Upper South East. Salt Paper bark and Samphire dominated communities are common in saline swamps.
- Naturally brackish to saline these swamps are driven by saline groundwater and evapoconcetration of surface water tun off.

Threats to swamps include physical conversion to other land-uses and changes to the timing, freshness and volume of surface water inputs due to drainage, reduced rainfall and groundwater level declines.

Figure 8. Freshwater marsh conceptual model

Rare wetlands of the South East

Springs and soaks

In the South East soaks and springs are associated with groundwater rising to the surface under pressure. As permanent water sources, they are very important refuge areas for many species during droughts. Along the far southern coastline of the region, the karst springs support some of the most unique communities and species in the region.

The karst springs of the region and the peat fens that surround them:

- are important for tourism, recreation and conservation
- have deep karstic pools that feature aquatic plants growing at exceptional depths due to the very clear water
- support a very large number of threatened species not found elsewhere in the region
- are always associated with peat soils, evidence of hundreds of years of freshwater inundation of organic material. Silky tea tree (Leptospermum lanigerum) is strongly associated with these types of wetlands and they are a haven for rare orchids.

Less than 20 springs with karst pools exist in the region and they are all very small. The Piccaninnie Ponds Karst Wetlands Ramsar site is the most recognised and high value karst spring in the region. Other examples include Ewens Ponds, Deep Creek, Cress Creek and Stratman's Pond.

The karst springs formerly existed within extensive peat based swamps around the southern coast of the region. These have all been heavily drained and cleared, now the only system left that still supports a relatively large area of spring fed peat swamp is in the Piccaninnie Ponds Conservation

Park where the restoration of Picks Swamp has reinstated a large area of peat swamp. Other more poorly understood types of springs include:

- the range springs that occur on the western side of some ranges, these have formed where water percolates through the range from wetlands on the eastern side
- the beach springs of the southern coast, around Piccaninnie Ponds, are another type of related poorly understood spring which are an important water source for shorebirds.
- the lake springs which fringe some of the large coastal lakes and the southern lagoon of the Coorong, are an important source of fresher water in otherwise saline systems.

All springs and soaks are driven by groundwater expressing at the surface and groundwater pressure decline is a major threat. As permanent freshwater sources, they are very important refuge areas for many species during droughts.

Threats to springs and soaks:

- groundwater pressure decline
- drainage, peat drying and oxidisation
- changes to water quality, including salt water intrusion and increased nutrients from diffuse sources are a major challenge for springs.

Seasonal Herbaceous Wetlands of the Temperate Lowland Plains

This nationally listed (EPBC Act) community is a rare type of freshwater marsh wetland that:

- supports a particular suite of flowering herbs when wet, but only for a short period of time
- is found around Padthaway, Bangham and scattered down the eastern side of the region
- is sometimes associated with Gilgai soils
- are mostly in degraded condition.

Approximately 200 examples of the community have been identified in the region. These wetlands are vulnerable to disturbance of the wetland bed by ploughing or ripping and reduced rainfall represents a big challenge for these shallow ecosystems.

Environmental water requirements

Water is the key ingredient a wetland needs. When there are changes in the amount or timing of water availability or the quality of water changes, the ecology of a wetland changes. If the hydrology of a wetland changes enough it starts to become a different type of ecosystem, supporting different species. It may even become a dry-land ecosystem that does not support any aquatic species.

Elements of a wetland's hydrology

- volume (how much water it receives)
- duration (how long it is wet for)
- timing (when it gets wet)
- water quality

Some types of wetlands are more vulnerable to specific threats to their hydrology. For example, shallow swamps will dry out faster than deeper wetlands if rainfall declines, and groundwater fed systems will be more impacted if groundwater drops. Understanding the hydrological function of wetlands, their water requirements, and the species they support, helps us to manage them more effectively.

Some wetland species have evolved with very specific needs for reproduction and survival. Many species of aquatic plants, such as River Red Gums, will only germinate if their seed is wet for a specific period of time. Fish and frogs may have temperature or flow triggers for breeding and spawning, and waterbirds can only raise chicks if there is water for long enough for them to fledge.

Because there are so many wetlands in the South East, it is a challenge to understand their water requirements and describe management approaches specific to each wetland. To overcome this, the Strategy has used new data from satellite imagery and remote sensing analysis techniques to help describe the current and past hydrology of a large number of wetlands across the region.

Water Observations from Space (WOfS) data is derived from Landsat imagery collected over the past 40 years and has been used to determine if a wetland's hydrology has changed over that period. This information fed into the prioritisation approach used for wetlands of the region (refer to the Technical Supplement for more detail on the methodology and results). It has also been used to help identify management options for wetland in each catchment for which no other data or first hand information exists. 54 percent (9531) of the region's wetlands were detected and classified using the WOfS data, the remaining 7883 were either too small (less than 30 x 30m) or too vegetated for water to be detected in the imagery.

Challenges

- The community want to see wetlands remain in the landscape
- Balancing competing primary production and social and environmental demands for water
- Reinstating the hydrology of wetlands in a developed landscape
- Regional scale, diffuse threats like regional groundwater decline and water quality
- A drying climate with reduced rainfall resulting in reduced runoff and reduced groundwater availability to wetlands
- Maintaining permanent refuge sites for threatened species
- Meeting our obligations under international conventions and national legislation

Opportunities

- Despite the losses, the South East still has many significant, although changing, wetland ecosystems
- We value our water resources and are seeking to make better use of them to protect wetlands
- We understand that retaining water in wetlands will benefit all natural resources, including groundwater
- The skeleton of the old wetland systems remain, many can be improved or restored through careful management of water
- Our wetlands return value to us as important tourism and recreation sites, and managing them to improve their condition will increase their value to the community
- Individual companies, notably plantation companies, now utilise environmental certification and audit processes to inform their management and monitoring of wetlands.

Management priorities:

1. Actively manage high value, intact wetlands to preserve them
2. Restore wetland hydrology wherever feasible
3. Make use of available water in the drainage network to improve wetland condition where feasible
4. Manage regional groundwater levels to support wetlands
5. Manage land use impacts (clearance, conversion, chemicals, plantation, stock etc) on individual wetlands.

Refer to wetlands strategic framework Page 25

Retaining water in the landscape

In a drying climate freshwater resources are becoming more scarce and valuable. The community has called on the Boards and the government to prioritise the retention and use of surface water flows in the region. Retaining surface water is described as being important for supporting primary production and wetlands, to reduce the impacts of drain discharge on marine values and to maximise the recharge of groundwater (in the mid-lower South East).

Retaining water to recharge groundwater

Recharge of groundwater with excess water in drains and creeks is an appealing idea. Some examples already exist in the region: in Bordertown the town water supply is from the local aquifer below Poocher swamp which is directly recharged via runaway holes fed by Tatiara Creek flows.

Given the very flat nature of the region there are few real options to create large water holding dams, and existing wetland basins and drains provide the most logical options for storing water.

The best areas for retaining water for groundwater recharge will logically be where:

- there are large wetland basins that are not at capacity when there is water available, and
- groundwater levels are five or more metres below the surface, providing capacity for infiltration

Holding water in drains and wetlands provides a simple method for increasing recharge of groundwater with surface water. Although a relatively slow process of natural infiltration, there are other advantages to this approach, it allows for natural filtration of water via biological and chemical processes to remove some of the nutrients and chemicals found in run-off. It also benefits biodiversity, amenity and landscape function.

Maps 6 and 7 show the depth to groundwater and the known interaction between groundwater and wetlands. Map 8 shows some identified areas that may provide good groundwater recharge potential.

Drainage bores, and other managed aquifer recharge options, are being investigated globally and offer opportunities but require detailed investigation. Drainage bores in drainage lines are considered a possible option for the region, but a major limitation would be water quality.

Note: any engineered solutions will require detailed design and feasibility studies, including hydrogeological and environmental impact assessments. Infiltration (or recharge) rates vary by soil type across the region and are not considered here.

Retaining water to reduce discharge to sea

The community is also concerned about the discharge of large volumes of drainage water to the marine environment each year, and have frequently suggested investigating of options for retaining or diverting this water to recharge aquifers and support wetlands.

The direct impacts of this discharge on the marine environment includes:

- impacts of freshwater discharge and associated pollutants on seagrass beds which are significant assets, including important breeding grounds for many fish species
- impacts to beach morphology, including altering beach erosion and sand deposition patterns.

Retaining water to support productivity

Retaining water in drains or wetlands over summer, or during a drought, is already a management priority in some areas where low weirs and regulators provide capacity to create drain pools which help recharge soil moisture and provide refuge sites for native aquatic species.

Retaining water in drains and wetlands at the end of the season helps to prevent dehydration of soils and supports a longer growing periods for pasture and crops.

Prioritising opportunities to retain more water to support productivity should consider:

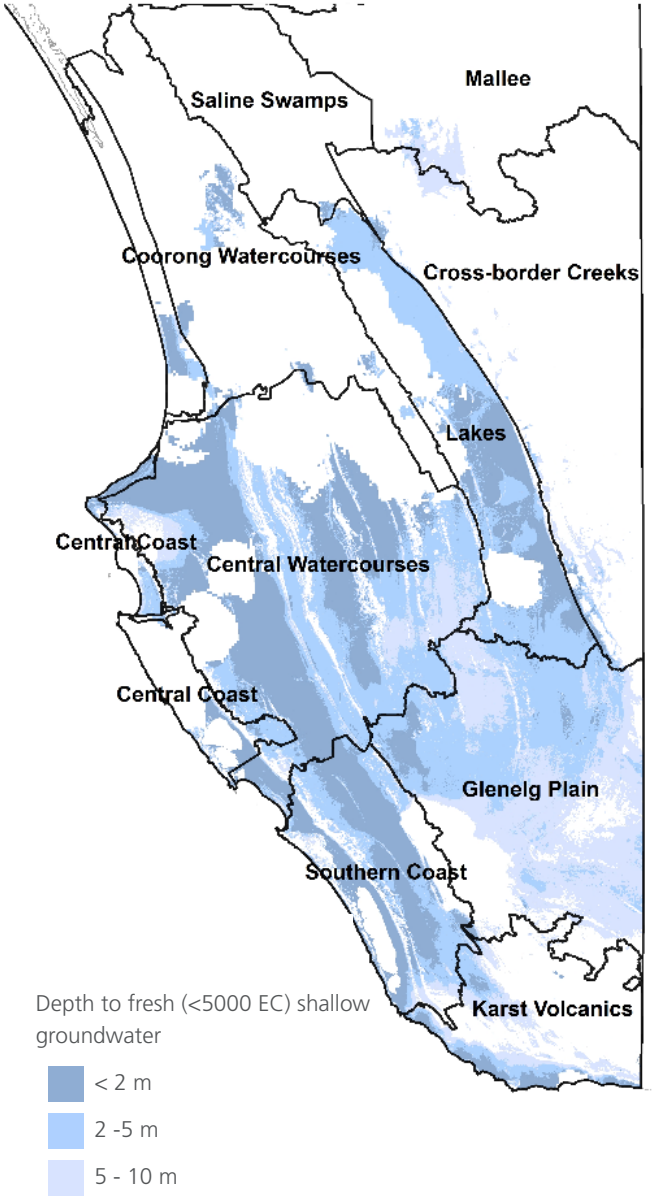
- the availability of surface water of the right quality
- the scale and reach of benefits of retaining water for longer in specific locations
- the capacity and resources needed to establish or manage infrastructure or flows adaptively any potential downstream impacts; holding water in one location should not be at the cost of other assets or values downstream.

Management options:

1. Maximise opportunities to retain water locally in wetlands and drains, support projects to reinstate natural sill heights (reverse drainage) for wetlands either permanently or via regulation
2. Manage regulators on drains and wetlands, to 'catch the tail' of winter/spring flows where they are of good quality. Consider weirs or other low cost structures to create weir pools in drains
3. Investigate methods to improve groundwater recharge options in priority areas
4. Regulate coastal outfalls to reduce risks and improve management options retaining or diverting this water to recharge aquifers and support wetlands.
5. Investigate other managed aquifer recharge options.

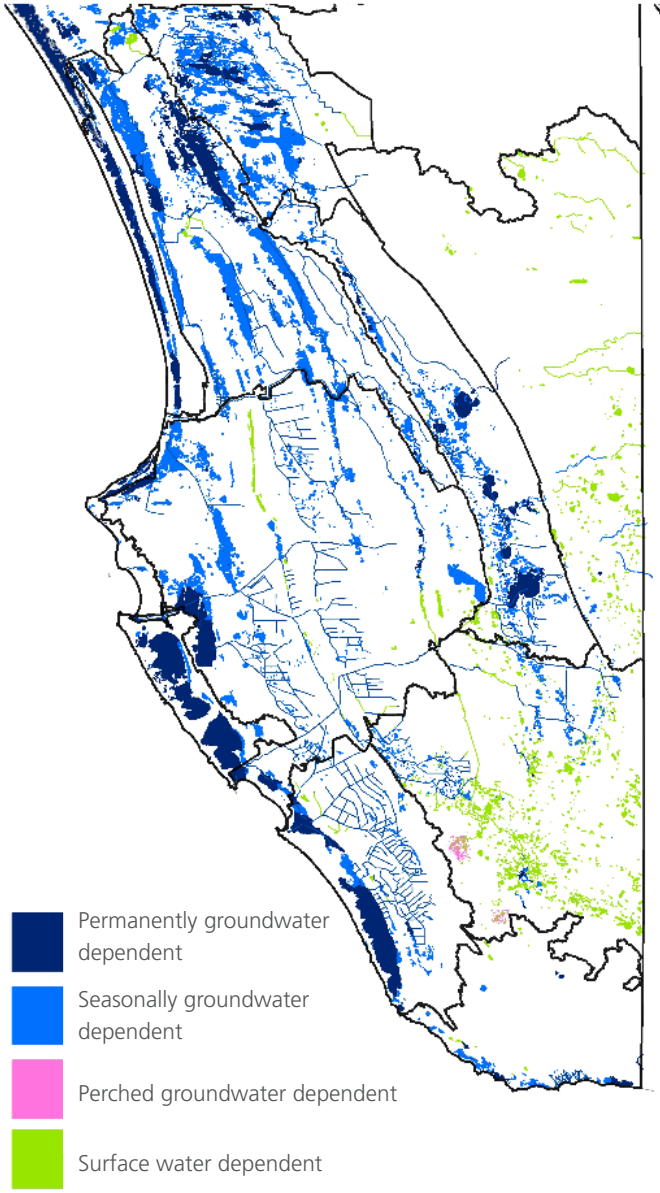
Refer to retaining water strategic framework - Page 26

Shallow fresh groundwater (2010- 2015 baseline)



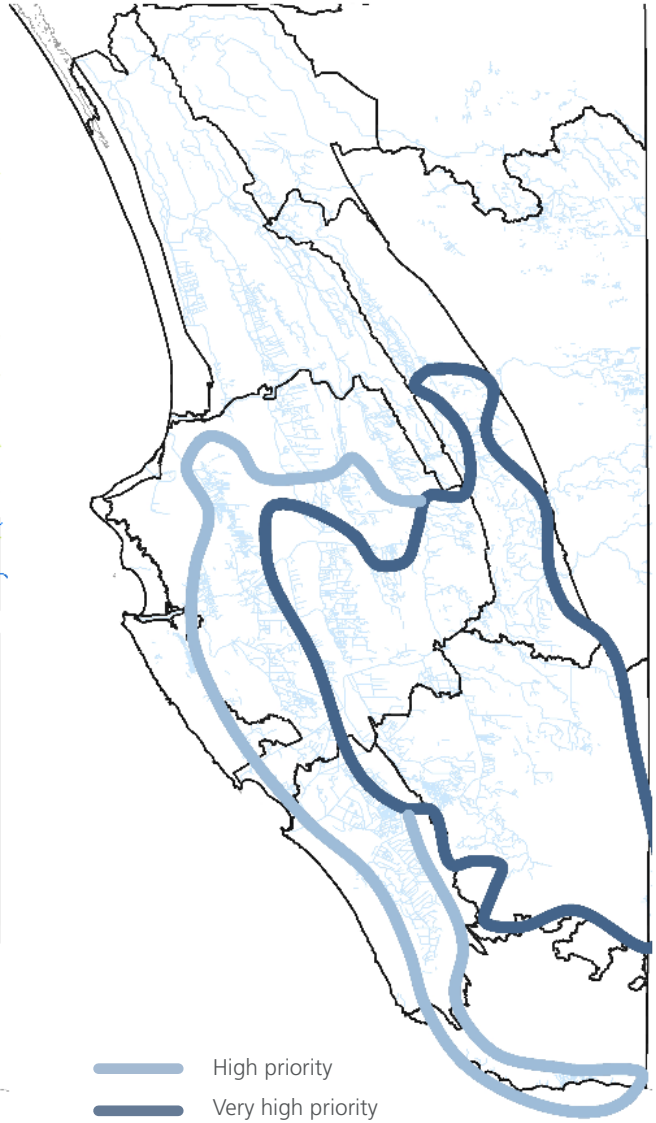
Map 6 Depth to groundwater map

Groundwater dependency of wetlands and drains (2010- 2015 baseline)



Map 7 Drain and wetland groundwater interaction map

Priority zones for retaining water in the landscape for recharge



Map 8 Priority zones for retaining water in the landscape for recharge purposes.

Water quality

Water quality is an important driver of wetland ecology and primary production. Many plants and animals prefer a specific salinity range to be able to survive and breed. Nutrients, pollutants, the amount of dissolved oxygen, water clarity and pH of water are other water quality parameters that can affect the health of wetlands and the function of the landscape.

Salinity

In the south of the region, both groundwater and surface water are very fresh, whereas in the northern parts of the region there are large areas of naturally saline swamps and salt lakes driven by saline groundwater. These different water sources support different land uses, wetland ecosystems and values.

Managing salinity is an important function of the drainage network in the Upper South East where increasing salinisation of land was a key driver for the establishment of drains. These drains were established to leach saline sub-surface water away from the root zone of plants to support the productivity of pasture. Maintaining appropriate salinity regimes in the landscape, including diverting freshwater into wetlands, continues to be an important function of drainage network management in the mid to upper South East.

The reduction in freshening surface water flows from the southern water courses into the landscape of the mid-upper South East has impacted the water availability and salinity levels in many wetlands. Although freshwater wetlands can tolerate short periods of higher salinities, they will eventually need flows to refresh the system, flush out salt and recharge the biological activity.

If altered salinities persist then the wetland will start to transition towards a more saline system and the species composition will slowly change to favour more salt tolerant species.

Salinity (mg/L) range	Category
up to 1,000	Very Fresh
1,000 to 3,000	Fresh to brackish
3,000 to 5,000	Brackish
5,000 to 35,000	Saline
35,000 and above	Hyper-saline

Table 4 Salinity classification categories

Agricultural chemicals (fertilisers, pesticides and herbicides)

Agricultural chemicals are widely used across the regional landscape, and can contaminate surface water and groundwater.

Only a relatively small amount of data exists to describe the amounts of these pollutants in surface water across the region. Results from the limited data that exists show that nitrogen levels in particular are high in the surface water resources of the region.

Nitrogen is a concern because it promotes plant growth and in wetlands and drains it contributes to the development of algal blooms. These can impact on amenity and water quality, producing anoxic conditions, reducing water clarity and sometimes producing dangerous by-products.

Industrial by-products

Discharge of industrial by-products in waste water is heavily regulated and monitored by the EPA.

In the past pollutants were legally disposed of into drains and wetlands. Although there have been some legacy issues from past practices, very few surface water resources are currently impacted by industrial discharges in the region.

Management priorities:

1. Continue to monitor water quality to inform decision making
2. Support projects that reinstate freshening flows to wetlands of the inland watercourses that have become more saline
3. Reduce pollutants entering surface water wherever possible
4. Embrace opportunities to improve the quality of surface water via filtration/residence time in wetlands or drains

Refer to water quality strategic framework - Page 27

A changing climate

The regional climate is changing, with average rainfall declines of 30 to 100 mm recorded since the 1940s across much of the region.

Declines in spring rainfall are predicted to be around 20% by 2070 across much of the region (URPS, 2016). Spring rainfall is important for the growth of crops and pasture species and for maintaining wetlands and their biodiversity throughout the summer months.

While an average annual rainfall decrease of 6.8% does not sound like a lot over the next 50 years, the decrease is based on change since the period 1986-2005 (URPS and Seed Consulting, 2015).

Rainfall has already declined substantially up to that point so the predicted declines should be considered on top of the rainfall declines up to that period.

Rainfall is not the only climate variable that will affect surface water. Temperature increases, increased evaporation and altered evapotranspiration, sea level rise and rainfall intensity increases will all have impacts.

Note: The predicted decreases in rainfall were developed based on average results of a range of climate models using moderate emissions levels. If emissions levels are higher than those used in the modelling then the scale of the impacts will be greater.

What does this mean for water in the landscape?

- Greater risk of groundwater declines as use of allocations increases and recharge decreases
- Reduced flows in drains over spring most years
- In average to dry years there will be less water available to hold in the landscape over late spring and summer
- Less water available to divert to priority wetlands and it will be more erratic
- Reduced discharge to the sea over spring
- Soil moisture levels over spring/summer will decrease more rapidly
- Waterlogging and flooding risk in very low lying catchments will be reduced in average years but will still be impacted by heavy, intense rainfall events
- Storm surge risk to agricultural land and wetlands near ocean outlets will increase.

Refer to climate change strategic framework - Page 28

What does this mean for wetlands?

- Wetlands will not fill as much and will not stay wet for as long. Recreational use of some wetlands will be compromised. More shrubs will invade the beds of wetlands
- Some will dry out permanently
- Wetlands of the watercourses are likely to become more saline as reduced flushing flows are available
- The naturally shallow meadow wetlands may disappear altogether as rainfall declines
- Waterbirds like Brolgas, ducks and swans will have reduced opportunities to raise chicks successfully
- Cross-border creeks will flow very irregularly during normal years but will still experience occasional extreme high flow, flooding events
- Storm surge up drain ocean outlets will increase in regularity and intensity, and reach further inland to wetland
- Refuge sites for threatened species, including fish, will become less viable, alternative sites and adaptation options should be investigated now
- Freshwater fish will be restricted to a few core refuge sites as wetlands becomes less permanent
- Warmer weather will encourage more algal growth

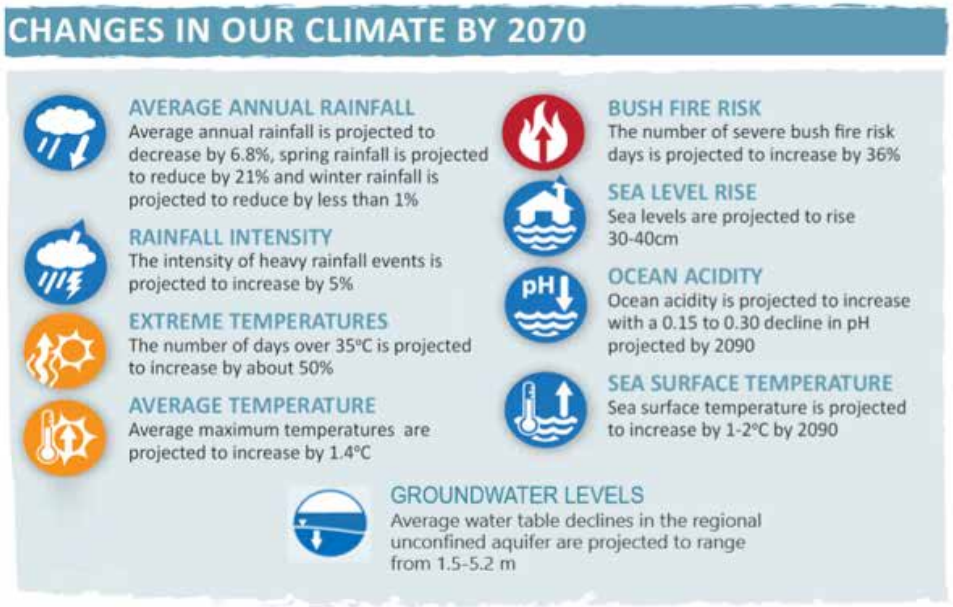


Figure 9. Average climate predictions by 2070 for the region (URPS, 2016)

Part B

Strategic Framework

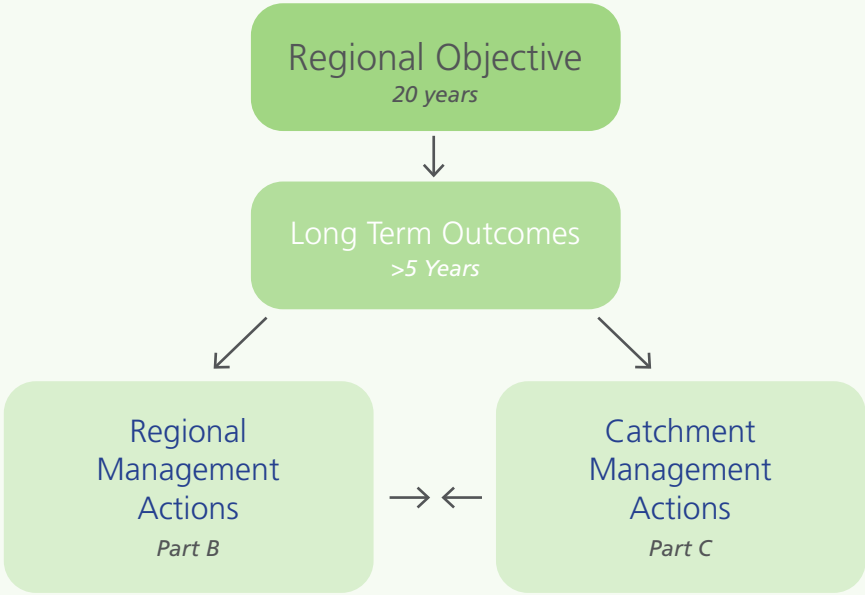
Regional Objectives

The following overarching regional objectives have been developed to reflect the high level priorities of the community for the management of surface water and wetlands in the region.

1. Primary Production is supported by managing the surface water system to reduce the impacts of flooding, waterlogging and dryland salinity
2. The extent and diversity of wetlands in the region is maintained or improved from current levels
3. More surface water is retained in the landscape, replenishing groundwater and reducing marine discharge.
4. The quality of water in wetlands and drains is fit for its intended end use
5. The impacts of climate change are factored into management of surface water

In this section of the Strategy (Part B), the long-term (5-20 year) regional outcomes and key regional management actions for each Regional Objective are detailed. There is also a discussion about implementation and how progress of the strategy will be measured.

In Part C, each catchment is discussed in detail, including the catchment actions required to meet the Regional Objectives.



1. Primary production strategic framework

Regional Objective
20 years

Primary production is supported by managing the surface water system to reduce the impacts of **flooding, waterlogging and dryland salinity**.

Long term outcomes
>5 years

P1. Drainage infrastructure is used to manage risks to productive land associated with inundation and waterlogging.

P2. Salt continues to be removed from the root zone by drainage infrastructure (USE).

P3. Water is retained to support soil moisture and pasture growth

Our challenges

- Managing water movement and transmission in a very flat landscape.
- Limited resources to manage and maintain a large network of drains and monitor surface water.
- Balancing the need to retain water and wetlands with the expectation of drainage service.
- A large, complex network that balances the needs of individuals, requires adequate staff to manage and maintain relationships and communication.
- Helping the community to understand that drains are designed with a maximum capacity, they cannot alleviate all issues that occur under wet conditions.

What do we need to do?

Long Term Outcomes	Regional management action	Responsibility
P1, P2	Maintain a regular schedule of drain cleaning and maintenance to ensure that existing drains function as designed (optimally)	SEWCDB
P1	Operate infrastructure to provide short-term drainage service to productive land adversely impacted by flooding, waterlogging and dryland salinity	SEWCDB, Land managers
P1, P2, P3	Work with landholders to ensure that private and public drains are managed effectively, consistently, and in an agreed manner	SEWCDB, Land managers
P3	Establish more weirs in drains to slow water movement and improve recharge at the tail end of the wet season	SEWCDB
P1, P2, P3	Continue current monitoring programs for water quality and flow parameters and seek additional resources to instigate a more comprehensive monitoring program across the region (drains and wetlands) to inform decision-making in real time	SEWCDB, DEW
P3	Encourage retention of water locally wherever possible	SEWCDB, SENRMB
P1	Support projects that seek to regulate major drain outfalls to reduce risks of storm surge and increase management options	SEWCDB, SENRMB
P1, P2, P3	Build relationships and communicate effectively with local landholders about the management and operation of the drainage network	SEWCDB
P1	Continue to review the occupational license system for drainage reserves including improved documentation and management conditions to improve land and and water management outcomes.	SEWCDB

2. Wetlands strategic framework

Regional Objective
20 years

The extent and diversity of **wetlands** in the region is maintained or improved from current levels

Long term outcomes
>5 years

W1. Wetlands that are currently ingood hydrological condition and support high values are maintained

W2. Wetlands that are drained or have altered hydrology are restored

W3. Wetlands that are in poor condition are better able to support values.

Our challenges

- Retaining more water in wetlands in a landscape that is heavily drained.
- Managing regional scale threats like groundwater decline and increased nutrients in water.
- The large number of wetlands in the region that we do not know anything about (there is data for 2000 of the 17,000 wetlands).
- Retaining rare permanent water in wetlands and drains to provide refuge areas for aquatic species during dry times.
- Impacts of the changing climate on wetlands and the water resources they depend on.
- Restoring flows to wetlands that are hydrologically isolated in the landscape.

What do we need to do?

Long Term Outcomes	Regional management action	Responsibility
W1, W2, W3	Improve the risk assessment and allocation of water for groundwater dependent ecosystems in Water Allocation Plans	SE NRM Board, DEW
W2, W3	Investigate priority data deficient wetlands	SE NRM Board, DEW
W1, W2, W3	Divert water of suitable quality in drains to wetlands or regional watercourse systems with altered hydrology	SEWCDB
W1	Document high value sites and ensure that they have updated management prescriptions to ensure that hydrological and land use threats are managed appropriately	SENRMB, SEWCDB DEW, Land managers
W1, W2	Reduce regional scale (diffuse) nutrient inputs in surface water and groundwater by educating land managers	SENRMB, DEW
W2	Support projects/works that seek to retain water in local wetlands, watercourses or drains	Land managers SEWCDB, SENRMB
W2, W3,	Identify landscape scale opportunities to retain water in the landscape and reconnect functioning systems	SEWCDB, Land managers, SENRMB
W2	Support landholders/projects that seek to reinstate the natural hydrological function of wetlands (e.g. reinstating breached sills, regulating outlets)	SEWCDB, Land managers, SENRMB
W1, W2	Support projects that seek to regulate major drain outfalls to reduce risks of storm surge and increase management options	All
W1	Prioritise the provision of water (where feasible) to permanent freshwater wetlands and pools to retain their values as refuge sites for aquatic fauna species during drought. Consider species specific recovery and adaptation actions (e.g. translocations) to build species resilience to landscape and climate change	DEW SEWCDB
W1, W2, W3	Seek opportunities to establish a strategic land purchase fund to acquire vulnerable wetlands that can be restored to support conservation	SEWCDB,SENRMB, NGOs

3. Retaining water strategic framework

Regional Objective
20 years

More surface **water is retained** in the landscape, replenishing groundwater, reducing marine discharge and supporting wetlands

Long term outcomes
>5 years

R1. More water is retained in inland drains and wetlands

R2. Drain ocean outlets are managed to reduce discharge rates

Our challenges

- Retaining large volumes of water in a flat landscape while maintaining drainage service.
- Finding areas where retaining water does not have an unacceptable impact on adjacent landholders.
- The resources that are required to redirect, retain and manage large volumes of water, including regulating the drain outlets.

What do we need to do?

Long Term Outcomes	Regional management action	Responsibility
R1	Support projects/works that seek to retain water in local wetlands, watercourses or drains	SEWCDB, SENRMB
R1	Identify landscape scale opportunities to retain water in the landscape and reconnect functioning systems	
R1	Divert water of suitable quality in drains to wetlands or regional watercourse systems with altered hydrology	SEWCDB
R1	Investigate opportunities and pursue funding to increase use of surface water to recharge groundwater (e.g. direct recharge, MAR, water holding dams)	All
R1	Increase the number of weirs in suitable drains to hold water late in the season	SEWCDB
R1	Retain water in wetlands of the far south coast to maintain groundwater pressure and reduce salt water intrusion into the unconfined aquifer	SEWCDB, SENRMB
R2	Support projects that seek to regulate major drain outfalls to reduce risks of storm surge and increase management options	SEWCDB, SENRMB

4. Water quality strategic framework

Regional Objective
20 years

Long term outcomes
>5 years

The **quality of water** in wetlands and drains is fit for its intended end use

WQ1. The quality of water in wetlands doesn't exceed their tolerance levels.

WQ2. The quality of water in drains is appropriate for its discharge point

Our challenges

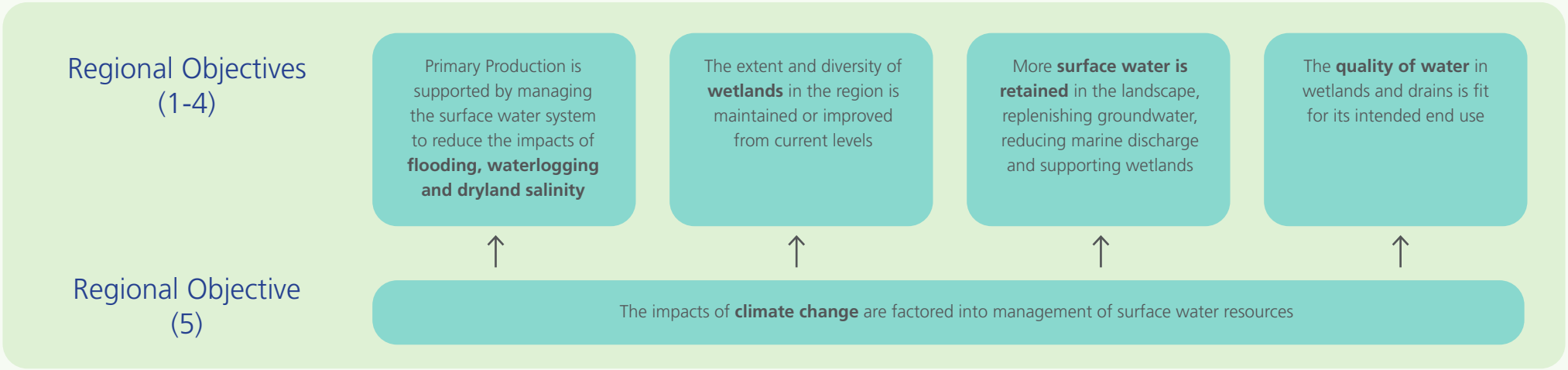
- There is little consistent data about surface water quality or water quality trends in the region.
- Investment in monitoring equipment, data storage and resources for analysis and reporting is very limited.
- There is little knowledge about changes in wetland ecosystems of the South East due to water quality change.
- Identifying diffuse and point sources of pollutants.
- Chemical processes in wetlands are complicated and variable.
- The need to balance diverting water of less than optimal quality into wetlands when it is the only water available.

What do we need to do?

Long Term Outcomes	Regional management action	Responsibility
WQ1, WQ2	Continue current monitoring programs for water quality and flow parameters and seek additional resources to instigate a more comprehensive monitoring program across the region (drains and wetlands) to inform decision-making in real time	SEWCDB DEW
WQ2	Develop appropriate (reasonable) limits of acceptable water quality to be discharged into wetlands	SENRMB, SEWCDB DEW
WQ1	Provide flushing freshwater flows via the drainage network, as available, whenever possible, to help manage nutrient and salinity build up and changes in pH	SEWCDB
WQ1, WQ2	Reduce regional scale (diffuse) nutrient inputs in surface water and groundwater by educating land managers	SENRMB Land managers
WQ1, WQ2	Investigate trends in water quality change and timing to identify peak sources and conditions that impact water quality	Land managers
WQ1, WQ2	Use wetland basins and vegetation to naturally filter and improve the quality of water in the system	All

5. Climate change strategic framework

The Regional Objective of factoring the impacts of climate change on surface water management is important for achieving the other four Regional Objectives



Our challenges

- Managing for the impacts of climate change on water availability.
- Managing climate risk or supporting adaptation of wetland species with specific environmental water requirements.
- The current and future impacts of storm surge and sea water inundation on low lying primary production and wetland systems near the coast.
- Maintaining our permanent wetlands as refuge habitat for highly mobile water birds and migratory waders as other habitats in Australia become drier and more episodic.

What do we need to do?

The Limestone Coast Regional Climate Change Adaptation Plan (Limestone Coast, 2015) was developed by key regional bodies and the community to consider climate projections and which assets will be most vulnerable to potential changes. It identified adaptation options that would support assets to be maintained. Water resources and wetlands were both identified as key priorities in the Plan. The adaptation priorities that were identified in the LC Regional Climate Change Adaptation Plan that are relevant to this Strategy are shown in the table below.

Adaptation code in brackets.

Regional Objective	Adaptation priority in Limestone Coast Regional Climate Adaptation Plan	Responsibility
1	Develop a new approach to the management of the drainage network and the allocation of water (W2)	SEWCDB, SENRMB
2	Establish environmental water allocations (NE6);	SENRMB, Stakeholders
	Undertake landscape-scale habitat restoration (NE7);	SENRMB, State/Cwth govts
	Prioritise wetlands for future investment (W1);	SENRMB
	Demonstrate the social and economic value of functional native ecosystems (NE3)	SENRMB
3	Investigate options to recharge aquifer with drainage water and options for retaining water in the landscape (WS6);	SENRMB, SEWCDB
	Greater use of the drainage network for localised groundwater recharge (IAHV2)	SEWCDB
4	Undertake land management activities that improve surface water quality and quantity (MBF)	SENRMB, Councils, Land managers

Regional management actions by regional objective

● Primary action for this objective
❍ Related Action for this objective

	1. Primary production			2. Wetlands			3. Retaining water		4. Water quality		5. Climate change
	P1	P2	P3	W1	W2	W3	R1	R2	WQ1	WQ2	CC
Maintain a regular schedule of drain cleaning and maintenance to ensure that existing drains function as designed (optimally)	●	●									
Operate infrastructure to provide short-term drainage service to productive land adversely impacted by flooding, waterlogging and dryland salinity	●										
Work with local landholders to ensure that private and public drains are managed effectively, consistently and in an agreed manner	●	●	●	❍	❍	❍					❍
Establish more weirs in drains to slow water movement and improve recharge at the tail end of the wet season			●				❍				❍
Continue current monitoring programs for water quality and flow parameters and seek additional resources to instigate a more comprehensive monitoring program across the region (drains and wetlands) to inform decision-making in real time	●	●	●			❍			●	●	❍
Encourage retention of water locally wherever possible			●	❍	❍	❍	❍	❍			❍
Support projects that seek to regulate major drain outfalls to reduce risks of storm surge and increase management options	●	❍	●	❍			❍	●		❍	❍
Build relationships and communicate effectively with local landholders about the management and operation of the drainage network	●	●	●								
Improve the risk assessment and allocation of water for groundwater dependent ecosystems in Water Allocation Plans			❍	●	●	●					❍
Divert water of suitable quality in drains to wetlands or regional watercourse systems with altered hydrology	●		❍	●	●	●	●		●	❍	❍
Document high value sites and ensure that they have updated management prescriptions to ensure that hydrological and land use threats are managed appropriately				●							❍
Manage regional scale (diffuse) nutrient levels in surface water and groundwater by educating land managers	❍	❍	❍	●	●				●	●	❍
Support projects/works that seek to retain water in local wetlands, watercourses or drains			❍	●			●	●			❍

	1. Primary production			2. Wetlands			3. Retaining water		4. Water quality		5. Climate change
	P1	P2	P3	W1	W2	W3	R1	R2	WQ1	WQ2	CC
Support landholders/projects that seek to reinstate the natural hydrological function of wetlands (e.g. reinstating breached sills, regulating outlets)			❍	●			❍	❍			❍
Prioritise the provision of water (where feasible) to permanent freshwater wetlands and pools to retain their values as refuge sites for aquatic fauna species during drought. Consider species specific recovery and adaptation actions (e.g. translocations) to build species resilience to landscape and climate change				●			❍	❍			❍
Identify landscape scale opportunities to retain water in the landscape and reconnect functioning systems			❍	❍	●	●	●				❍
Support landholders/projects that seek to reinstate the original (natural) hydrological function of wetlands (e.g. reinstating breached sills, regulating outlets)				●	●	●	●				❍
Investigate opportunities and pursue funding to increase use of surface water to recharge groundwater (e.g. direct recharge, MAR, water holding dams)			❍				●				❍
Increase the number of weirs in suitable drains to hold water late in the season			❍				●		❍		❍
Retain water in wetlands of the far south coast to maintain groundwater pressure and reduce salt water intrusion into the unconfined aquifer			❍				●		❍	❍	❍
Develop appropriate (reasonable) limits of acceptable water quality to be discharged into wetlands				❍						●	❍
Provide flushing freshwater flows via the drainage network, as available, whenever possible, to help manage nutrient and salinity build up and changes in pH		❍		❍	❍	❍			●		❍
Investigate trends in water quality change and timing to identify peak sources and conditions that impact water quality									●	●	❍
Use wetland basins and vegetation to naturally filter and improve the quality of water in the system				❍	❍	❍			●	●	❍
Continue to review the occupational license system for drainage reserves including improved documentation and management conditions to improve land and water management outcomes.	●			❍	❍	❍					
Seek opportunities to establish a strategic land purchase fund to acquire vulnerable wetlands that can be restored to support conservation.				●	●	●	●	●	❍	❍	❍

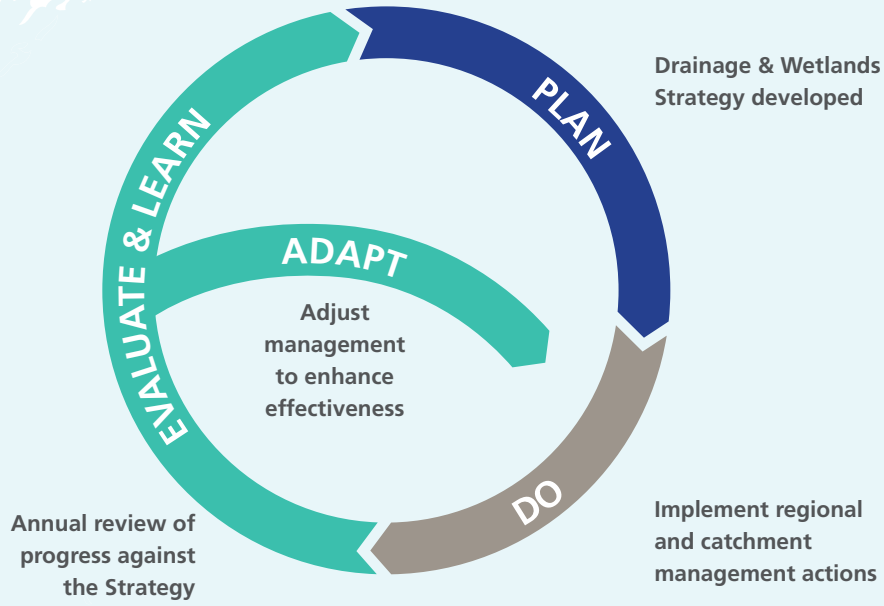
Monitoring progress and adaptive management

The implementation of this strategy will require a collaborative effort by the South Eastern Water Conservation and Drainage Board and the South East Natural Resources Management Board, Federal and State governments, Councils, land managers and the community.

The boards are committed to monitoring progress of the implementation of this Strategy. This will be achieved through annual reporting to both boards outlining progress against the regional management actions. The Boards will monitor achievements under the strategy using Key Performance Indicators (KPIs) that align with the SE Regional NRM plan indicators.

The following table shows some suggested KPIs that could be used by both of the Boards to measure achievement against the regional objectives.

Regional Objectives	Suggested basic KPI's
1. Primary Production is supported by managing the surface water systems to reduce the impacts of flooding, waterloggin and dryland salinity 2. The extend and diversity of wetlands in the region is maintained or improved from current levels 3. More surface water is retained in the landscape, replenishing groundwater and reducing marine discharge 4. The quality of water in wetlands and drains is fit for its intended end use 5. The impacts of climate change are factored into management of surface water	• Area of agricultural land inundated (use of WOfS)* • Number of wetlands in moderate or good Hydrological State* • Area of wetlands inundated (WOfS)* • Analysis of above by wetland type as indicator of diversity change* • Volume of water discharged to marine environment from drains • Number of area of wetland habitat reinstated or under altered management • Nutrient, salinity and pollutant levels at major diversion and discharge points **WOfS - refer methodology and baseline discussed in technical supplement oand Harding (in prep, 2019)*



Additionally, there are a number of management actions in the Strategy that focus on monitoring water quality, flows, and the ecological values and condition of wetlands.

This additional monitoring is the ultimate test of whether the actions are working and the condition of the resources is being maintained or improved.

An adaptive management approach is adopted by the boards in the implementation of their programs. This means decision-making is adapted in response to changes in conditions, monitoring, and local knowledge from the community.

Part C

Catchment Descriptions

Catchment Management Units

To identify values, issues and strategic actions that are locally meaningful, the region has been divided into catchment management units.

These were created based on the underlying hydrology, natural and drainage catchment boundaries, drainage infrastructure and purpose, the influence of groundwater, and water quality characteristics.

In Part C, each catchment management unit is examined in more detail, including a brief description of values, issues and threats. Catchment specific management actions are also identified to help meet the regional objectives.

1. Saline Swamps

Naturally saline swamps. Water management focused on diverting water to the Coroong.

2. Coorong Watercourses

Extensive drainage system in the interdunal watercourses. Drains divert water to the north. Many high priority interdunal wetlands.

3. Central Watercourses

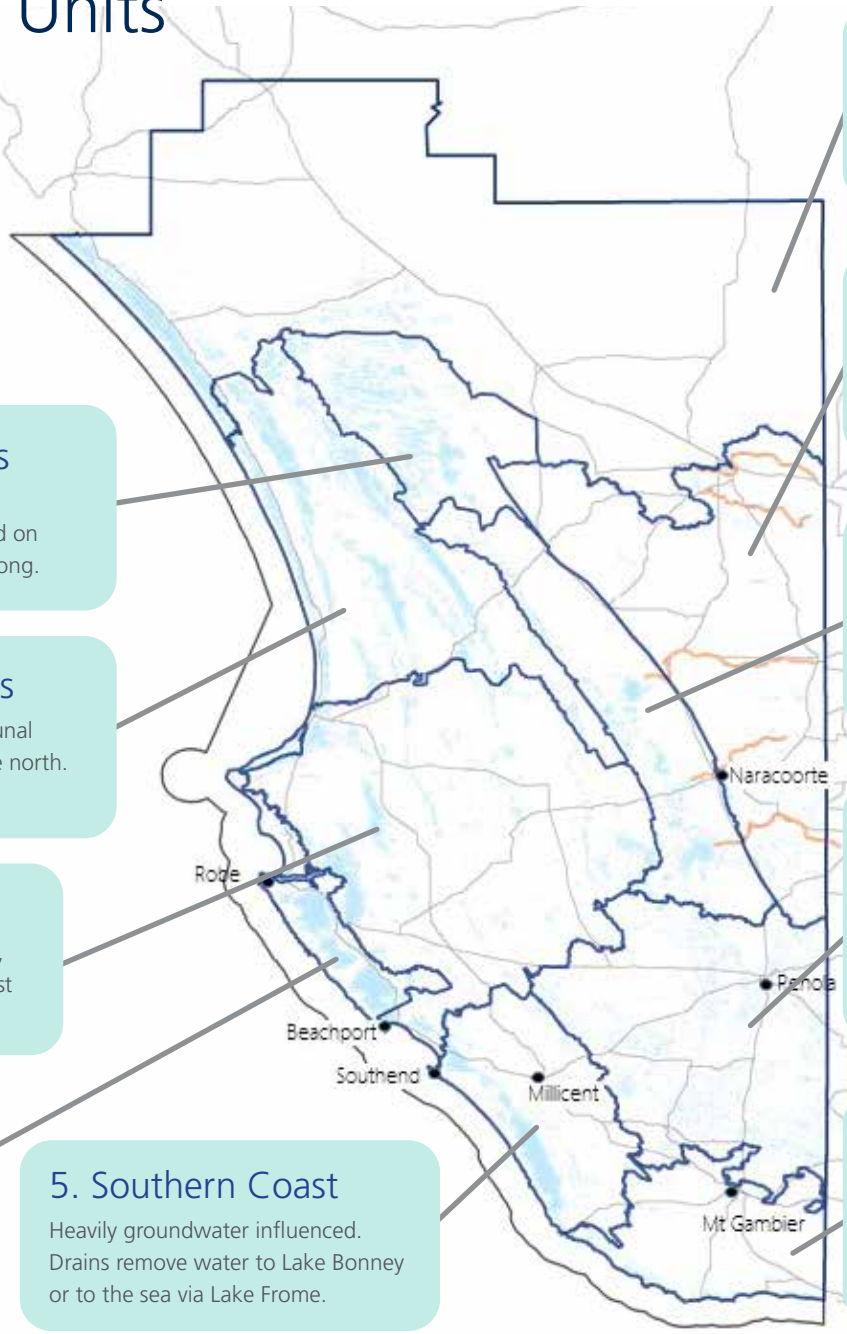
Freshwater watercourses fed by groundwater, extensive drainage system. The large east-west drains run to the sea through this catchment.

4. Central Coast

Large coastal salt lakes and coastal dune lakes. Most lakes not impacted by drains (except Lake George).

5. Southern Coast

Heavily groundwater influenced. Drains remove water to Lake Bonney or to the sea via Lake Frome.



6. Mallee

Few drains or management structures. Surface water driven by rainfall and groundwater.

7. Cross-border Creeks

Few drains or management structures, driven by flow across the border and down the creeks

8. Inland Lakes

Low lying receiving environment for flows from the creeks. Intensively managed drainage system with freshwater lakes.

9. Glenelg Plain

Few drains in the east, some drains from Mt Burr direct water north. Many small wetlands in plantation estate driven by local rainfall and groundwater.

10. Karst Volcanics

Heavily groundwater influenced system with permanent wetlands. Drains near the coast discharge large volumes of water to the sea.

1. Saline Swamps Catchment Management Unit

The Saline Swamps Catchment management unit has many unique natural areas, with Gum Lagoon, Bunbury and Messent Conservation Parks providing habitat for Malleefowl and many other species. The surface water in this catchment is often brackish to saline but there are freshwater pockets scattered throughout. 87% of the catchment is used for livestock (84%) and other agricultural (3%) production.

Many of the drains in this catchment were constructed in the 1990s and 2000s. They aimed to leach saline groundwater away from the rootzone of plants to support agricultural productivity.

Many of these groundwater drains are greater than two metres deep and have had widespread impacts on the availability of water in the landscape. This catchment is serviced by 330kmof drains including the Rosemary Downs, Taunta hut, Mt Charles and Bunbury drains wh ich direct water to the Coorong via the Northern Outlet drain.

There is a relatively large number of regulators in the catchment (20) which are used to divert saline flows away from wetland s, or to retain water, and support production, when flows are fresh.

Intermittent large flows from the south and the east were traditionally important to provide flushing, fresh water to the wat ercourses. This water helped to maintain the character and function of the large inland swamps of the catchment.

The timing and volume of these flows have been much changed by the development of the drainage network and many of these wetlands are in altered condition and now support more brackish to saline species. The invasion of shrub species into the bed of wetlands is an indicator that these wetlands are not as wet as they once were. When shrub densities are high in wetlands, the amount of viable open water habitat for waterbirds is reduced.

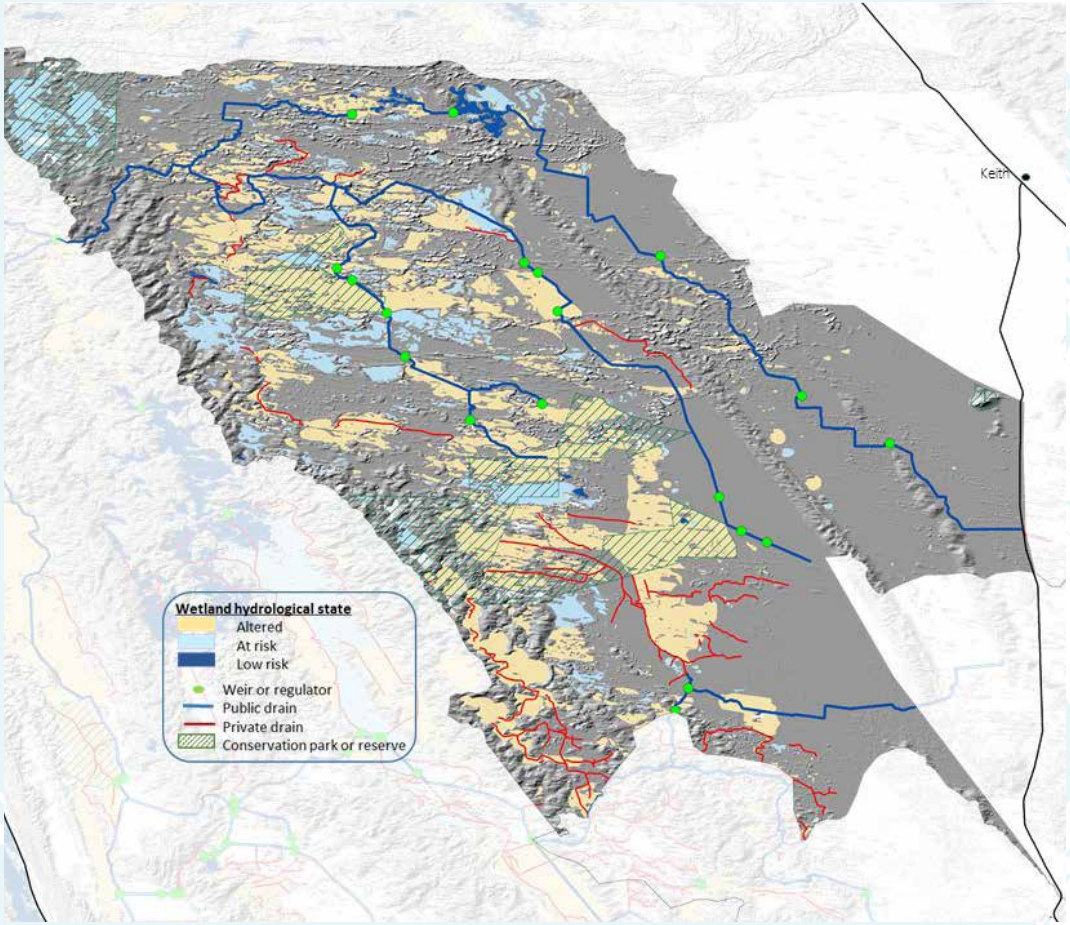
Many swamps are found on private land.

Conservation reserves make up 11% of the area, much of this is found in the larger conservation parks, some of which support large areas of saline swamps.

Community Priorities

Improving the salinity of water in drains and wetlands.

Wetlands on private and public land and providing water to support the species that rely on them.



Surface water management issues

- Increasing salinisation of soil and wetlands as salts accumulate in the root zone
- Drying of the soil profile/landscape due to drainage and reduced rainfall/flow
- Reduced availability of freshwater flushing flows to leach flush salts from soil profile
- Reduced surface water availability as rainfall decreases
- There are a large number of regulators on drains that can be or are operated to retain water in the landscape.

Wetland issues

Hydrological condition

Almost all (96%) wetlands in the catchment are heavily connected to groundwater, in this catchment saline groundwater is close to the surface.

- Of the 850 that can be detected by satellite imagery:
  - 501 (59%) are in an altered hydrological state, meaning that they are dry or getting drier
  - 330 (39%) are at risk of getting drier
  - 19 (2%) are at low risk, meaning at least part of the wetland has stable hydrology, driven by naturally saline groundwater (sometimes with drain inputs).
  - 417 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

- Changed salinity regime is a risk to all wetlands as rainfall and surface water availability and freshening watercourse flows continue to decline.

Land use implications

Most wetlands (1091) occur on private land, although a large number of these (489) are at least partially surrounded by native vegetation, land use threats to these wetlands are considerably reduced. Threats associated with landuse include:

- physical disturbance, including ploughing, mounding and planting with non-native species
- grazing, trampling and pugging of soil associated with stock
- higher pesticide, herbicide and nutrient levels from run off or overspray
- pest plant and pest animals impacts.

Infrastructure	Amount	% of regional
Drains and watercourses - public	172 kms	6.6%
Drains and watercourses – private	159 kms	2.7%
Regulators and weirs	20	11%

Wetland type	Number	% of regional
Saline Swamps	1003	35%
Grass Sedge Wetlands	3	0.03%
Interdunal Swamps	10	0.9%
Unknown	251	21%
Total	1267	7.28%

Strategic Opportunities

- Review the operation of the regulators of the catchment to determine if alternative operation would provide benefits for landholders and/or wetlands.
- Increase our knowledge about wetland function, values and condition – there is little data about the values and function of the wetland of the catchment.
- Manage the transition of wetlands communities to maintain values. For example – improving habitat values for water birds by managing the shrub invasion of wetland beds.

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging flooding dryland salinity**	Flooding Flows	**Monitor** the amount of surface water in the catchment during wet periods.			X	SEWCDB
	Dryland Salinity	**Manage flow** of saline groundwater in drains to divert appropriate quality water to en-route wetlands or the Coorong (via Morella Basin).		X	X	SEWCDB
		Maintain groundwater drains that flow during dry to average years.	X	X		
		Monitor salinity levels in drains UNDER different conditions.	X	X	X	
	Soil Moisture	**Retain** fresher water in groundwater drains and wetlands to support pasture growth at the tail end of season		X	X	SEWCDB
	Community involvement	**Build** relationships with community members to develop cooperative management solutions for drainage infrastructure	X	X	X	SEWCDB
2 **Wetlands**	All wetlands	**Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animal, altered surface water availability) Restore fringing riparian vegetation.	X	X	X	Land managers
	Saline swamps in good hydrological condition – in reserve or remnant vegetation	**Restore** flow to priority sites that retain function and values if feasible.		X	X	SEWCDB Land Managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.	X	X	X	DEW, SENRMB
	Regulated wetlands	**Improve** the condition of all wetlands that are regulated by reviewing the management (especially hydrological) and function of existing regulators		X	X	DEW, SEWCDB
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any available freshwater over late spring summer to support soil moisture, recharge and wetland processes.		X	X	SEWCDB
		Support projects that seek to retain more fresh water in landscape.		X	X	SENRMB
4 **Water quality**	Fresh surface water and saline groundwater interactions/balance	**Restore** freshwater flushing flows to watercourses from southern catchments if feasible.		X	X	SEWCDB
		Reduce the amount of chemicals entering surface water through education of land managers.	X	X	X	SENRMB, Land managers
		Monitor the quality of water in surface water systems	X	X	X	
	Salinity tolerances	**Adapt** decisions about the quality of water diverted to wetlands based on knowledge of their salinity tolerances, water availability and monitoring data.		X	X	SEWCDB, Land managers
	Discharge points to downstream values	**Monitor** the quality of water being discharged to the Coorong Watercourses.		X	X	SEWCDB

2. Coorong Watercourses Catchment Management Unit

The Coorong Watercourses Catchment surface water hydrology is driven by flows from the south and east. Surface water in the catchment historically pooled and flowed along the broad watercourses formed on the inter-dunal flats. Large volumes of fresh flushing flows used to move through the catchment towards the north and the Coorong. As a consequence, this catchment once supported many freshwater wetlands.

Now, surface water in the catchment is heavily managed with drainage infrastructure established largely under the Upper South East Program to help manage the impacts of dryland salinity on agricultural land and wetlands. Deeper groundwater drains running parallel to the watercourses now divert water to the north more directly but have also disrupted the movement of local surface water into wetlands. Theses drains carry the first flush of salty water in winter as salt is leached from the soil profile but become fresher later in the season.

The construction of the Blackford/Fairview drain to take water to the sea, along the bottom of the catchment also changed the availability of fresh flushing flows to the catchment significantly.

Providing adequate water to watercourse wetlands is a challenge in this landscape, and a range of different infrastructure options have been developed to improve management.

Drain management is important for primary production in the catchment with 84% of land used for livestock production and 4% for other forms of agriculture.

Brackish to saline water intercepted by drains is diverted north towards the Coorong, providing much needed inputs of fresher water to the hypersaline southern lagoon of the Coorong. Flows are directed through Morella Basin and released via Salt Creek.

The South East Flows project has directed water through this catchment, from the Blackford drain. The project has resulted in the reduction in the volume of fresh water being disposed of to the sea at Kingston. En-route wetlands of the Tilley Swamp watercourse will benefit from flows diverted through the watercourse and less water will be lost to the sea.

Conservation reserves make up 9% of the catchment but there are large parcels of remnant vegetation, including wetlands, on private land.

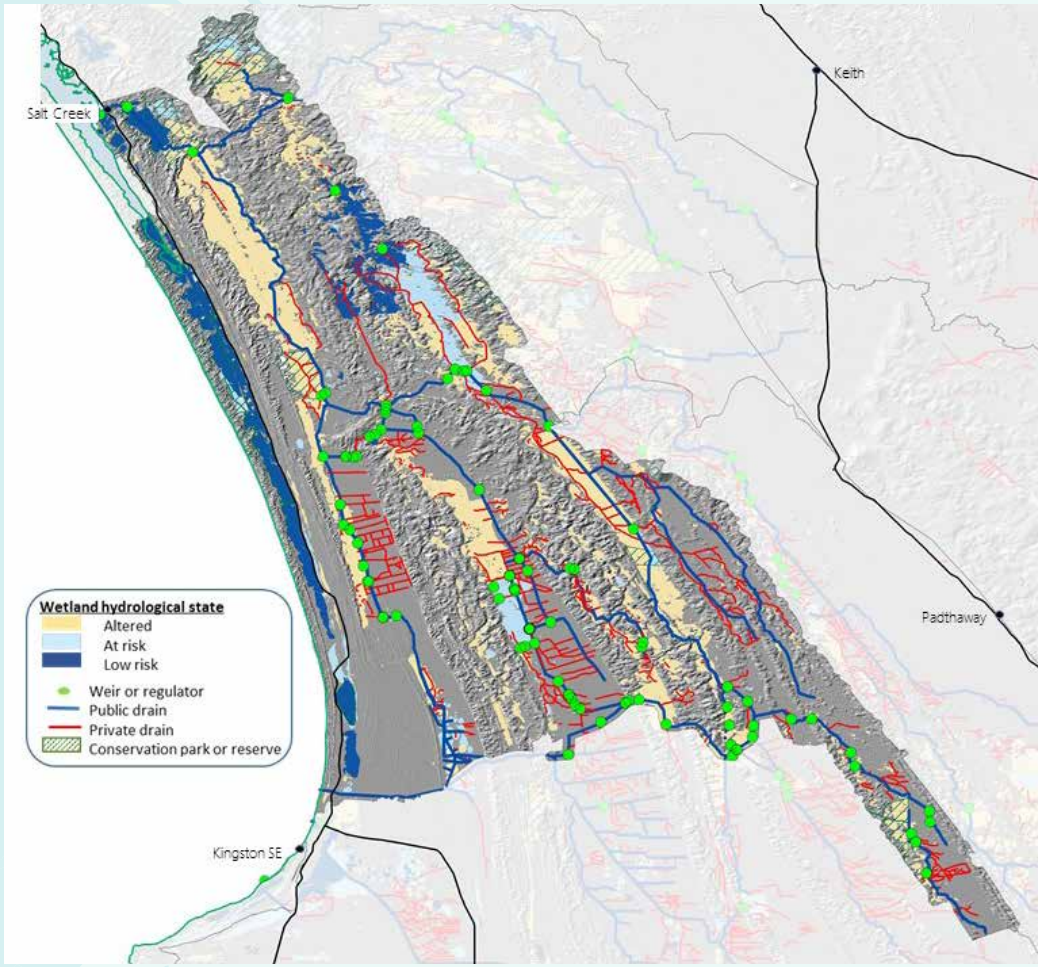
Community Priorities

Improving the salinity of water in drains and wetlands

Managing waterlogging and dryland salinity impacts

Wetlands on private and public land and providing water to support the species that rely on them

Providing flows to the Coorong



Surface water management issues

- Large amount of surface water management infrastructure to maintain and manage
- Increasing salinisation of soil and wetlands as salts accumulate in the root zone
- Drying of the soil profile/landscape due to drainage and reduced rainfall/flow availability
- Reduced availability of freshwater flushing flows to flush salts from the system
- There are a large number of landholders who are involved in helping to manage infrastructure
- Management plans are used to help ensure that water is managed consistently but this requires effort and resources to manage, update and monitor.

Infrastructure	Amount	% of regional
Drains and watercourses - public	622 kms	24%
Drains and watercourses – private	650 kms	11%
Regulators and weirs	108	61%

Wetland issues

Hydrological condition

Almost all (93%) wetlands in the catchment are connected to groundwater. In this catchment saline groundwater is close to the surface although there may be fresher shallow groundwater lenses under some wetlands.

- Of the 1106 that can be detected by satellite imagery:
  - o 757 (68%) are in an altered hydrological state, meaning that they are dry or getting drier
  - o 273 (25%) are at risk of getting drier
  - o 76 (7%) are at low risk, meaning at least part of the wetland has stable hydrology
- 276 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Wetland type	Number	% of regional
Salt Lakes	12	57%
Saline Swamps	696	24.5%
Grass Sedge Wetlands	76	0.8%
Interdunal Swamps	160	34%
Unknown	437	21%
Total	1381	7.9%

Land use implications

Most wetlands (1185) occur on private land, and a large number of these (675) occur, at least partially in native vegetation, land-use threats to these wetlands are considerably reduced compared to wetlands that are not buffered by native vegetation.

Threats associated with land-use include:

- physical disturbance, like ploughing, mounding and planting with non-native species
- grazing, trampling and pugging of soil associated with stock
- higher pesticide, herbicide and nutrient levels from run off or over-spray.

Strategic Opportunities

- Consider the current operation of infrastructure in the catchment to determine if alternative operation would provide benefits for landholders and/or wetlands
- Actively manage the transition of altered wetlands to maintain as many values as possible. For example: improving habitat values for water birds by managing the shrub invasion of wetland beds
- Consider opportunities to re-establish freshening flows from southern watercourses,to improve the condition of wetlands and to freshen the landscape generally
- Retain available fresh water in drains or wetlands wherever possible.

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging flooding dryland salinity divert, manage flow, manage, retain, Monitor**	Waterlogging and flooding	**Divert** excess surface water into wetlands or drains (as quality dictates)		X	X	SEWCDB
		Manage wetland storages up and downstream to provide storage capacity to the limits of infrastructure and seasonal conditions Review private works in catchment to ensure capacity of the system is not exceeded for flood prone sections.		X	X	
		Monitor the amount of surface water in the catchment during wet periods.		X	X	
	Dryland Salinity	**Manage flow** of saline groundwater in drains to divert appropriate quality water to en-route wetlands or the Coorong (via Morella Basin).		X	X	SEWCDB
		Divert first flush of water in the season (typically, carrying the most salt) away from fresher wetlands, as quality improves, manage diversion to wetlands.	X	X		
		Monitor salinity levels in drains under different conditions.	X	X	X	
	Soil Moisture	**Retain** fresher water in groundwater drains and wetlands to support pasture growth at the tail end of season		X	X	SEWCDB Land managers
	Community involvement	**Build** relationships with community members to develop cooperative management solutions for drainage infrastructure	X	X	X	SEWCDB
2 **Wetlands**	Interdunal swamps in moderate to good hydrological condition – connected to network	**Maintain** flows to existing high value interdunal wetlands **Improve** the condition of all wetlands that have managed hydrology by reviewing the management and function of existing infrastructure		X	X	DEW, SEWCDB
	Sites in poor hydrological condition with low values	**Support Adaptation** of sites with altered hydrology that cannot be restored. Manage transition and or for other values.	X	X	X	SEWCDB, SENRMB
	All wetlands	**Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animal, altered surface water availability) Restore fringing riparian vegetation.	X	X	X	Land managers
	Interdunal swamps in good hydrological condition – disconnected from network/ creeks	**Restore** flow to priority sites that retain function and values if feasible.		X	X	SEWCDB Land managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.	X	X	X	DEW, SENRMB
	Refuge sites for threatened species (e.g. Henry Creek pools)	Manage refuge sites to maintain important refuge habitat for threatened species.	X	X	X	DEW, SEWCDB Land managers

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any suitable ground water over late spring/summer to prevent dehydration, support recharge and wetland processes.		X	X	SEWCDB
		Support projects that seek to retain more fresh water in landscape.	X	X	X	SENRMB
4 **Water quality**	Fresh surface water and saline groundwater interactions/ balance	**Restore** freshwater flushing flows to watercourses wherever feasible to improve water quality.		X	X	SEWCDB
		Reduce the amount of chemicals entering surface water through better communication and engagement with land managers.	X	X	X	SENRMB, Land managers
		Monitor the quality of water in surface water systems	X	X	X	
	Salinity and pH tolerances,	**Adapt** decisions about the quality of water diverted to wetlands based on knowledge of their salinity and pH tolerances, water availability and monitoring data.		X	X	SEWCDB, Land managers
	All wetlands	**Manage** wetting and drying regimes to reduce nutrient releases from sediment		X	X	
	Watercourses that don't receive adequate currently flow	**Manage** pH and salinity within tolerance ranges by flushing wetland systems with fresher water.		X	X	SEWCDB, Land managers
	Discharge points to downstream values	**Monitor** the quality of water being discharged to the Coorong.		X	X	SEWCDB

3. Central Watercourses Catchment Management Unit

The Central Watercourses Catchment surface water hydrology is driven by flow from the east, groundwater inputs and its own topography. Much of the catchment was historically a series of watercourses on the interdunal flats, now developed for agriculture. One of the most consistently flat and wet parts of the region, surface water creates widespread issues for farmers during wet years or wet seasons.

Fresh groundwater interacts freely with the surface water in this catchment and many of the low lying areas, including wetlands, both depend on groundwater and recharge it.

There are areas in the east of the catchment where groundwater has declined rapidly, associated with blue gum plantations.

The catchment is characterised by the amount of water that moves through it. The major drains that divert freshwater to the sea do so through this catchment. Blackford/Fairview border the north of the catchment, Drain L runs through the middle and Drain M skirts the bottom.

89% of the catchment is used for livestock production with more hardwood forestry than other catchments.

Drain management is important for primary production in the catchment, which has almost 3000km of drains, around two thirds of which are privately managed.

Fresh water is diverted to the west and north before being drained to the sea. The conservation estate in this catchment is fairly small (around 2% of the area) but includes some of the most important wetlands of the region, like Lake Hawdon South.

Near Kingston, the Butchers Gap Conservation Park supports near coastal salt lakes and swamps.

There are significant large wetlands on private land and crown land.

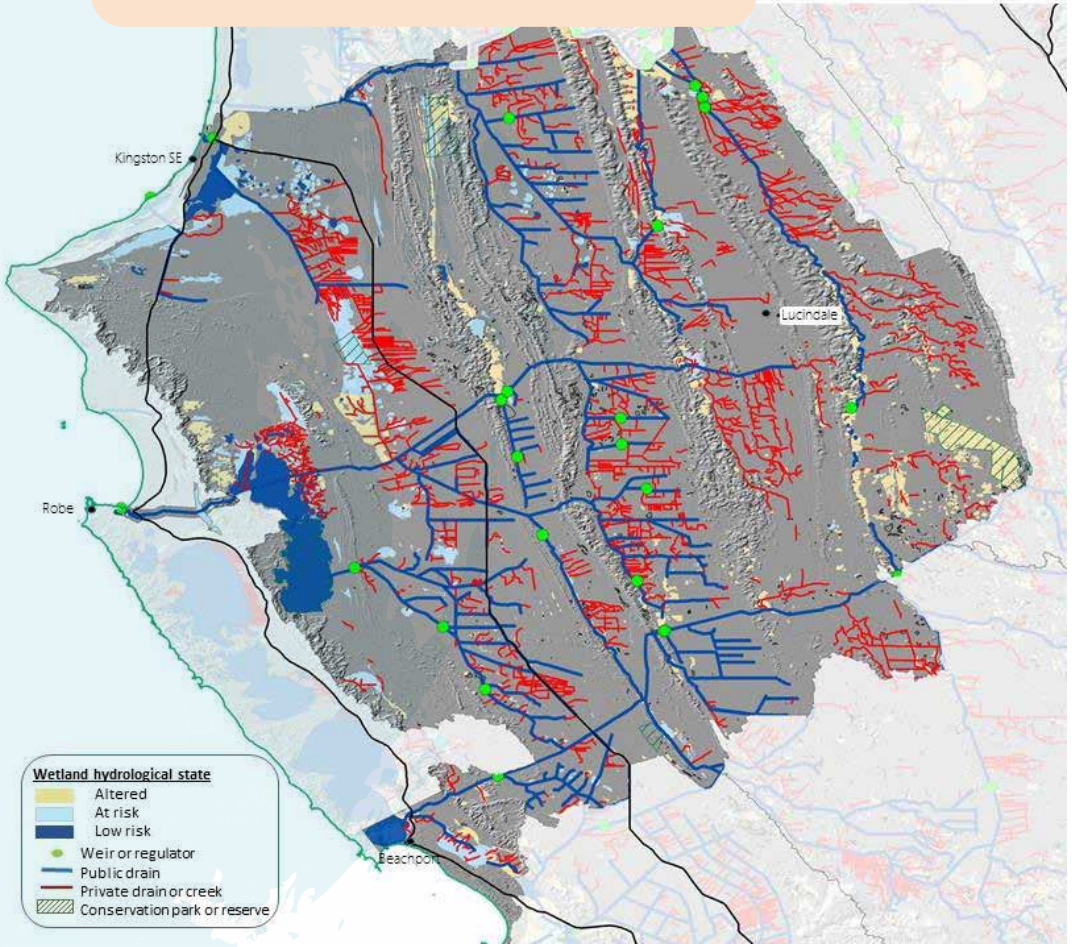
Community Priorities

Managing waterlogging of productive land

Maintaining water in the landscape to recharge groundwater

Keeping wetlands on private and public land and providing water to support the species that rely on them

Reducing waste of water to the sea



Surface water management issues

- Large amount of surface water management infrastructure to maintain and manage to support drainage service
- A very flat landscape with broad interdunal flats prone to waterlogging under wet conditions
- Sand build up in drains and sea outlets
- Nutrients and other pollutants in surface water
- Sea water risk to agricultural land and wetlands due to episodic storm surge up drains

Infrastructure	Amount	% of regional
Drains and watercourses - public	858 kms	33%
Drains and watercourses – private	1792 kms	30%
Regulators and weirs	23	13%

Wetland issues

Hydrological condition

Almost all (93%) wetlands in the catchment are connected to groundwater. In this catchment fresh groundwater is close to the surface in the west.

- Of the 1228 that can be detected by satellite imagery:
  - o 595 (48%) are in an altered hydrological state, meaning that they are dry or getting drier
  - o 541 (44%) are at risk of getting drier
  - o 92 (7.5%) are at low risk, meaning at least part of the wetland has stable hydrology
  - o 650 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Wetland type	Number	% of regional
Freshwater Lake	1	6.6%
Freshwater Meadows	2	2%
Peat Swamps	5	5%
Soaks and Springs	38	30%
Grass Sedge Wetlands	936	10%
Interdunal Swamps	343	37%
Saline Swamps	207	7%
Unknown	346	16%
Total	1878	9.2%

Land use implications

Most wetlands (1724) occur on private land, 105 in forestry and only 40 on public land.
Threats associated with land-use include:

- physical disturbance, like ploughing, mounding and planting with non-native species
- grazing, trampling and pugging of soil associated with stock
- higher pesticide, herbicide and nutrient levels from run off or over-spray

Strategic Opportunities

- Large scale retention of water in large wetlands near the coast and restoration of hydrological connectivity between wetlands
- Retain available fresh water in drains or wetlands wherever possible to support permanent refuge values
- Managing wetlands to improve their value for use for tourism and recreational activities
- Preserving Drain L as a Gambusia free area
- Managing the availability of flow to Lake George to maintain its water requirements, including investigating options to divert flow from the Reedy Creek-Mt Hope drain and reduce reliance on flows from Drain M and Bool Lagoon
- Loss of habitat for threatened aquatic species
- Risks to migratory bird habitats protected by international treaties
- Maintaining groundwater availability to highly groundwater dependent wetlands

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging flooding dryland salinity**	Waterlogging and flooding	**Divert** excess surface water into wetlands or drains (as quality dictates).		X	X	SEWCDB
		Manage wetland storages up and downstream to provide storage capacity to the limits of infrastructure and seasonal conditions **Review** private drainage works in catchment to ensure capacity of the system is not exceeded for flood prone sections.		X	X	
		Monitor the amount of surface water in the catchment during wet periods.		X	X	
	Flooding and waterlogging of agricultural land upstream (Bray Drain) of Lake Hawdon South	**Manage** flow – review options to improve flow within Lake Hawdon South altered by vegetation encroaching in the lake bed. Investigate the use of fire or other passive methods consistent with the ecological values of the site.		X	X	DEW
		Monitor new private works applications in Bray drain catchment to ensure capacity of the system is not exceeded for flood prone sections.	X	X	X	SEWCDB
	Soil moisture	**Retain** fresher water in groundwater drains and wetlands to support pasture growth at the tail end of season.		X	X	SEWCDB Land managers
	Impacts to seagrass beds from drain outflows	**Manage** wetland storages up and downstream (Drain M, Blackford, Maria Creek, Butchers Gap) to reduce the impacts of freshwater/nutrients on seagrass beds.		X	X	SEWCDB
	Community involvement	**Build** relationships with community members to develop cooperative management solutions for drainage infrastructure.	X	X	X	SEWCDB
2 **Wetlands**	Lake Hawdon South Thrombolites	**Maintain** the condition of the site by managing the water levels and quality to protect the Thrombolites values as outlined in the Park Management Plan. Thrombolites are likely to have a high degree of dependency on water of the right quality to support function of the microbiota. **Investigate** options to further recognise and protect the unique community of the Thrombolites by listing under the EPBC Act.		X	X	DEW SEWCDB
	Gambusia free status of Drain L	**Manage** any connectivity to Drain L to ensure that Gambusia holbrooki (Mosquito fish) don't invade the catchment.	X	X	X	SEWCDB
	Interdunal swamps in moderate to good hydrological condition (eg Lake Hawdon North)	**Maintain** flows to existing high value interdunal wetlands **Improve** the condition of all wetlands that have managed hydrology by reviewing the management and function of existing infrastructure.		X	X	SEWCDB
	Interdunal swamps in moderate hydrological condition – disconnected from network	**Restore** flow to priority sites that retain function and values if feasible.		X	X	DEW, SEWCDB
	Sites in poor hydrological condition with low values	**Support adaptation** of sites with altered hydrology that cannot be restored. Manage transition and or for other values.	X	X	X	SEWCDB, SENRMB

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any suitable ground water over late spring/summer to prevent dehydration, support recharge and wetland processes.		X	X	SEWCDB
		Support projects that seek to retain more fresh water in landscape.	X	X	X	SENRMB
	All drains	**Investigate** opportunities to reduce marine discharge by diverting or retaining more freshwater. **Support** proposals that seek to increase retention or reuse of freshwater locally.	X	X	X	SEWCDB, SENRMB
4 **Water quality**	Water quality	**Reduce** the amount of chemicals entering surface water through better communication and engagement with land managers.		X	X	SEWCDB, SENRMB, Land managers
		Monitor the quality of water in surface water systems	X	X	X	
	Salinity and pH tolerances, All wetlands	**Adapt** decisions about the quality of water diverted to wetlands based on knowledge of their salinity and pH tolerances, water availability and monitoring data.		X	X	SEWCDB, Land managers
		Manage wetting and drying regimes to reduce nutrient releases from sediment	X	X	X	
	Wetlands on the nework that don't receive adequate volumes of flow to promote turnover.	**Manage** pH and salinity within tolerance ranges by flushing wetland systems with fresher water.		X	X	SEWCDB, Land managers
	Discharge downstream values	**Monitor** the quality of water being discharged to the sea.		X	X	SEWCDB

4. Central Coast Catchment Management Unit

The Central Coast Catchment is characterised by the outflow of water to the sea with Drain L, Drain M and the Butchers Gap Drain meeting the sea through this catchment. Despite this the unit has only small amounts of surface water management infrastructure with only 2 regulators (both at coastal drain outlets) and 10km of public drains.

The large drain outfalls are important infrastructure that is regularly impacted by coastal issues, like sand build up and storm surge. Freshwater discharged from the drains has been linked to the loss of seagrass beds in the bay.

The catchment is home to three of the regions large coastal lakes - Lake St Clair, Lake George and Lake Eliza, as well as numerous smaller permanent coastal lakes. These wetlands are all heavily dependent on groundwater and range from fresh to saline in water quality. Lake George is an important wetland of the region that also receives fresh surface water flows from Drain M.

The large coastal lakes are significant in the region and nationally. They are some of the most intact wetlands in the region, embedded in conservation estate or crown land and often surrounded by bushland.

The coastal lakes are important sites for tourism and recreation and add a unique element to coastal towns like Beachport and Robe. Lake George is an important wetland of the catchment that once supported a commercial fishery.

63% of the catchment is used for livestock and other agricultural production. The catchment is very important for tourism. The coastline and the marine values (including seagrass meadows) are important assets for fishing and tourism industries. The conservation reserves, making up 23% of the area, and relatively untouched coastline are important recreational assets for tourists and residents.

Coastal lakes support feeding habitat for waders and other waterbirds, and at times, support significant number of international migratory waders, which spend the summer here before heading back to their breeding grounds in the northern hemisphere.

The presence of adequate food, shallow water and exposed mud flats are all prerequisites that the large lakes supply.

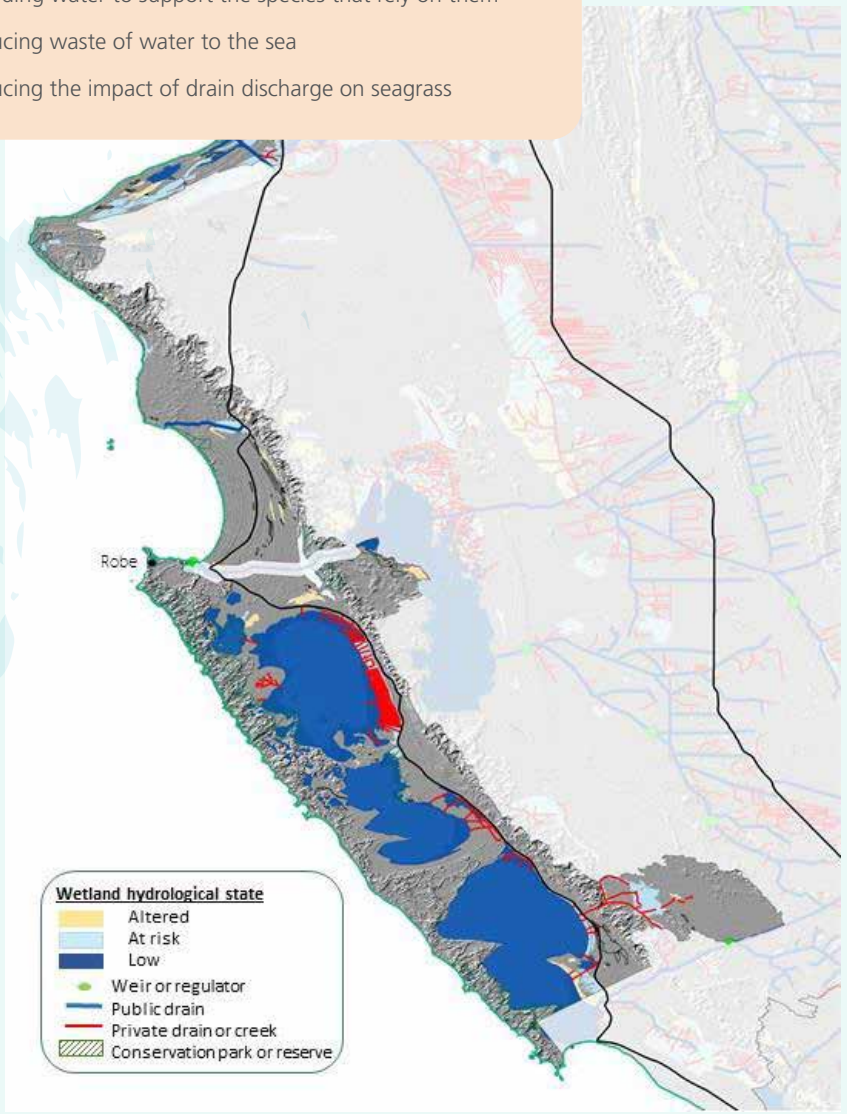
Community Priorities

Managing water availability to Lake George

Keeping wetlands on public land in good condition and providing water to support the species that rely on them

Reducing waste of water to the sea

Reducing the impact of drain discharge on seagrass



Surface water management issues

- Sand build up in drains and sea outlets
- The impact of sea outlets on beach morphology, erosion, sedimentation and marine values
- Nutrients and other pollutants in surface water discharging to the Lakes, resulting algal blooms impact on amenity and tourism values
- In the Butchers Gap area and other parts of the catchment that are close to sea level there is a risk that storm surge associated with sea level rise will result in inundation of shacks, agricultural land and wetlands
- Providing sufficient water to meet the needs of Lake George

Wetland issues

Hydrological condition

- Almost all (93%) wetlands in the catchment are connected to groundwater, in this catchment fresh groundwater is close to the surface in the west.
- Of the 110 that can be detected by satellite imagery:
  - 28 (25.5%) are in an Altered hydrological state, meaning that they are dry or getting drier.
  - 32 (29%) are at risk of getting drier
  - 50 (45.5%) are are at low risk, meaning at least part of the wetland has stable hydrology
  - 80 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Land use implications

Most wetlands (153) occur on private land and 37 on public land. Those on public land are generally large. Threats associated with land use include:

- Coastal wetlands are subject to more recreational pressures than in other catchments but many recreational uses of wetlands are relatively passive
- Development of land for housing or tourism facilities is a direct risk to wetlands in the coastal catchments
- Wetlands in urban areas are often impacted by increased nutrients from runoff and septic systems
- Grazing, trampling and pugging of soil associated with stock in agricultural areas

Infrastructure	Amount	% of regional
Drains and watercourses - public	10 kms	<1%
Drains and watercourses – private	106 kms	2%
Regulators and weirs	2	1%
Coastal outlets	3	

Wetland type	Number	% of regional
Salt Lakes	6	27%
Coastal Dune Lakes	30	97%
Soaks, springs and peat swamps	35	16%
Grass Sedge Wetlands	40	<1%
Interdunal Swamps	3	<1%
Saline Swamps	58	2%
Unknown	18	<1%
Total	190	1%

Strategic Opportunities

- Infrastructure investment to mitigate risks associated with storm surge
- Supporting or improving the amount and quality of habitats for migratory waders and water birds to maintain the international standing of habitat
- Supporting or creating permanent refuge areas in drains or wetlands for threatened species including fish
- Managing wetlands to improve their value for tourism and recreational activities
- Managing the availability of flow to Lake George to maintain its water requirements
- Reducing nutrient rich marine discharge from drain outlets

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging, Flooding and Dryland Salinity**	Small scale waterlogging issues in low lying areas	**Maintain flow** in the Butchers Gap drain and Maria Creek as needed. Replace the Butchers Gap regulator to improve management feasibility and reduce risks of inundation with sea water **Encourage** landholders to maintain private drains appropriately		X	X	SEWCDB
	Impacts to seagrass beds from drain outflows	**Manage** wetland storages up and downstream (Drain M, Blackford, Maria Creek, Butchers Gap) to reduce the impacts of freshwater/nutrients on seagrass beds.		X	X	SEWCDB
2 **Wetlands**	Lake George	**Maintain** the condition of the site by managing the water levels to protect the values as outlined in the management plan (AHD 0.42-0.58, end of winter). Target flows to Lake George are 40GL when water is available).	X	X	X	DEW SEWCDB
	Lake Eliza, St Clair and other coastal dune lakes in good hydrological condition	**Improve** the condition of degraded sites by managing threats associated with adjacent landuses. **Manage** the impacts of weeds and feral animals on values. **Restore** fringing riparian habitat. **Maintain** the hydrology of priority GDE sites that retain values via the Lower Limestone Coast WAP.	X	X	X	SENRMB Land Managers
	Saline/ brackish wetlands of the Butchers Gap area	**Restore** a more natural hydrology to large drained brackish/saline wetlands of the Butchers Gap area. **Manage** weeds, feral animals and changes to vegetation communities.		X	X	SEWCDB SENRMB Land Managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	SEWCDB Land Managers
	Refuge sites for threatened species (e.g. permanent drain pools)	**Manage** refuge sites to maintain important refuge habitat for threatened fish.	X	X	X	DEW, SEWCDB Land Managers
3 **Retaining water**	All drains	**Investigate** opportunities to reduce marine discharge by diverting or retaining more freshwater upstream. **Support** proposals that seek to increase retention or reuse of freshwater locally.	X	X	X	SEWCDB, SENRMB
4 **Water quality**	Groundwater quality	**Reduce** the amount of farm pollutants, including nutrients entering surface water through education of land managers.		X	X	SEWCDB, SENRMB, Land managers.
			X	X	X	
	Drain discharges	**Improve** the quality of water being discharged to wetlands or the sea.	X	X	X	SEWCDB, Land managers.

5. Southern Coast Catchment Management Unit

The Southern Coast Catchment is driven by fresh groundwater expressing near or on the surface. Soils are rich and productive. Some of the first drainage schemes in the region started in this area in the 1860s around Millicent. The catchment has a fairly large amounts of drains for a small catchment, including 450 km of public and 240 km of private drainage works. These drains carry water to the west, either directly into Lake Bonney or Lake Frome (and then to the sea at Southend). Land use is focused on grazing and some cropping to the east of Lake Bonney and conservation and public land to the west.

While there are a large amount of drains, there is very little regulation (only 7 regulators in the entire catchment) and drains freely carry water.

The Millicent flats are highly productive areas for grazing (63% of the catchment is used for livestock and other agricultural production).

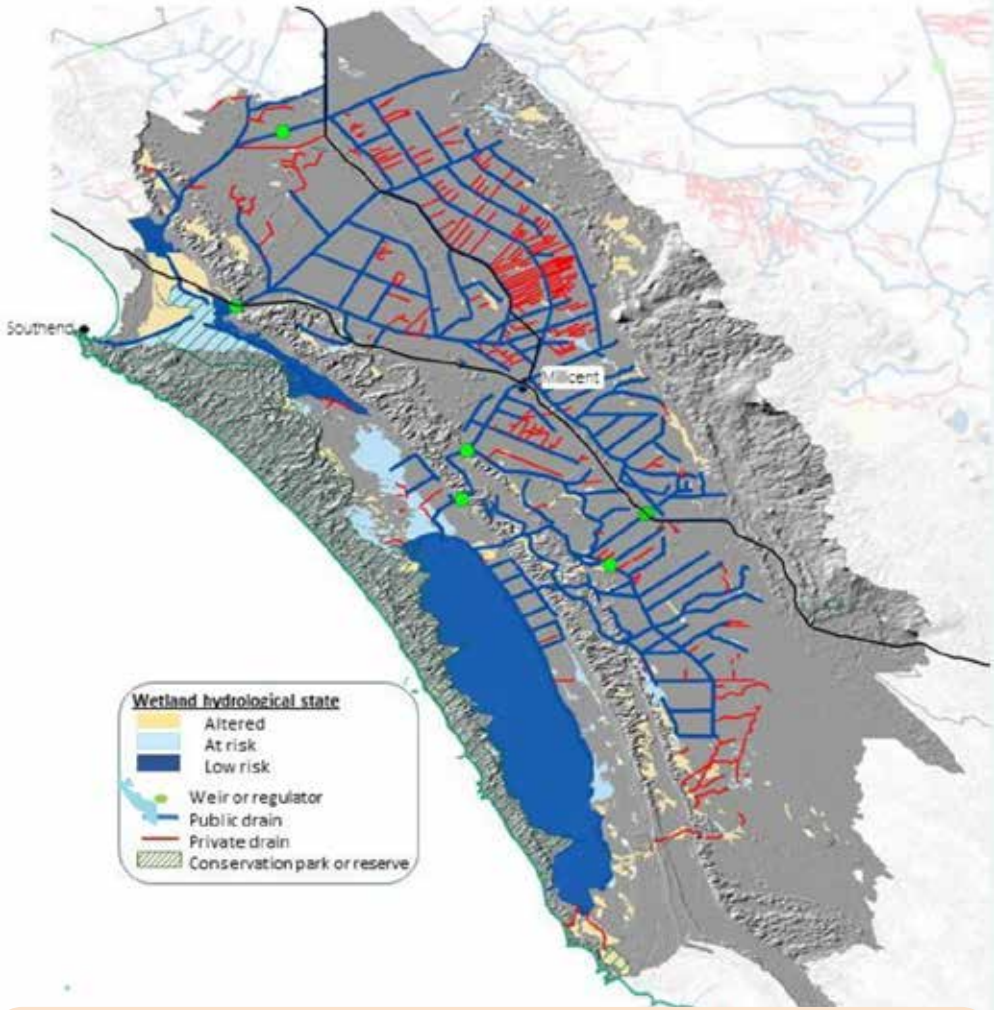
The whole of the coastline is very important for tourism and the Canunda National Park is a popular camping and fishing destination for residents and visitors.

Many of the wetland values in this region are concentrated near the coast, where groundwater drives wetland water availability. Lake Bonney is the largest wetland in the region and in fact is the largest freshwater lake in South Australia. Its condition has been very poor but it is rapidly improving.

Lake Frome is also ecologically important and, together with other shallower swamps, like Mullins swamp and the Iluka wetland, provides significant habitat for a wide variety of water birds and native freshwater fish.

Groundwater also drives a number of freshwater soaks and springs in this catchment including the Snuggery, the only inland karst spring.

The availability of groundwater and excess surface water means that there is considerable scope to restore drained and degraded wetland habitats in this catchment, to retain more water and reduce the impacts of drain discharges on seagrass beds and the coastline.



Community Priorities

Managing the impacts of discharge on the coast (erosion, sedimentation and nutrients)

Improving the condition of wetlands

Reducing waste of water to the sea

Managing storm water in townships

Reducing the impact of drain discharge on seagrass

Flooded caves

Surface water management issues

- Changes to beach morphology, erosion and impacts to seagrass beds associated with drain discharge at Southend
- Waterlogging of low lying agricultural land on the Millicent flats
- Loss of habitat for threatened aquatic species
- Sand build up in drains and sea outlets

Infrastructure	Amount	% of regional
Drains and watercourses - public	454 kms	17%
Drains and watercourses – private	239 kms	4%
Regulators and weirs	7	4%
Coastal outlets	1	

Wetland issues

Hydrological condition

Almost all (66%) wetlands in the catchment are connected to groundwater, in this catchment fresh groundwater is close to the surface near the coast.

- Of the 248 that can be detected by satellite imagery:
  - 174 (70%) are in an altered hydrological state, meaning that they are dry or getting drier
  - 65 (26%) are at risk of getting drier
  - 9 (4%) are at low risk, meaning at least part of the wetland has stable hydrology
  - 299 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Wetland type	Number	% of regional
Permanent freshwater lake	1	7%
Freshwater meadows	2	<1%
Coastal Dune Lakes	1	3%
Soaks, springs and peat swamps	41	18%
Grass Sedge Wetlands	441	4%
Interdunal Swamps	26	3%
Unknown	35	1%
Total	547	3%

Land use implications

Most wetlands (338) occur on private land with 59 on public land and another 146 in forestry. Threats associated with land use include:

- grazing, trampling and pugging of soil associated with stock in agricultural areas
- high pesticide, herbicide and nutrient levels from run off or over-spray
- impacts of recreational activities, e.g. motor boating at recreational sites.

Strategic Opportunities

- Large scale retention of water in large wetlands near the coast and restoration of hydrological connectivity between wetlands, ensuring that mud flats are still available for waders
- Mitigating risks associated with storm surge at Southend Improving the condition of Lake Bonney, Lake Frome and other significant wetlands of the coastal areaof the coastal area
- Building tourism and recreational use of coastal wetlands
- Supporting or improving the amount and quality of habitats for migratory waders and water birds to maintain the international standing of this catchment
- Supporting or creating permanent refuge areas in drains or wetlands
- Reducing nutrient rich marine discharge at Southend and related erosion issues

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging, Flooding and Dryland Salinity**	Limited waterlogging issues on flats east of Lake Bonney	**Maintain flow** in the catchment drains. **Encourage** landholders to maintain private drains.		X	X	SEWCDB
	Storm surge up drain outlet (Lake Frome)	**Prevent storm surge** from entering wetlands via drains by regulating drain ocean outlets.		X	X	SEWCDB
2 **Wetlands**	Lake Bonney SE	**Improve** the condition of the site by managing threats associated with landuse **Manage** the impacts of weeds and feral animals on values. **Restore** fringing riparian habitat. **Maintain** the hydrology of priority GDE sites that retain values via the Lower Limestone Coast WAP.	X	X	X	DEW SEWCDB
	Lake Frome	**Restore** a more natural hydrological regime to Lake Frome to improve the amount of open water habitat and halt changes to its character.	X	X	X	SENRMB Land managers
	Grass sedge wetlands in good hydrological condition – connected to network	**Restore** the hydrology of sites that can be improved through manipulation or infrastructure.		X	X	SEWCDB SENRMB Land managers
	Freshwater fish	**Improve** the condition of wetlands important for native fish by reinstating connectivity, flows and improving water quality.		X	X	SEWCDB Land managers
	Refuge sites for threatened species (e.g. permanent drain pools)	**Manage** refuge sites to maintain important refuge habitat for threatened fish.	X	X	X	DEW, SEWCDB Land managers
3 **Retaining water**	All drains	**Investigate** opportunities to reduce marine discharge by diverting or retaining more freshwater upstream. **Support** proposals that seek to increase retention or reuse of water locally.	X	X	X	SEWCDB SENRMB
	Wetland restoration	**Investigate** the potential to retain large volumes of excess surface water either in existing degraded wetlands (like Lake Frome) or by restoring drained wetlands.				SEWCDB SENRMB DEW
4 **Water quality**	Lake Bonney site	**Monitor** the condition of water in Lake Bonney and ecosystem recovery.				DEW
	Discharge points to downstream values	**Monitor** the quality of water being discharge to other wetlands/ the sea.				SEWCDB DEW
	Groundwater quality	**Reduce** the amount of farm pollutants, including nutrients entering surface water through education of land managers.		X	X	SEWCDB SENRMB Land managers
			X	X	X	

6. Mallee Catchment Management Unit

The Mallee Catchment surface water is driven by rainfall generating local runoff. In the east of the catchment rare flooding flows from the Tatiara and Nalang Creeks make their way into the catchment, from the west, after Poocher and Mundulla Swamps fill. These flows, in a very wet year, may make their way via a poorly defined natural floodway towards what is now the Mount Charles drain (Saline Swamps Catchment) but this is very rarely reported.

The porous deep sands of the catchment ensure that there are no large volumes of surface water flow generated and as a consequence there are no publicly managed drains or other infrastructure.

81% of the catchment is used for livestock and other agricultural production, including cropping. Rainfall is an important source of stock and domestic water in this catchment and there is ongoing development of dams to catch local surface water runoff. Flows from the southern catchments were traditionally important to freshen watercourse wetlands and the Coorong.

Freshwater in otherwise dry or saline landscapes is significant for many species and the function of wetland systems.

The Coorong is an important part of the lives and beliefs of the Ngarrandjeri people.

It is an internationally significant wetland that is part of the Coorong and Lakes Alexandrina and Albert Ramsar site, most of which lies outside the region to the north.

The Coorong was originally listed because of the significant numbers of migratory waders and other water birds it supported.

Although its condition is altered the Coorong remains an iconic natural asset of the region and continues to support significant commercial fishery operations.

Improving the condition of the Coorong ha been a focus of onground and hydrological works throughout i ts catchment.

A very small number of inland freshwater swamps are found near the border with the cross-border creeks catchment on the floodplain of the Tatiara and Nalang creeks.

These wetlands are significant in a catchment that is otherwise drier and more saline than the rest of the South East landscape.

Most of the other wetlands of the catchment are naturally saline swamps which support their own unique values.

Community Priorities

Wetlands on private land

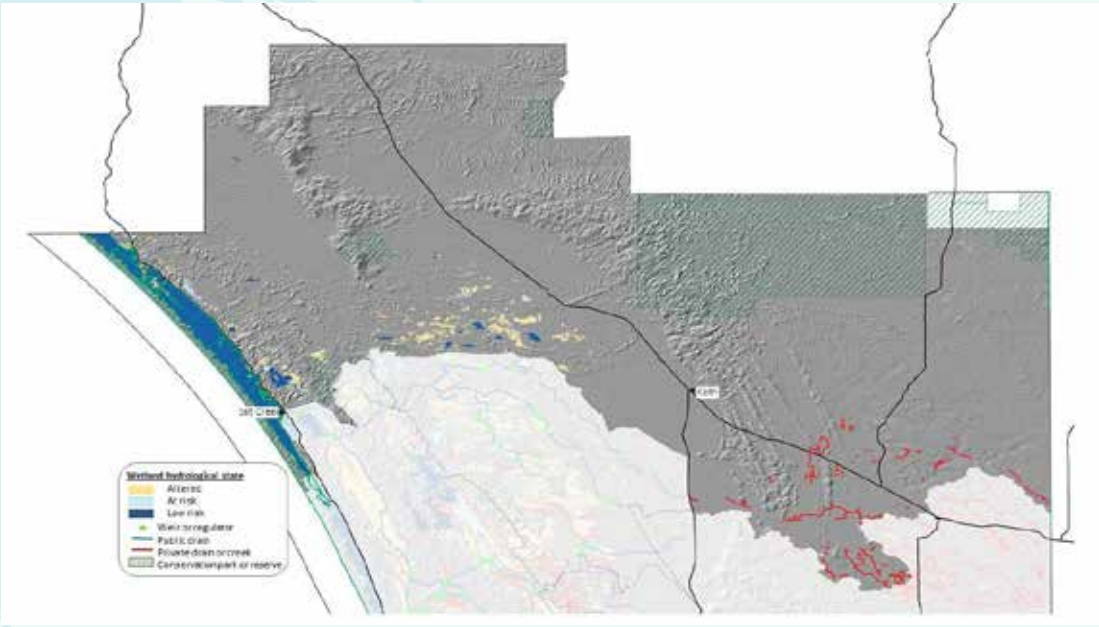
Runaway holes

The Coorong and Lower Lakes

Maintaining freshwater inputs including springs, seeps and flows from the south.

Retaining water in the landscape

Maintaining cultural values



Surface water management issues

- Occasional flooding of low lying areas to the east associated with rare flooding flows from the Tataiara and Nalang Creeks
- Dryland salinity issues as excess sub-surface water carries salt to the surface
- Reduced rainfall - reduced recharge of local aquifers that feed former fresh water sources (springs, soaks and wells).
- Increased nutrients in surface water
- Reduced surface water availability as rainfall decreases and diversion and interception increase.

Infrastructure	Amount	% of regional
Drains and watercourses - public	0 km	0
Drains and watercourses – private	182 km	3%
Regulators and weirs	0	0

Wetland issues

Hydrological condition

Almost all (95%) wetlands in the catchment are heavily reliant on saline groundwater close to the surface.

- Of the 546 that can be detected by satellite imagery:
  - 353 (65%) are in an altered hydrological state, meaning that they are dry or getting drier
  - 157 (29%) are at risk of getting drier
  - 36 (6%) are at low risk, meaning at least part of the wetland has stable hydrology
  - 257 have unknown hydrological state and little is known about the values and condition of most.

** For more information on the prioritisation method and results refer to the Technical Supplement*

- Altered salinity is a risk to saline and freshwater swamps as surface water availability and freshening flows decline.
- Declining flow and water quality to the Coorong South Lagoon from South East watercourses.

Wetland type	Number	% of regional
Saline Swamps and	749	26.40%
Salt Lakes	3	14.29%
Grass Sedge Wetlands	15	0.15%
Freshwater Meadows	20	1.60%
Wet Heath	3	30%
Unknown	13	0.58%
Total	803	4.61%

Land use implications

Most wetlands (90%) occur on farms. Threats associated with land use include:

- physical disturbance, including ploughing, mounding and planting with non-native species
- grazing, trampling and pugging of soil associated with stock
- higher pesticide, herbicide and nutrient levels from run off or over-spray
- weed and pest animals
- visitor impacts (reserves)

Strategic Opportunities

Improve the condition of the Southern Lagoon of the Coorong and survival of species associated with it by managing the values of the South East watercourses, the availability of water and the function of the system as a whole.

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging flooding dryland salinity**	Whole of catchment	**Monitor** the amount of surface water in the catchment during wet periods.			X	SEWCDB
		Monitor the quality of water in surface water systems.		X	X	
	Saline swamps in good hydrological condition – in reserve or remnant vegetation	**Improve** the condition of priority sites. **Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animal, altered surface water availability).			X	Land managers
2 **Wetlands**	Freshwater swamps and runaway holes	**Restore** the hydrology of priority sites that retain values if water is available. **Manage** risks by developing management plans for sites with significant values.			X	SEWCDB Land managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	DEW SENRMB
	Coorong Ramsar site	**Manage flow** to support the condition of the Coorong and the species that are important to its ecological character. **Monitor** change in water quality associated with flows from the South East and recovery of species and communities within the Lagoon.	X	X	X	DEW SEWCDB Research institutions
3 **Retaining water**	Few opportunities to retain freshwater in this system	Improve land management associated with dryland salinity in the catchment.				SENRMB Land managers
4 **Water quality**	All wetlands	**Reduce** the amount of chemicals entering surface water through education of land managers. **Monitor** the salinity of water in wetlands.				SENRMB Land managers SEWCDB

7. Cross-border Creeks Catchment Management Unit

The Cross-border Creeks Catchment is driven by flow down the creeks from their catchments that extend , into Victoria. The creeks are the Tatiara and Nalang, Morambro, Naracoorte and Mosquito Creeks. Of these Mosquito Creek has the largest catchment and produces the most flow.

In very high flow periods Mosquito Creek will flood for a period of days. In the same years Naracoorte Creek may produce localised flooding in the Naracoorte township. Flood waters drain down onto the flats very quickly (Inland Lakes Catchment).

Mosquito Creek has a relatively long history of flow gauging. Discharge from the creek has been gauged at Struan since 1971. Mosquito Creek recorded permanent flow (flow every day) until January 2001 when it ceased to flow for the first time. Since then flows over summer have ceased every year. Now most flow is recorded in winter and spring and little to none in Summer/Autumn. The reduced availability of flow in the creek has significantly impacted on the quality of habitat found along it.

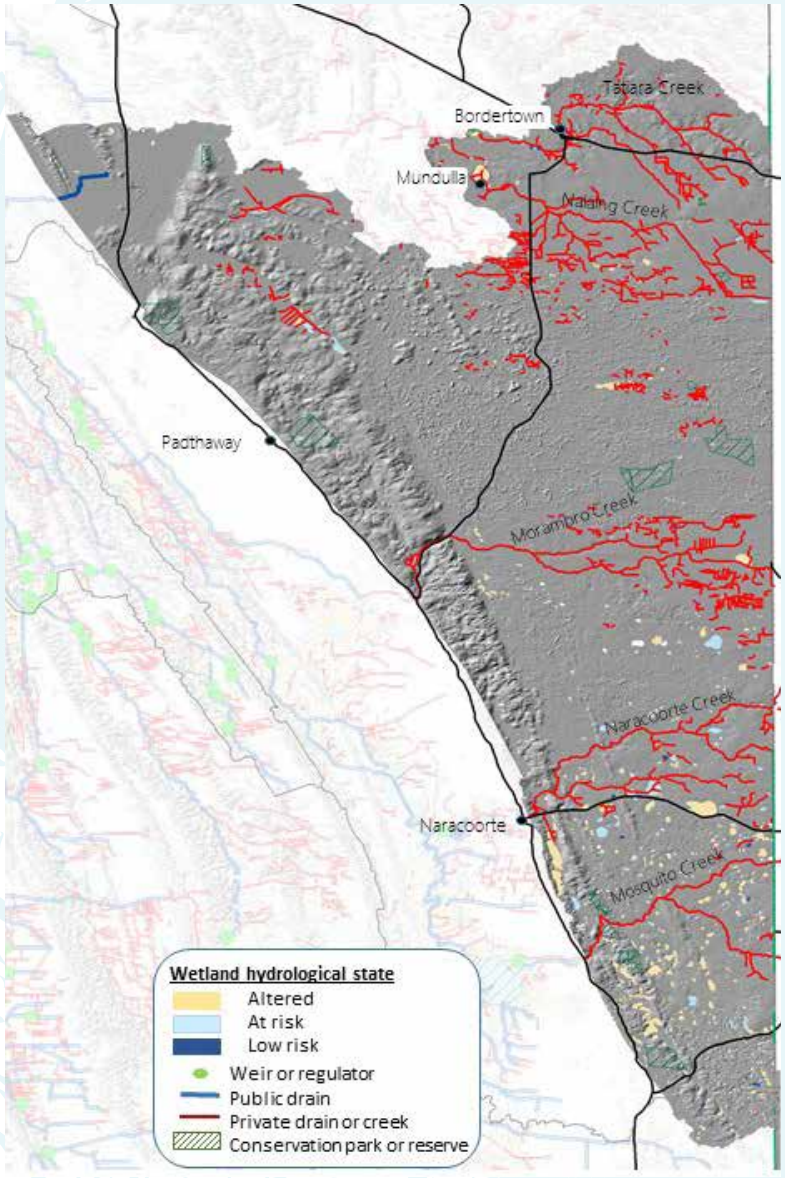
Mosquito Creek used to have permanent pools along its length that were supported by the continuous discharge of shallow groundwater into the creeks. These pools supported a number of threatened andcommon native fish species and provided a security population to repopulate the Bool and Hacks Lagoons Ramsar site after drought. The pools on the Mosquito Creek continue to degrade despite the relatively high rainfall since 2016. The highest total annual flow volume recorded at the Struan gauging station (at the bottom of Mosquito Creek, was 78 GL in 2016.

Flows from the Tatiara creek are directed into the Poocher swamp runaway holes to replenish the shallow groundwater and provide the domestic water supply for Bordertown. This flow is important to maintain the condition and volume of groundwater near Poocher Swamp .

The Morambro creek is the only current prescribed surface water resource in the South East.

There is no water management infrastructure or public drains in the catchment, apart from monitoring weirs in the creeks.

Small-scale waterlogging is short term in nature in this catchment, however there are some small scale private drains that divert water into the creeks.



Community Priorities

Managing flows to Poocher swamp runaway holes

Retaining water for groundwater recharge

Maintaining habitat for wetland species

Improving water availability in Mosquito Creek in dry to average periods

Managing the impacts of reduced rainfall but increased intensity of episodic rainfall events

Surface water management issues

- Reduced availability of freshwater inflows (base flow and flushing flows) as local aquifers are exhausted and rainfall declines
- Flooding within the creek floodplains due to episodic high intensity rainfall Intense rainfall events in the catchment are likely to increase under climate change scenarios
- Large catchment areas are able to generate large volumes of run-off quickly under very wet conditions
- Reduced recharge of aquifers due to rainfall declines and reduced run-off
- Loss of permanent base flow in Mosquito Creek and reduced reliable flow in the other creeks
- Managing catchments that extend into Victoria, with different policy and legislative controls

Wetland issues

Hydrological condition

Almost all (93%) wetlands in the catchment are now disconnected from the regional unconfined aquifer, in this catchment fresh surface water flows drive wetland function. There is evidence that small perched freshwater aquifers under wetlands and along the creeks once provided water to aquatic ecosystems.

- Of the 598 that can be detected by satellite imagery:
  - 380 (31%) are in an altered hydrological state, meaning that they are dry or getting drier
  - 197 (16%) are at risk of getting drier
  - 21 (1.7%) are at low risk, meaning at least part of the wetland has stable hydrology
  - 632 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Land use implications

Most wetlands (1026) occur with agriculture or forestry (147) and 44 are on public land.

Threats associated with land use include:

- high nutrient levels in permanent pools along the creeks
- clearance and loss of remnant vegetation along riparian areas
- grazing, trampling and pugging of soil associated with stock in agricultural areas
- reduced run-off and surface water availability due to interception of surface water by dams and forestry plantations close to the creeks.

Infrastructure	Amount	% of regional
Drains and watercourses - public	0 kms	N/A
Drains and watercourses – private	905 kms	15
Regulators and weirs	0	N/A

Wetland type	Number	% of regional
Freshwater meadows	619	50%
Creeks	5	100%
Springs, creek pools & peat swamps	29	16%
Grass Sedge Wetlands	329	%
Interdunal Swamps	3	<1%
Unknown	250	<1%
Total	1235	7%

Strategic Opportunities

- Improving the hydrological and physical condition of Mosquito Creek. It is the main source of surface water to the Bool and Hacks Lagoons Ramsar site, and the permanent pools of the creek provide the source populations for native fish to repopulate the Ramsar site when it dries. Managing the interception of surface water is a priority
- Identifying opportunities to help manage flooding flows down the creek, which can be generated much quicker than they can be released from the wetlands at the bottom of the system (Inland Lakes Catchment). Improving forecasting for extreme flow events will allow for improved adaptive management of the system
- Deterioration of habitat quality in the permanent pool habitats of Mosquito Creek
- There are a number of larger wetlands that appear to be in good hydrological condition higher in the catchment that are relatively unknown, investigating these and supporting land managers to manage threats is a priority

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging, flooding and dryland salinity**	Flooding of Mosquito Creek	**Manage** storage capacity in Bool Lagoon in line with the agreed levels in the park management plan during periods of intense rainfall			X	DEW SEWCDB
	Flooding of Naracoorte Creek	**Monitor** – continue to monitor flow movement in the catchment and support the agencies responsible for flood mitigation in monitoring flows. **Provide** advice to landholders downstream of creeks during high flow events.			X	DEW SEWCDB
	Water use from the Morambro Creek	**Manage** Morambro Creek in accordance with the Morambro Creek Water Allocation Plan.				
2 **Wetlands**	Permanent pools of Mosquito Creek supporting threatened native fish	**Improve** the condition of permanent pools by managing land use threats -riparian condition, water quality, weeds.	X	X	X	DEW SEWCDB
		Consider artificial watering of priority pools.	X	X	X	
		Discourage land uses that interfere with surface water availability (like plantation forestry) close to the creeks.	X	X	X	
	Freshwater marshes in good hydrological condition – disconnected from network/creeks	**Improve** the condition of degraded sites by managing threats associated with landuse.	X	X	X	SEWCDB
	Freshwater marshes – drained Deeper wetlands are more likely to be resilient under reduced rainfall	**Restore** the hydrology of priority sites that retain values.		X	X	SEWCDB
	All wetlands	**Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animal, altered surface water availability) Restore fringing riparian vegetation.	X	X	X	Land managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	SEWCDB Land managers
	Refuge sites for threatened species (e.g. permanent creek pools)	**Manage** refuge sites to maintain important refuge habitat for threatened fish and frog species. Wedge holes provide refuge habitat in parts of this catchment during drought.	X	X	X	DEW, SEWCDB Land managers
3 **Retaining water**	Upper catchment	**Support** projects and landholders that seek to retain more fresh water in wetlands that are, where this will not reduce availability of water to the creeks locally (consistent with other legislation and policy).		X	X	SEWCDB
4 **Water quality**	Poocher Swamp and Tatiara Creek	**Reduce** the amount of chemicals entering surface water through better communication and engagement with land managers.		X	X	SEWCDB
	Bool and Hacks Lagoons Ramsar site	**Monitor** the quality of water in surface water systems.	X	X	X	SENRMB Land managers

8. Inland Lakes Catchment Management Unit

The Inland Lakes Catchment surface water hydrology is driven by flow from the cross-border creeks and the presence of groundwater close to the surface. The Morambro, Naracoorte and Mosquito Creeks naturally terminate in this catchment in freshwater lakes. Lake Ormerod, Hacks Lagoon and Cockatoo Lake are all significant inland freshwater lakes formed on the flats and reliant on fresh surface water inputs from the creeks.

The creeks have relatively large catchments and can generate large volumes of flow quickly following high rainfall events. These sporadic flows, and the consistent presence of groundwater near the surface makes this one of the most flood-prone parts of the region. Under average to wet conditions, the very flat, low-lying nature of the catchment limits the ability to manage excess surface water.

Most of the catchment forms a long narrow watercourse of semi-permanent swamps and lakes which are now connected directly by artificial channels. When flow down the creeks exceeds the capacity of the receiving lakes, water fills and spills through the wetlands of the water course.

Many of the wetlands of this catchment are drained and cropped or sown to pasture. 79% of the catchment is used for livestock production with agriculture and horticulture also important land uses (14%).

A relatively small amount of land in the catchment is set aside for conservation (3%).

The Bool and Hacks Lagoons Ramsar site is an important wetland in this catchment. The Ramsar site receives flow from Mosquito Creek, and is managed as a water storage, to mitigate flooding downstream, and to maintain its ecological character. The hydrological management of the site is set out in its Park Management Plan. As water levels reach agreed limits, water is released into Drain M.

The size (capacity) of Drain M limits how fast water can be released from the site.

Flows from the Naracoorte and Morambro Creeks are directed North into Drain E, as wetlands on the flats fill.

Bool Lagoon is an important inland tourism site, visited for birdwatching and camping when wet. Cockatoo Lake is important to residents and used for recreational activities, including boating and fishing.

Supporting the most inland fresh water lakes in the region, the catchment is particularly important for native fish and water birds including a wide variety of ducks. The catchment supports a wide diversity of water birds at different times including migratory species like the Australasian Bittern and Magpie Geese.

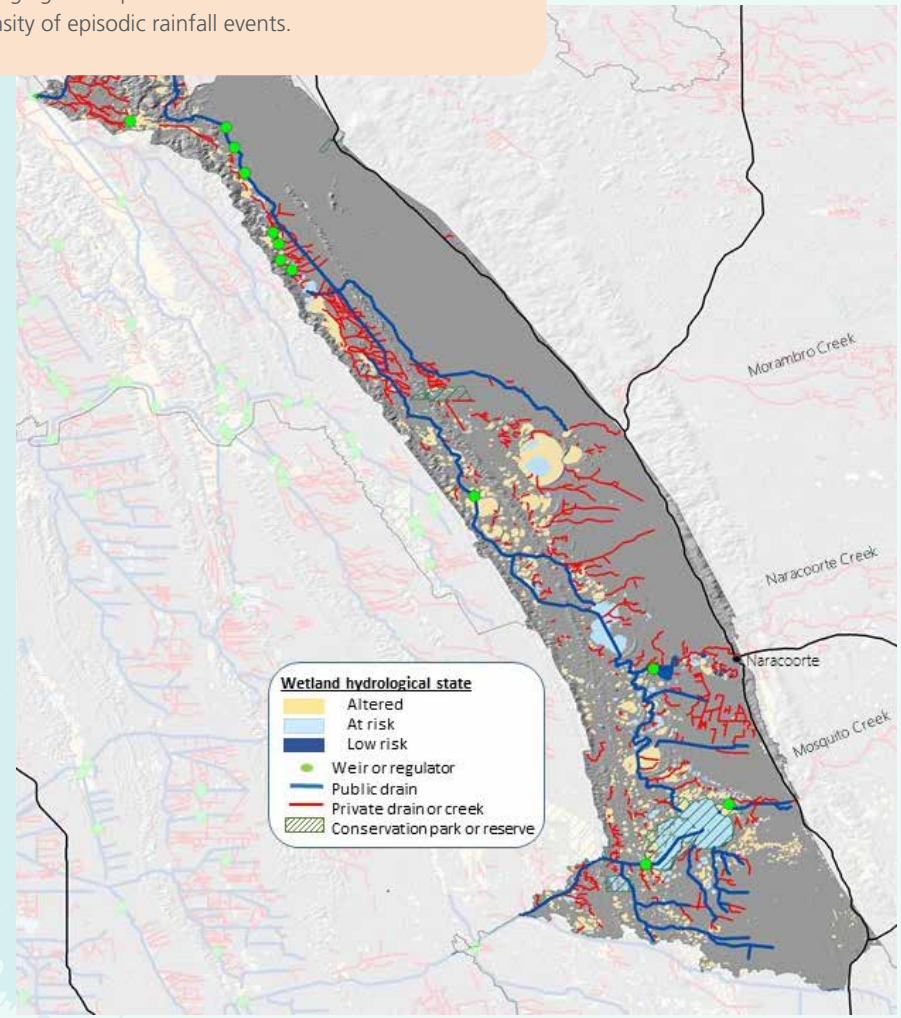
Community Priorities

Managing waterlogging of productive land.

Providing refuge areas for wildlife during droughts.

Keeping wetlands on private and public land and providing water to support the species that rely on them.

Managing the impacts of reduced rainfall but increased intensity of episodic rainfall events.



Surface water management issues

- Large amount of surface water management infrastructure to maintain and manage.
- Waterlogging and flooding of low lying flats in wet seasons.
- Flooding impacts on Naracoorte townsite in very wet periods.
- Flow down the creeks can be generated much quicker than it can be released from the wetlands in the system. Adaptive management requires better hydraulic modelling of the catchment to help predict impacts of decisions.
- Intense rainfall events in the catchment are likely to increase under climate change scenarios.
- Water quality changes including increasing pH.

Wetland issues

Hydrological condition

Of the 1106 that can be detected by satellite imagery:

- 748 (60%) are in an altered hydrological state, meaning that they are dry or getting drier
- 311 (25%) are at risk of getting drier
- 14 (1%) are at low risk, meaning at least part of the wetland has stable hydrology
- 173 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

- As wetland condition is driven by flow from the creeks and sustained by groundwater, any changes to the volume or timing of water availability changes the character of these wetlands.

Land use implications

Most wetlands (1178) occur on private land, there is very little remnant vegetation in the catchment apart from in wetlands. Most wetlands sit alongside agricultural and grazing land uses. Ten are associated with forestry land. Threats associated with land use include:

- physical disturbance, including ploughing, mounding and planting with non-native species
- grazing, trampling and pugging of soil associated with stock
- higher pesticide, herbicide and nutrient levels from run off or overspray
- weed and pest animals (including fox predation of waterbirds).

Infrastructure	Amount	% of regional
Drains and watercourses - public	286 kms	11%
Drains and watercourses – private	584 kms	10%
Regulators and weirs	14	8%

Wetland type	Number	% of regional
Freshwater meadow	1	<1%
Grass Sedge Wetlands	525	5%
Interdunal Swamps	396	42%
Inland freshwater lakes	12	67%
Saline Swamps	110	4%
Salt Lake	1	5%
Unknown	201	10%
Total	1246	7%

Strategic Opportunities

- Need to manage flushing flows to terminal wetlands like Lochaber Swamp to help manage pH in the system
- Maintaining availability of flow, and balancing demand, from Bool Lagoon to downstream assets like Lake George, the SE Flows alignment, and other significant wetlands
- Retaining water for longer
- The inland freshwater semi-permanent wetlands of this catchment are uncommon in the region and across the country and are important refuge areas for waterbirds, waders, fish and frogs
- The large volume of surface water flows from the creeks can be diverted to a number of different uses from this catchment via existing infrastructure

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging flooding dryland salinity**	Waterlogging and flooding of agricultural land	**Manage flow** and discharge – undertake hydraulic modelling for the catchment to improve adaptive management and decision making based on predicted impacts of releases and diversion (including to downstream assets). Subject to this, continue to:			X	SEWCDB
		Divert excess surface water into wetlands or drains (as quality dictates).			X	
		Manage wetland storages up and downstream to provide storage capacity to the limits of infrastructure and seasonal conditions				
		Review private drainage works in catchment to ensure capacity of the system is not exceeded for flood prone sections.		X	X	
		Monitor the amount of surface water in the catchment during wet periods.		X	X	
	Flooding of Mosquito Creek	**Manage** storage capacity in Bool Lagoon in line with the agreed levels in the Park Management Plan during periods of intense rainfall.			X	DEW SEWCDB
	Flooding of Naracoorte Township	**Monitor** – continue to monitor flow movement in the catchment and support the agencies responsible for flood mitigation in monitoring flows. Provide advice to landholders downstream of creeks during high flow events.			X	DEW SEWCDB
	Soil moisture	**Retain** fresher water in groundwater drains and wetlands to support pasture growth at the tail end of season	X	X	X	SEWCDB Land managers
	Community involvement	**Build** relationships with community members to develop cooperative management solutions for drainage infrastructure	X	X	X	SEWCDB
2 **Wetlands**	Bool and Hacks Lagoons Ramsar site	**Maintain** water requirements of the site by managing the water levels to protect the Ramsar values as outlined in the Park Management Plan (review as scheduled)	X	X	X	DEW SEWCDB
		Improve the condition of the site by managing threats to its values (weeds, pest animals, lack of riparian vegetation etc).	X	X	X	
		Monitor the ecological character of the site (including changes) to inform reporting on Ramsar obligations.	X	X	X	
	Freshwater lakes – regulated e.g. Lochaber Swamp, Lake Ormerod	**Improve** the values of priority sites that retain values by managing threats to condition and flows to significant sites. Develop and/or review management plans if necessary	X	X	X	SEWCDB
	Freshwater swamps in moderate to good hydrological condition – connected to network	**Maintain** flows to existing high value wetlands. **Improve** the condition of all wetlands that have managed hydrology by reviewing the management and function of existing infrastructure.		X	X	SEWCDB

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
	Freshwater swamps in moderate hydrological condition - disconnected from network	**Restore** a more natural hydrological regime to priority sites that retain function and values if feasible.		X	X	DEW SEWCDB
	Sites in poor hydrological condition with low values	**Support Adaptation** of sites with altered hydrology that cannot be restored. Manage transition and/or for other values.	X	X	X	SEWCDB SENRMB
	All wetlands	**Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animal, altered surface water availability). **Restore** fringing riparian vegetation.	X	X	X	Land managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	SEWCDB Land managers
	Refuge sites for threatened species (e.g. permanent drain pools)	**Manage** refuge sites to maintain important refuge habitat for threatened fish and frog species. Wedge holes provide refuge habitat in parts of this catchment during drought.	X	X	X	DEW, SEWCDB Land Managers
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any suitable ground water over late spring/summer to prevent dehydration, support recharge and wetland processes.		X	X	SEWCDB
		Support projects and landholders that seek to retain more fresh water in landscape.	X	X	X	SENRMB
	All drains	**Investigate** opportunities to retain water through the use of weirs in drains. **Support** proposals that seek to increase retention or reuse of freshwater locally (consistent with other legislation and policy).	X	X	X	SEWCDB SENRMB
4 **Water quality**	Water quality	**Reduce** the amount of chemicals entering surface water through better communication and engagement with land managers.		X	X	SEWCDB SENRMB Land managers.
		Monitor the quality of water in surface water systems	X	X	X	
	Salinity and pH tolerances,	**Adapt** decisions about the quality of water diverted to wetlands based on knowledge of their salinity and pH tolerances, water availability and monitoring data.		X	X	SEWCDB Land managers
	All wetlands	**Manage** wetting and drying regimes to reduce nutrient releases from sediment	X	X	X	
	Wetlands on the network that don't receive adequate volumes of flow to promote turnover.	**Manage** pH and salinity within tolerance ranges by flushing wetland systems with fresher water.		X	X	SEWCDB Land managers

9. Glenelg Plain Catchment Management Unit

The Glenelg Plain Catchment surface water hydrology is driven by rainfall and groundwater very close to the surface. This catchment supports large areas of softwood and hardwood plantations (approx. 30%) and livestock, agriculture and viticulture (64%). In the northern part of the catchment smaller drains feed water into Drain B, Drain C and the Bakers Range Main drain, and eventually into Drain M downstream of Bool Lagoon. In the western part of the catchment the Reedy Creek system directs water north and west into the Reedy Creek/Mt Hope drain. The west of the catchment also contains the high point of Mt Burr from which water drains to the east and north.

The catchment is relatively flat and rainfall drains into local dips and hollows to form small wetlands that are not connected to each other. There is little natural flow in this catchment.

The catchment supports 48% of the region wetlands, over 8000, mostly small, shallow freshwater swamps and marshes found scattered throughout the grazing land and plantations. These small shallow swamps (puddles in paddocks), often red gum fringed, are important for waterbird breeding and are characteristic of the catchment.

The catchment also supports some more unusual wetlands. The permanent wetlands of the Mt Burr area are believed to be fed by a perched aquifer which is connected to the regional unconfined aquifer.

These wetlands, including the Marshes and Honans complexes, are located mostly in forest reserves and appear to have relatively stable water supply from the groundwater.

The volcanic lakes, Lake Leake and Lake Edward, are permanent freshwater lakes, dependent on groundwater and are important areas for recreation.

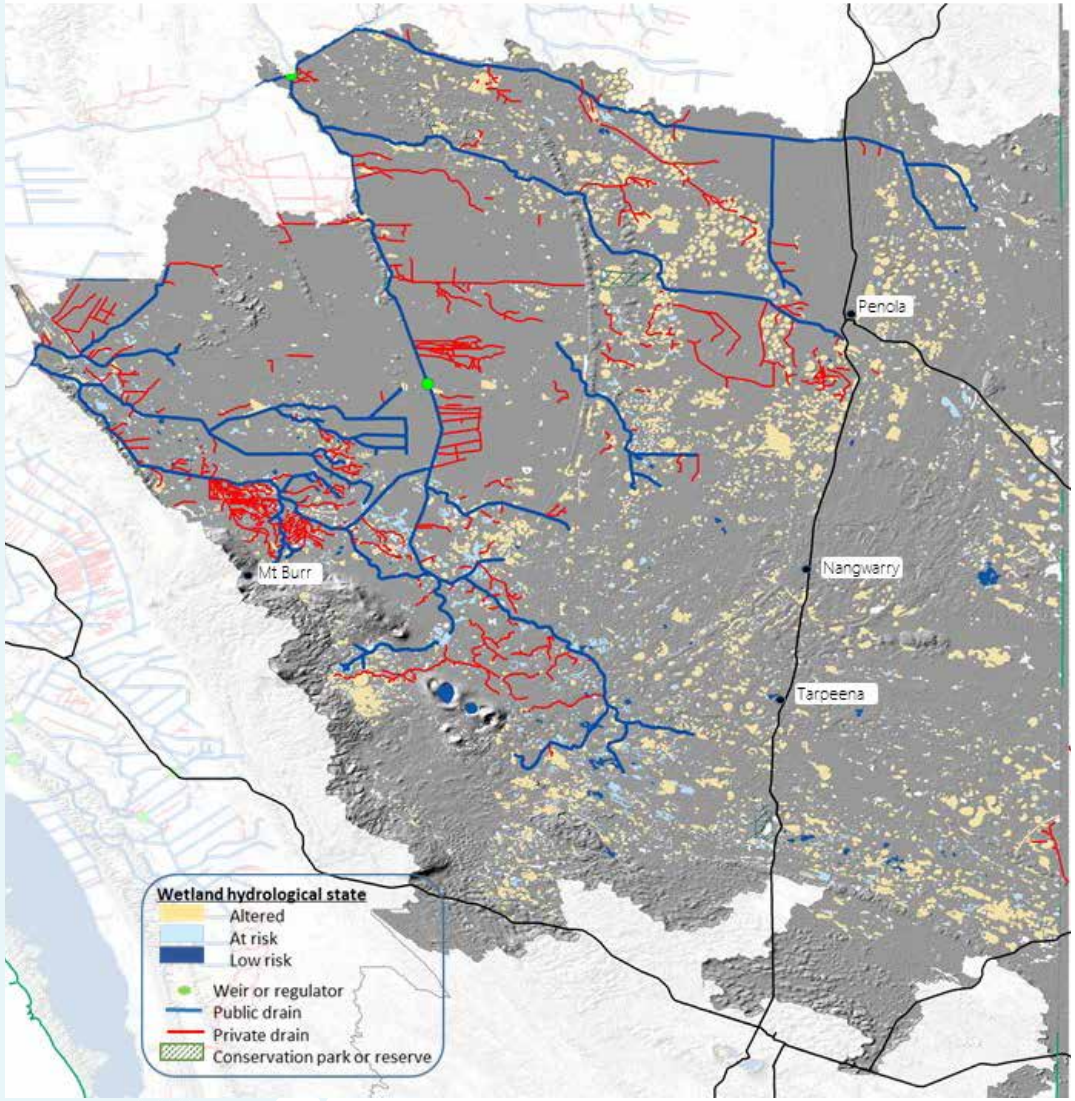
Community Priorities

Lake Leake and Lake Edward

Waterlogging of grazing land

Retaining water for groundwater recharge

Red gums and red gum swamps



Surface water management issues

- Waterlogging of low lying agricultural land to the east of the Mt Burr range
- Altered wetting and drying regimes in wetlands due to reduced rainfall, groundwater declines and interception of surface water in plantations
- Reduced recharge of aquifers due to rainfall declines and reduced runoff

Wetland issues

Hydrological condition

Almost all (90%) wetlands in the catchment are now disconnected from the regional unconfined aquifer.

- 294 wetlands are reliant on perched aquifers
- Of the 3676 that can be detected by satellite imagery:
  - 2718 (74%) are in an altered hydrological state, meaning that they are dry or getting drier
  - 874 (24%) are at risk of getting drier
  - 84 (2%) are at low risk, meaning at least part of the wetland has stable hydrology
  - 4713 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Land use implications

Most wetlands occur with agriculture (5449) or forestry (2415) and 480 are on public land. Threats associated with land use include:

- grazing, trampling and pugging of soil associated with stock in agricultural areas
- predation by foxes
- increased nutrients, road building and altered fire regimes
- physical disturbance including ploughing, deep ripping, mounding and planting.

Infrastructure	Amount	% of regional
Drains and watercourses - public	347 kms	N/A
Drains and watercourses – private	532 kms	15
Regulators and weirs	2	1%

Wetland type	Number	% of regional
Freshwater meadows	462	38%
Permanent Lakes	2	13%
Saline Swamps	16	<1%
Peat swamps	27	28%
Grass Sedge Wetlands	7354	74%
Interdunal Swamps	4	<1%
Unknown	524	25%
Total	8389	48%

Strategic Opportunities

- Impacts of reduced rainfall, groundwater decline and surface water availability on small shallow wetlands of the eastern part of the region (undrained)
- Investigating the aquifer that supplies the wetlands of the Mt Burr range and managing it to support recharge
- Improving management of land uses around small freshwater marshes to support their condition
- This catchment is likely to be an important area for recharge of the regional unconfined aquifer

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging, flooding and dryland salinity**	Temporary waterlogging of plantation of agricultural land on drainage network	**Maintain** existing drain flow rates. Regular maintenance schedule. Review private works in catchment to ensure capacity of the system is not exceeded for waterlogging prone sections.	X	X		SEWCDB
		Monitor drain function and capacity.		X	X	
2 **Wetlands**	Significant groundwater dependent wetlands of the Mt Burr area, including: The Marshes, Honans, Kangaroo Flat	**Maintain** the condition of the site by managing the water levels to protect the existing values. **Restore** fringing riparian habitat where needed. **Manage** groundwater levels according to the Lower Limestone Coast WAP.	X	X	X	DEW SEWCDB
		Monitor groundwater resource changes.	X	X	X	
	Freshwater marshes and swamps wetlands in good hydrological condition – disconnected from network/creeks	**Improve** the condition of degraded sites by managing threats associated with landuse.	X	X	X	SEWCDB
	Freshwater marshes and swamps wetlands in moderate hydrological condition – connected to network	**Restore** a more natural hydrological regime to priority sites that retain function and values if feasible (e.g. reinstate breached sills, regulate etc).		X	X	SEWCDB
	Freshwater marshes and swamps in poor hydrological condition not connected to network	**Adapt** – it is likely that these wetlands may transition to drier communities, they are unlikely to be restored easily but may still retain natural values.	X	X	X	Land managers
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	SEWCDB Land managers
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any suitable ground water over late spring/summer to prevent dehydration, support recharge and wetland processes.		X	X	SEWCDB
		Support projects and landholders that seek to retain more fresh water in landscape.	X	X	X	SENRMB
	All drains	**Investigate** opportunities to retain water through the use of weirs in drains. **Support** proposals that seek to increase retention or reuse of freshwater locally (consistent with other legislation and policy).	X	X	X	SEWCDB SENRMB
4 **Water quality**	Water quality	**Reduce** the amount of chemicals entering surface water through better communication and engagement with land managers.		X	X	SEWCDB SENRMB Land managers
		Monitor the quality of water in surface water systems.	X	X	X	

10. Karst Volcanics Catchment Management Unit

The Karst Volcanics Catchment surface water hydrology is driven by groundwater close to the surface, in many cases ex pressing as springs and soaks. Some of the earliest drains in the region were established at Port M acDonnell and all drains in this catchment are near the coast. 61% of the catchment is used for livestock and dairy production and there are also large areas of softwood plantations (23%). This catchment has a higher population and more residential and rural residential areas than other catchments.

Groundwater resources drive wetlands and productivity in this catchment. Groundwater currently expressing at the surface is about 40 years old, for example, water in Ewens Ponds recharged the aquifer between 1977 and 1988.

Fresh ground water outputs to the sea are a natural part of the landscape, with beach springs a common feature. Drains now run from each karst spring complex directly to the sea and were established to assist in developing the extensive groundwater driven swamps that once fringed the coast. The drainage of large areas of peat swamp has resulted in land surface subsidence in some areas as the peat dries and is oxidised.

Most coastal wetlands have been cleared or are impacted by land use but some have been restored, like Picks Swamp, which is now part of the Piccaninnie Karst Wetlands Ramsar site. The availability of fresh groundwater flow through these wetlands means that they are rare refuge sites for threatened species no longer found throughout the region.

As groundwater under pressure drives discharge at the surface, the volume of flow through the springs to the sea is relatively consistent through dry and wet seasons but has been noted to be declining over time.

Wetlands of this catchment are vital to tourism in the region, with unique experiences associated with the Blue Lake, the clear waters of the sinkholes and caves and the diving and snorkelling opportunities offered by spring pools.

Community Priorities

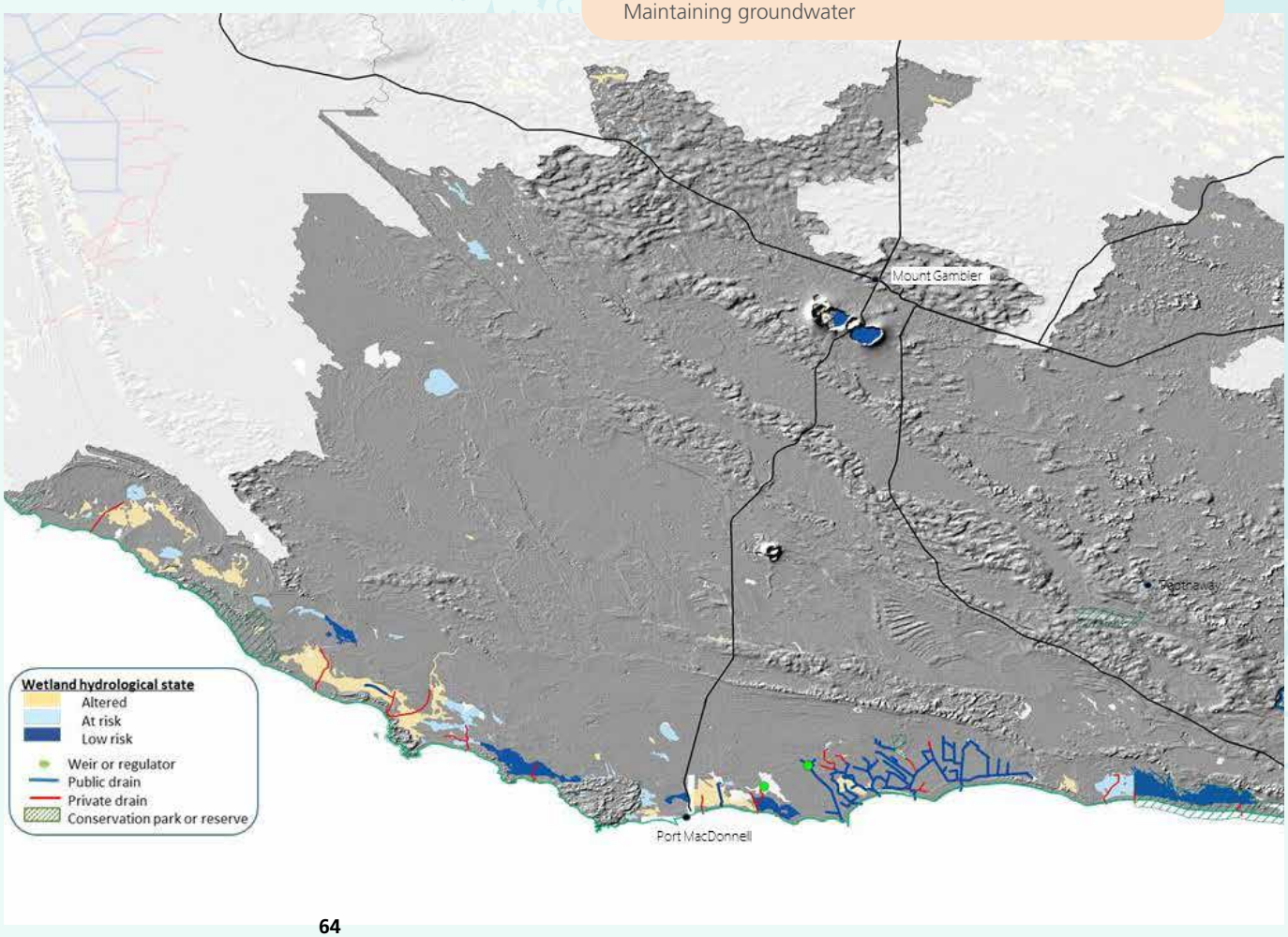
Concern about any more drainage near the coast disrupting the natural hydrology

Blue Lake, Piccaninnie Ponds, Ewens Ponds etc

Stromatolites and cave fauna (stygofauna)

Maintaining wetland values

Maintaining groundwater



Surface water management issues

- Waterlogging and compromised drainage function of peat soils near the coast.
- Groundwater declines and reduced water availability to highly groundwater dependent wetlands like the Blue Lake and the Valley Lake.
- Contamination of groundwater with nutrients and impacts on water resources and recreational and tourism values associated with wetlands like Ewens Ponds.
- Risks associated with storm surge and sea water inundation up the numerous unregulated small coastal drain outlets.
- Loss or deterioration of karst spring pools and associated peat swamps.
- Salt water intrusion into the aquifer along the coast as groundwater head pressure declines.
- Large volumes of groundwater discharged from the numerous sea outlets.
- Risks associated with storm surge up drains or over the low dunes onto land already below sea level and possibly subsiding further as peat oxidises.

Wetland issues

Hydrological condition

25% of wetlands in the catchment are directly reliant on expression of groundwater from the regional unconfined aquifer, many with characteristic springs or karst pools. The rest are inland rainfall dependent wetlands once supported by groundwater close to the surface.

Of the 96 wetlands that can be detected by satellite imagery:

- 52 (54%) are in an altered hydrological state, meaning that they are dry or getting drier
- 33 (34.5%) are at risk of getting drier
- 11 (11.5%) are at low risk, meaning at least part of the wetland has stable hydrology
- 386 have unknown hydrological state, these cannot be detected via satellite imagery and are likely to be either small and/or obscured by vegetation.

** For more information on the prioritisation method and results refer to the Technical Supplement*

Land use implications

Most wetlands occur with agriculture (277) or forestry (160) and only 24 are on public land.
Threats associated with land-use include:

- grazing, trampling and pugging of soil associated with stock in agricultural areas
- peat subsidence and direct drainage to the sea to support agricultural development
- impacts of land use on wetlands (nutrient, chemicals, intercepted runoff, road building, fire regimes

Infrastructure	Amount	% of regional
Drains - public	43 kms	N/A
Drains – private	23 kms	15
Regulators and weirs	5	1%
Sea outlets	15	

Wetland type	Number	% of regional
Freshwater meadows	115	11%
Permanent Lakes	2	13%
Soaks and springs	12	10%
Peat swamps	34	35%
Grass Sedge Wetlands	264	3%
Karst wetlands	10	91%
Unknown	45	25%
Total	482	48%

Strategic Opportunities

- Investigating the relationship between drainage and land subsidence of peat soils near the coast, to improve management and reverse declines
- Potential to sequester carbon in the large, drained near-coastal peat swamps by retaining groundwater currently lost to the sea
- Potential to reverse declines in freshwater aquatic threatened species found only in the karsts springs and associated habitats
- Retaining surface water near the coast is likely to help manage the intrusion of seawater into the unconfined aquifer and the resulting salinisation of ground water

Regional Objective	Priorities	Catchment management action	Dry	Average	Wet	Responsibility
1 **Waterlogging, flooding and dryland salinity**	Peat soil subsidence and resultant waterlogging of the 8 Mile Creek area	**Monitor** drain function and capacity of 8 Mile creek and other drains in the Port MacDonnell area.	X	X		SEWCDB
	Peat subsidence is caused by drying of peat. Deepening of drains will exacerbate the problem and increase the risk of sea water contamination	**Investigate** changes to land levels in the area and improved methods/infrastructure options to improve rehydration of peat profile.		X	X	
2 **Wetlands**	All GDEs	**Maintain** water supply by managing groundwater levels according to the Lower Limestone Coast WAP.	X	X	X	DEW SEWCDB
	Piccaninnie Karst Wetlands Ramsar site	**Maintain** the condition of the site by managing the water levels to protect the Ramsar values as outlined in the Park Management Plan. **Manage** the impacts of weeds and feral animals on values. **Monitor** changes in the character of the site.	X	X	X	DEW
	Other Karst Springs and peat swamps	**Restore** hydrology by regulating drains (regulation) and developing agreed management prescriptions. **Maintain** ocean connectivity for species that have ocean life stage requirements. **Manage** the impacts of land use, including recreational activities on quality of in pool vegetation.		X	X	SEWCDB
	Poorly documented wetlands	**Monitor** data deficient sites to document their values and determine if threats can be managed.		X	X	SEWCDB Land Managers
	All wetlands	**Improve** the condition of wetlands by managing threats associated with surrounding landuse (weeds, feral animals, altered surface water availability). **Restore** fringing riparian vegetation.	X	X	X	Land managers
3 **Retaining water**	All wetlands and drains that are regulated	**Manage** regulators at the tail end of the wet season to hold any suitable ground water over late spring/summer.		X	X	SEWCDB SENRMB
		Support projects and landholders that seek to retain more fresh water in landscape.	X	X	X	
	Drain outfalls	**Regulate** ocean outfalls to reduce the risks and impacts of storm surge on agricultural and ecological values.				
4 **Water quality**	Water quality	**Reduce** the amount of chemicals entering surface water through better communication and engagement with land managers. **Maintain** groundwater levels and pressure to support turnover of spring pools, reduce the likelihood of further salt water intrusion and help manage the risks of storm surge. **Monitor** the quality of water in surface water systems.	X	X	X	SEWCDB, SENRMB, Land managers.

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