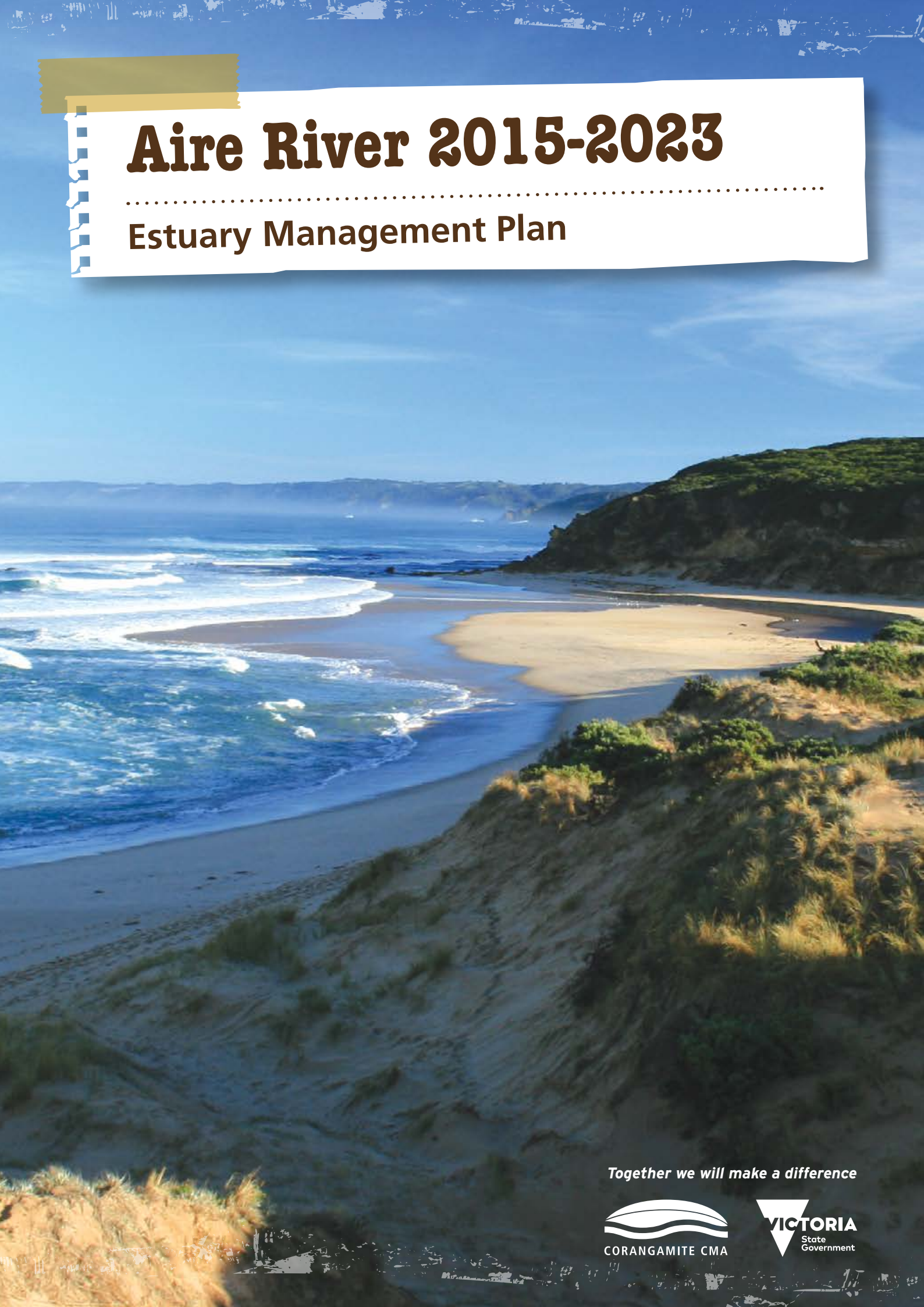


Aire River 2015-2023

Estuary Management Plan



Together we will make a difference



Aire River valley



Total Catchment: 35,310 Ha
River Length: 44 km
Estuary Length: 7.1 km
Location: 38°48'08.4"S
 143°28'41.8"E



Scale: 1:40,000



Legend

- Aire River
- Other watercourses
- Road
- Great Ocean Walk

Scale 1:40,000
 (at A4 page size)

Sources: DELWP-Roads, 2011 Imagery
 Filename: AEMP_Location_Map.mxd

Map Created:
 4 November 2015



Eastern Great Egret
(*Ardea alba*)

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1. Introduction

The Aire River Estuary Management Plan is an eight-year action plan aimed to improve the environmental condition of the Aire River estuary. Protection and improvement of the estuary environment will ensure it is able to support the values identified by stakeholders and the community during the plan's development.

The Aire River originates in the high rainfall Otway Ranges to the west of Apollo Bay in Victoria, and has been identified in the *Heritage Rivers Act 1992* as one of 18 Heritage River Areas in Victoria. The Aire River is one of the largest rivers in south-western Victoria and enters the sea via a large estuarine lake complex west of Cape Otway.

The Aire valley is a floodplain of the combined Aire, Calder and Ford river systems. These rivers coalesce before flowing out to sea at the Aire River mouth. The valley consists of private agricultural land, a wildlife reserve, and the Otway National Park including a natural lake and wetland system. The Aire valley is home to a number of rare and threatened species, significant Ecological Vegetation Classes (EVCs) and is recognised for its recreational values including camping, fishing, picnicking, sightseeing, walking tracks, game hunting and motor and non-motor boating.

The development of this Aire River Estuary Management Plan (EMP) follows an extensive community engagement process guided by the Aire River EMP Working Group. This group consists of agency stakeholders and community representatives.

Development of the plan has taken into consideration all previous work relevant to ecosystem health, and details the high value social and economic assets of the estuary. The plan contains a list of priority actions which contribute to four broad directions, as follows:

1. Biodiversity
2. Land use/agriculture
3. Tourism
4. Heritage values.

The Corangamite Catchment Management Authority (CMA) will manage the plan's implementation and review under the direction of an implementation committee, which includes agency and group representatives responsible for the plan's actions.



Aire River estuary upstream of Great Ocean Road bridge

1.1 Partners and their roles and responsibilities

The diversity of habitats, land use and land tenures surrounding estuaries typically results in a number of agencies and groups having responsibility for managing particular aspects of the system. This is the case for the Aire River.

Details of roles and responsibilities in estuary management at a state and local level can be found in Table 1 below.

The map on the following page identifies the complex land tenure divisions surrounding the estuary, which are a result of development history and current town planning.

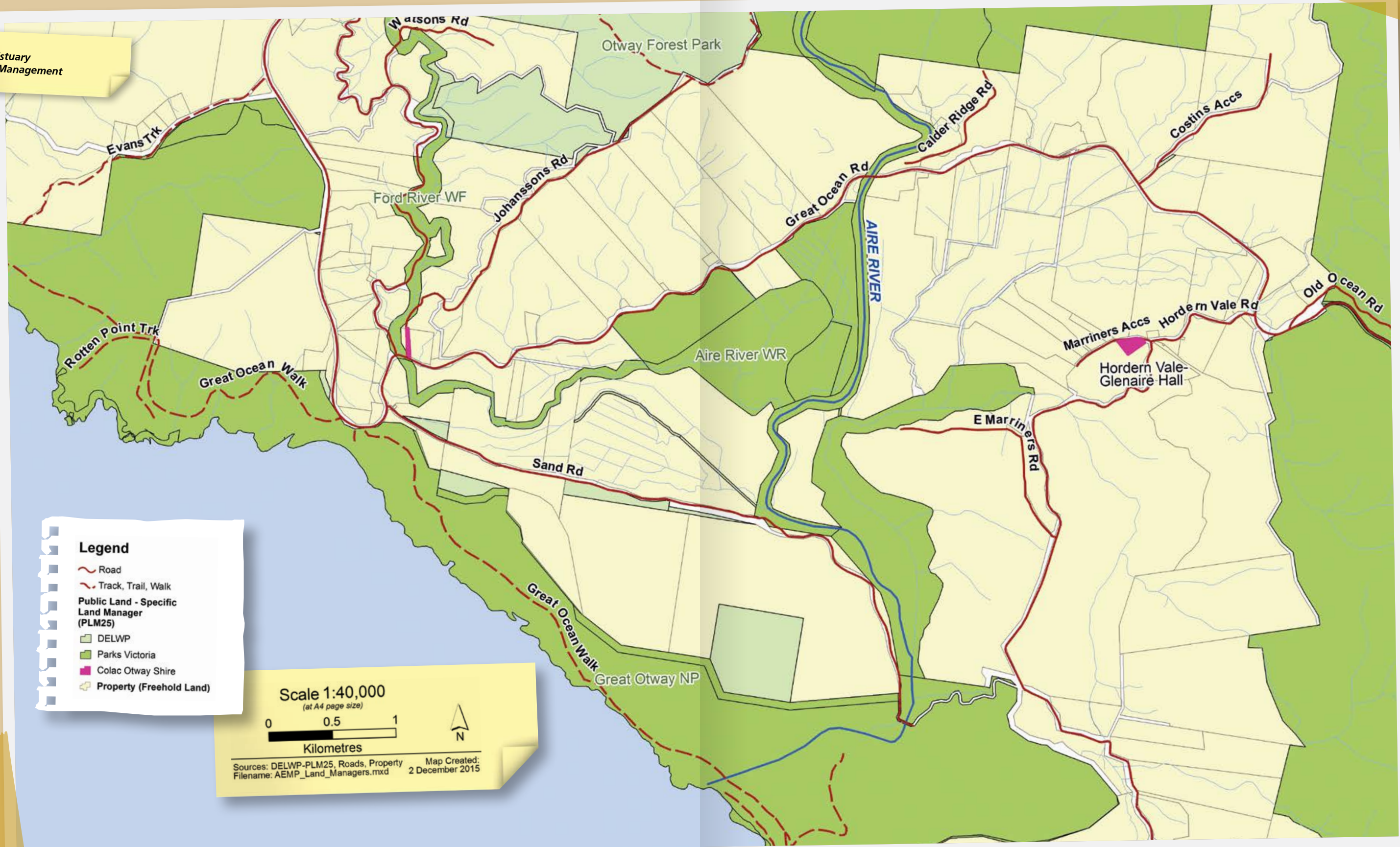
Table 1. Roles and responsibility of key stakeholders

Group or Agency	Regional responsibility
Corangamite Catchment Management Authority (CCMA)	Regional caretaker of water health, including the development of the Corangamite Waterway Strategy and Estuary Management Plan; implementation of waterway work programs; authorisation of works on waterways, including estuary mouth openings, responding to natural disasters and incidents affecting waterways.
Local Government (Colac Otway Shire)	Council has responsibilities under the <i>Planning and Environment Act 1987</i> to administer the planning scheme, under the <i>Road Management Act 2004</i> to maintain local infrastructure and under the <i>Emergency Management Act 1986</i> to coordinate emergency management at a municipal scale. Council also has statutory responsibilities under the <i>Environmental Protection Act 1970</i> to regulate septic systems on private land.
Department of Environment, Water, Land & Planning (DELWP)	Development of waterway policy, coordination of regional delivery and prioritisation of government investment in waterways; management of fisheries, including recreational fishing.
Department of Economic Development, Jobs, Transport & Resources (DEDJTR)	The purpose of DEDJTR is to create the conditions to sustainably develop the Victorian economy and grow employment.
Parks Victoria	Management of the Greater Otway National Park and Reserves.
Environmental Protection Authority (EPA)	Responsible for the protection and improvement of Victoria's environment by establishing environmental standards, regulating and working with organisations to meet these standards.
Western Coastal Board	Strategic coastal and marine planning and preparation of regional coastal plans.
Traditional Owners (TOs)	Traditional Owners have rights and interests to lands and waters within their recognised region, including participation in decision making on how land and/or waters are used.
Game Management Authority (GMA)	The Aire River floodplain wetlands are designated State Game Reserves, as such GMA as a state agency have wetland use responsibilities.



Localised flooding at the Aire River estuary

Aire Estuary
Land Management



Legend

- Road
- Track, Trail, Walk
- Public Land - Specific Land Manager (PLM25)**
- DELWP
- Parks Victoria
- Colac Otway Shire
- Property (Freehold Land)

Scale 1:40,000
(at A4 page size)

0 0.5 1
Kilometres

Sources: DELWP-PLM25, Roads, Property
Filename: AEMP_Land_Managers.mxd

Map Created:
2 December 2015

1.2 Connection to place

There is evidence Aboriginal people have occupied the Corangamite region for more than 30,000 years. Aboriginal people and their ancestors have cared for the environment for thousands of years and have always acknowledged their innate responsibility to care for the land.

During this time Aboriginals left physical evidence of their activities, which now survive as cultural heritage sites and archaeological artefacts.

Waterways were important for food, water and travel and many of these cultural sites are in close proximity to waterways.

The most common inland Aboriginal sites in the Corangamite region are stone artefact scatters, which are most likely the remains of resource processing locations or camps. Remains of campfires such as concentrations of charcoal, burnt rocks and burnt clay can also be found along with scarred trees, the result of the removal of bark from trees for the construction of canoes, shields or containers.

Less common sites are fish traps and stone houses. Along the coastline, the most common Aboriginal sites are shell middens, where discarded shells accumulated over time. These middens sometimes include animal bones, artefacts and charcoal and less frequently, Aboriginal burials.

European settlement of the continent is a relatively recent event, but one that dramatically changed the course of Australian history forever. Adapting to the effects of European settlement is a challenge that the Aboriginal community continues to respond to, and the preservation of Aboriginal cultural heritage is part of this challenge.

Shell midden adjacent to the Aire Rive estuary



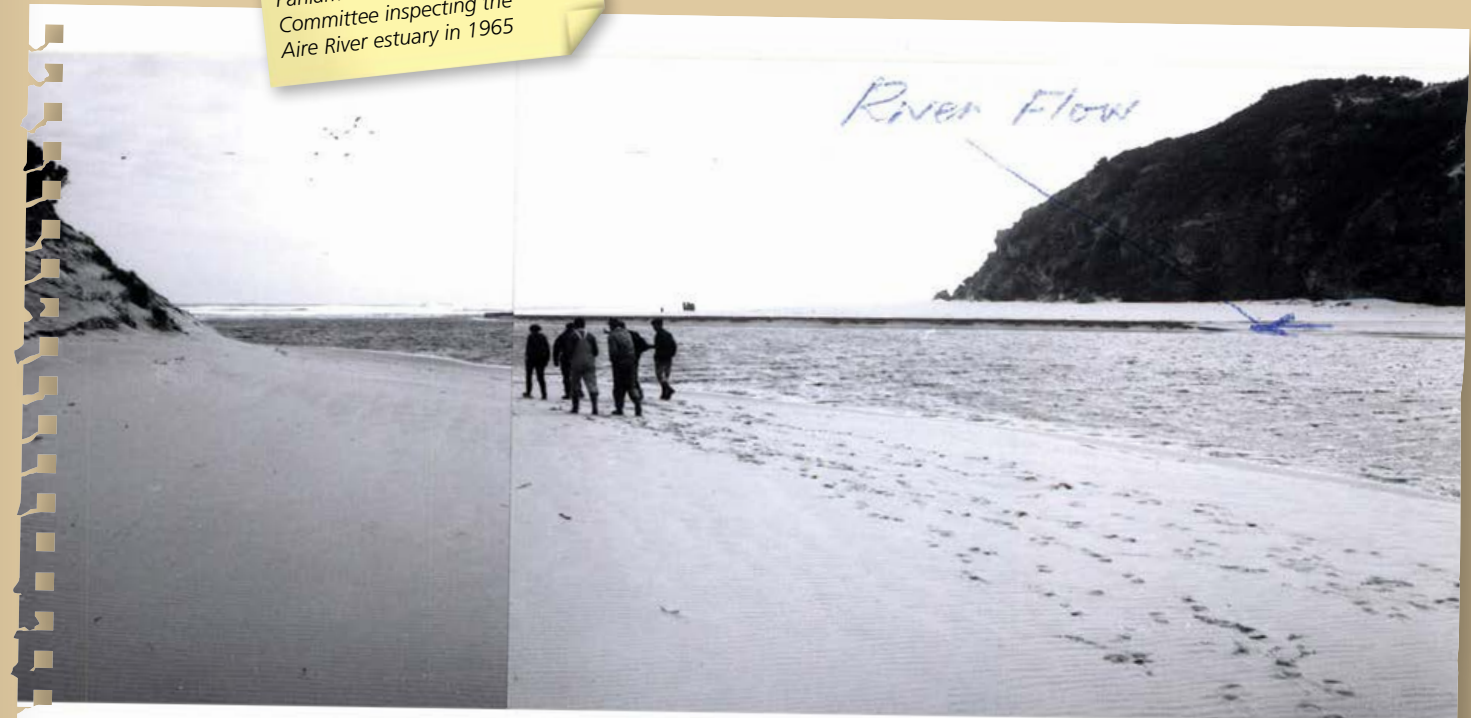
1.3 European heritage

European heritage of the Aire River estuary is significant with the first Europeans interested in pastoral settlement of southern Victoria landing on the coast from Tasmania in the mid-1830s.

The rich soils and high rainfall lead to most of the Otways being sold or made available for sale for farming by the 1880s and 1890s.

As highlighted in the image below landholders on the Aire River valley have worked for many generations to make agricultural practices on the floodplain economically viable.

Parliamentary Public Works Committee inspecting the Aire River estuary in 1965



Panoramic view of mouth. River was flowing seawards at time of inspection along line shown. It was reported that the sand-bar had blocked the mouth during the previous weekend and a new channel through the bar had been excavated by the landowners affected.

AD 12040

1.4 Development of this plan

The plan will guide the delivery of outcomes under the Corangamite Waterway Strategy and Coastal Action Plan. It will help provide a clear picture of the management activities required to maintain and improve the condition of the estuary.

Many existing documents, plans and research on ecosystem health, and the social and economic assets of the estuary were considered in developing this plan. These included research on the upstream catchment influences, influences on marine receiving waters and the potential impacts of climate change on the environmental condition of the estuary.

Further background information can be found in Appendix 1 to 5.



Aire River estuary bridge at the Great Ocean Road

1.5 Consultation

A working group was formed to guide the development of this Aire River EMP. This group comprised of staff and representatives from DELWP, DEDJTR (Fisheries), Parks Victoria, the Conservation Ecology Centre, Colac Otway Shire, Field and Game, VRFish, the Corangamite CMA and four community representatives. The working group met several times throughout the plan's development to discuss progress, structure and content.

In addition it was important to allow individuals, groups and agencies in the local area and beyond to share their thoughts about estuary management and values. This occurred through one-on-one interviews and an online survey.

The interviews and online survey consisted of 12 questions to identify community concerns, aspirations, knowledge and interests. There were 36 interviews and surveys completed.

The responses to the survey reiterated that the Aire River estuary is a high use area, with many environmental, social and economic values, as well as multiple threats.

More detail on the survey results can be found in Appendix 1.

The draft plan was released for public comment and five submissions were received. Feedback from the submissions was incorporated into the final plan.



The new Sand Road bridge

2. Planning context – asset based approach

An asset is a spatially defined component of the environment that provides values to the community e.g. a river reach, an estuary reach, an individual wetland or a wetland complex. An asset may provide social, environmental, cultural and economic values. Action planning to manage these assets, includes identifying any threats to the values, and following this, the risk of the threat affecting the values.

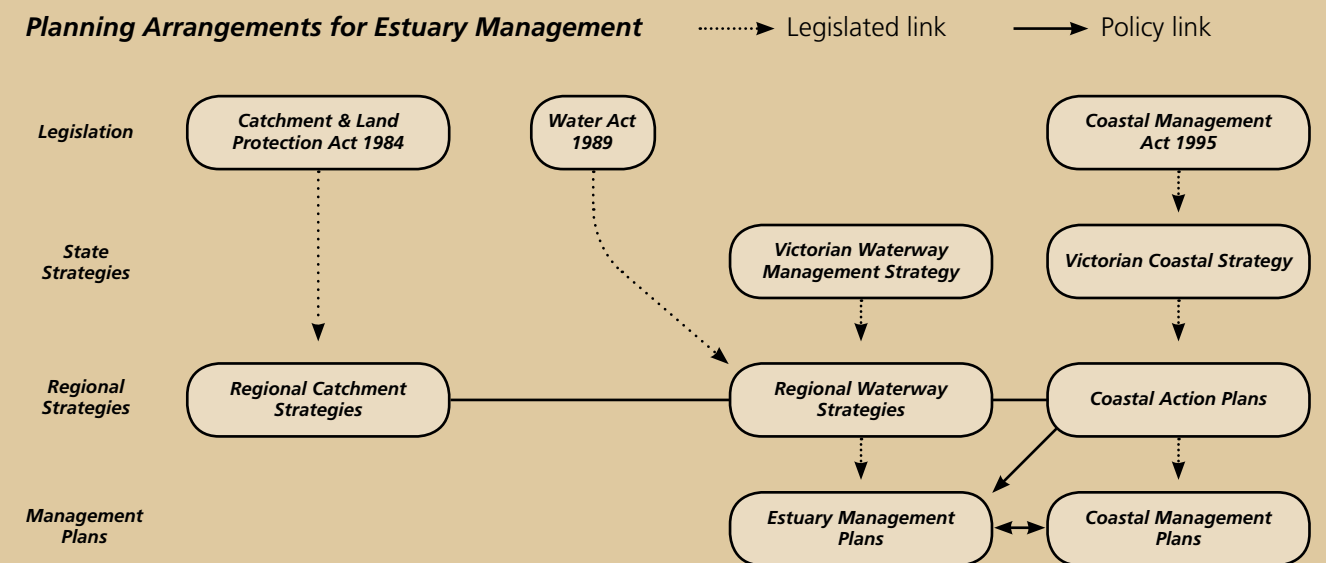
There is a complex mix of policy and planning relevant to managing the Aire River estuary. As shown below (Figure 1), the *Water Act*, the *Catchment and Land Protection Act*, and *Coastal Management Act* guide the management of waterways in Victoria. This legislation requires the development of regional strategies for waterways and coastal areas.

Under this framework The *Corangamite Waterway Strategy 2014-2022* was developed as a sub-strategy to the *Regional Catchment Strategy* and identifies actions to improve or maintain the health of waterways (rivers, estuaries and wetlands). This was informed by guidelines and policy developed through the *Victorian Waterway Management Strategy*.

In certain circumstances local plans are required to address areas of interest. The Aire River estuary is one such case, due to the significant environmental values and community interest.

In addition to the planning outlined above, there are many other planning processes which can benefit and protect the health of the Aire River estuary.

Figure 1. Estuary management strategy and planning arrangements in Victoria



Influencing: Other relevant State legislation eg. *Flora & Fauna Guarantee Act 1988*, *Environment Protection Act 1970*. Other relevant State strategies eg. *Victorian Biodiversity Strategy*, *SEPP (WoV)*.

Source: Victorian Waterway Strategy (2013)

3. Values, threats and management actions

Values, threats and management actions have been developed in consultation with stakeholders and agencies responsible for management of the Aire River estuary through the working group. Many documents have been reviewed to ensure the actions build on all previous work and discussions. Surveys of community interest have also helped shape the priorities.

3.1 Values of the Aire River estuary

The waterways in the Aire landscape zone are largely valued for their environmental condition and social amenity, with the Aire River listed as a Heritage River under the *Heritage Rivers Act 1992*.

These values align with responses to the online survey from the community (refer to Appendix 1). In addition, a key waterway value identified by the Aire community during the development of this EMP, was the strong historical connection of several generations accessing and utilising the waterways for agriculture.

The Corangamite Waterway Strategy identifies key values in the Aire landscape zone as being:

- known rare and threatened species
- significant Ecological Vegetation Classes
- significant bird species and important bird habitat
- recreation, including camping, fishing, picnicking, sightseeing, walking tracks, game hunting and motor and non-motor boating.

It was through discussion with the working group that these values were supported and grouped into the four key areas:

1. biodiversity
2. land use/agriculture
3. tourism and recreation
4. heritage values.



The Sand Road bridge at the Aire River estuary

3.2 Threats to the Aire River estuary

The Aire River estuary intermittently opens or closes depending on the prevailing conditions, e.g. freshwater flows, weather changes or tidal movements. Floodplain inundation resulting from estuary closure is a natural process and has an important role in the life cycle of many species and the cycling of nutrients. Artificially opening the estuary can result in adverse impacts to the surrounding environment and its associated species.

The Corangamite CMA is currently developing a *NRM Plan for Climate Change* and is working in partnership with Glenelg-Hopkins CMA and all councils in the South West to develop the *South West Climate Change Portal*. Both will be available in March 2016.

The working group and responses to the online survey also identified a wide range of threats to the health of the Aire River estuary.

These included:

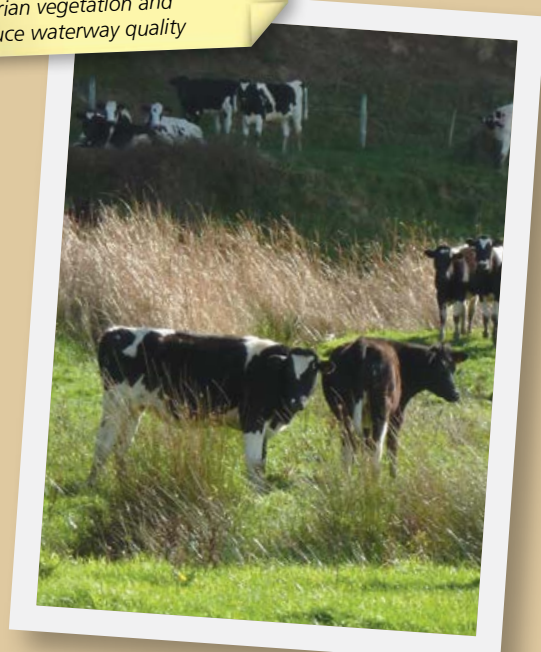
- agricultural practices
- modified flow regime through the artificial openings of the estuary
- water quality issues
- forestry practices
- climate change
- tourism
- pest plants and animals.

The *Corangamite Waterway Strategy* suggests parts of the Aire River's associated tributaries and wetlands have been subjected to grazing pressures. Livestock access to waterways can erode banks, damage riparian vegetation and reduce waterway quality through sedimentation and effluent contamination.

The red fox (*Vulpes vulpes*) was also identified as a threat to significant bird species inhabiting or visiting the wetlands and estuary of the lower Aire River.

Climate change has also been identified as a key threat to the Aire River estuary. Predicted sea level rise, temperature increase, reduction in rainfall and an increase in extreme natural events are all expected to impact the ecology and dynamics of the estuary.

Livestock access to waterways can erode banks, damage riparian vegetation and reduce waterway quality



3.3 Threats to Agriculture

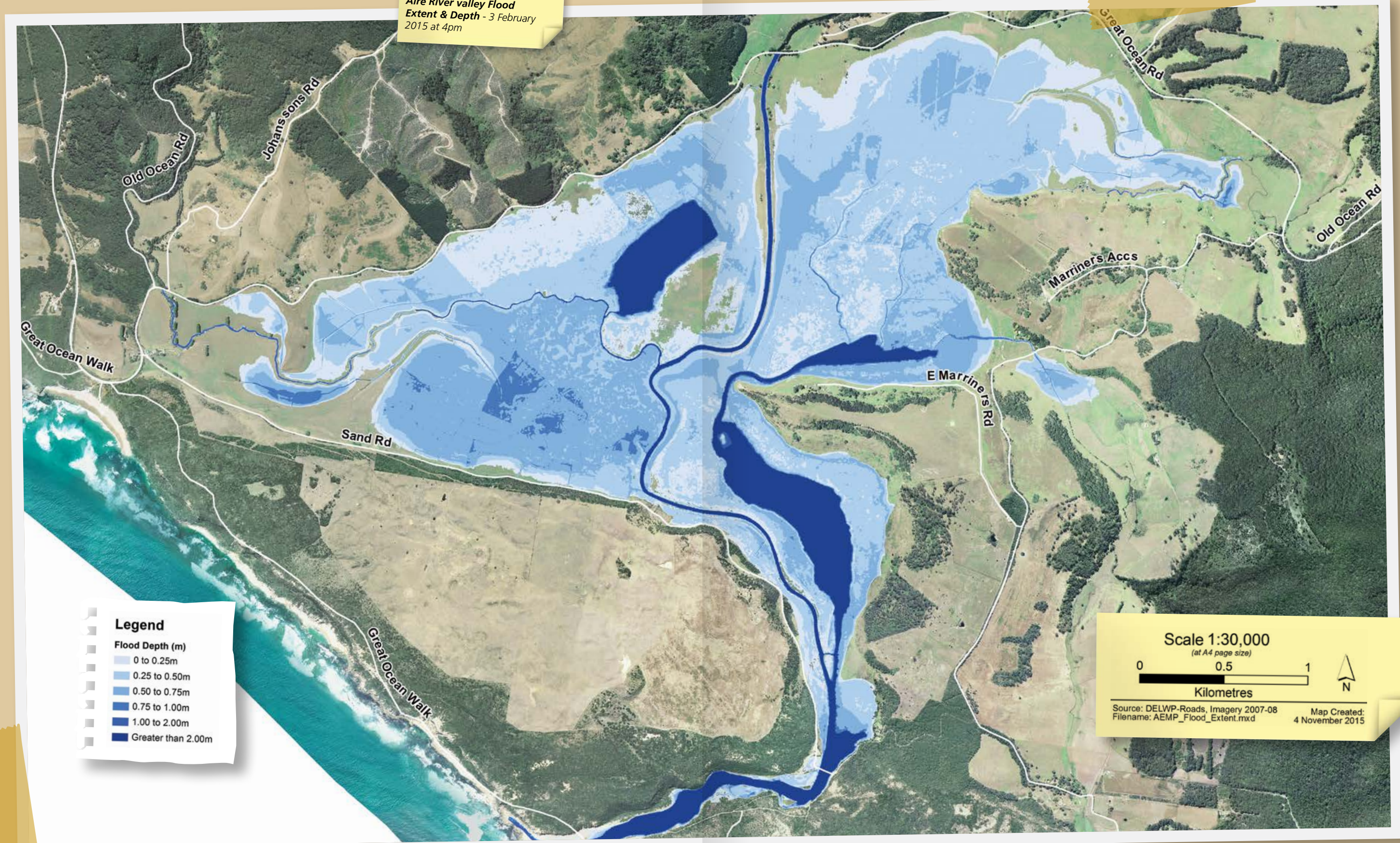
Consultation on the EMP as part of interviews to inform the development the Estuary Entrance Management Support System (EEMSS) established that while floodplain inundation provides benefit to the ecology of the system, it is a threat to agricultural practices in the Aire valley.

There were clear differences in stakeholder views on this issue and how it relates to future management of the system.

In addition, the impact of floodplain inundation on infrastructure, such as water pumps for livestock, was raised as a significant issue.

Flood extent of the Aire valley based off hydraulic modelling completed by Water Technology 2011

Aire River valley Flood Extent & Depth - 3 February 2015 at 4pm



Legend

Flood Depth (m)

Lightest Blue	0 to 0.25m
Light Blue	0.25 to 0.50m
Medium Blue	0.50 to 0.75m
Dark Blue	0.75 to 1.00m
Very Dark Blue	1.00 to 2.00m
Darkest Blue	Greater than 2.00m

Scale 1:30,000
(at A4 page size)

0 0.5 1
Kilometres

Source: DELWP-Roads, Imagery 2007-08
Filename: AEMP_Flood_Extent.mxd

Map Created:
4 November 2015

4. Key objectives

The goal and objectives were developed with the EMP working group in consideration of the diversity of views and values associated with the Aire River estuary to provide the context for developing this plan:

.....

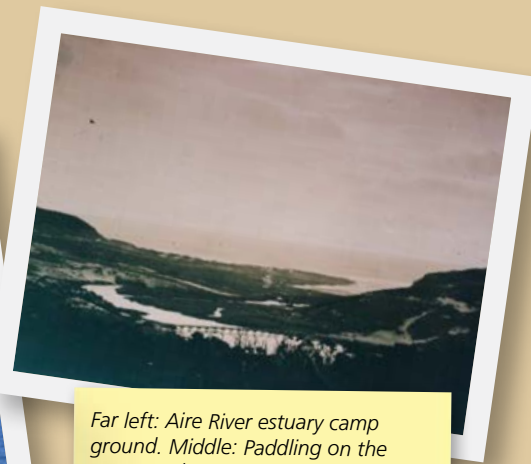
GOAL



The environmental condition of the Aire River estuary is maintained or improved, promoting a healthy, rich and diverse wetland and estuarine ecosystems that supports connectivity and can adapt to a changing climate.

Objectives

1. **Biodiversity**
Protect and enhance the natural features and living components of the estuary.
2. **Tourism and recreation**
Ensure management considers the aspirations and goals of estuary users; management considers both passive and active users and maintains estuary health to allow tourism and recreational values to continue.
3. **Land use / agriculture**
Ensure management of agricultural land on the Aire River floodplains is undertaken in a sustainable way.
4. **Heritage values**
Conserve cultural and European heritage values of the Aire River estuary.



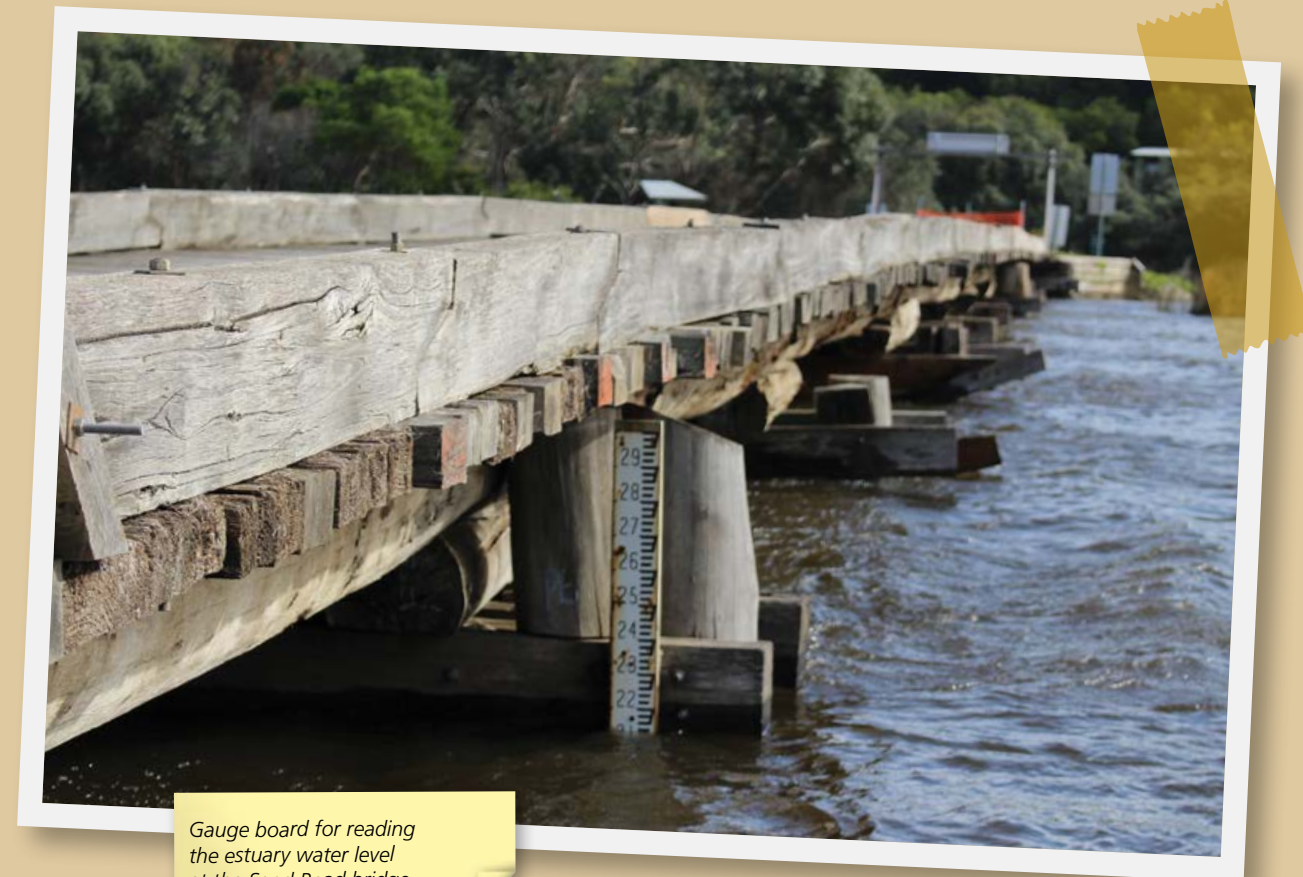
Far left: Aire River estuary camp ground. Middle: Paddling on the estuary. Above: Historical photo of Aire River estuary (Photo courtesy of Ros Denney)

5. Implementation, monitoring, evaluation and reporting of the EMP

An implementation committee will be established to meet annually and track actions and monitor impacts where funding is available.

.....

The committee's role is to conduct a review of the EMP after four years. This will allow for an assessment of the EMP's direction, consideration of new information and a review/update of actions.



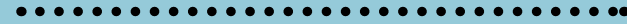
Gauge board for reading the estuary water level at the Sand Road bridge



6. Estuarine processes and characteristics

6.1 Berm dynamic and geomorphology

The factors contributing to physical change and landscape evolution are important concepts to grasp. They establish estuary functions and background to how the Aire River came to look the way it does today.



Sand is delivered to the estuary entrance through a number of mechanisms, including waves and along shore currents. Waves carry sand onshore in suspension and as waves break at an angle to the beach, or there is an along shore current, there is a net transport of sand along the beach. This causes a continual supply of sand to be deposited at the estuary entrance forming a flood tide delta (deposit of sand) in an area of low energy inside the entrance.

The size and shape of waves influences their ability to mobilise sand. If the sand supply exceeds the ebb tide water's ability to scour the sand away, there will be an increase in the berm volume. The greater the sand transport, the greater outflow that is required to keep the estuary open.

Sand transport and deposition can be exacerbated or reduced by offshore or near shore structures. The image below shows that waves refracting around the rocky reef create an area of deposition at the estuary entrance. For the Aire River estuary, the beach is further built up by the west to east along shore sand transport (image below).

The Aire River estuary also receives large and consistent swell generated in Bass Strait and the Southern Ocean (being located on the south facing Otway Coast). This provides challenges for estuary managers to artificially open the estuary with large swell that can rapidly close the estuary soon after opening.



The Aire River estuary

6.2 Water quality

The Aire River estuary is a dynamic system. The ratio of freshwater to saltwater depends on tide, freshwater flows, season, and how recently the mouth of the estuary has opened. These factors determine how the physical and chemical parameters of an estuary change with depth, known as the depth profile. The depth profile of the Aire River estuary can change dramatically from its upper reaches to where it meets the sea.



The largest dataset of water quality monitoring at the Aire River estuary is collected as part of the permit requirements for artificial opening of the estuary.

Water quality monitoring is conducted at nine sites throughout the estuary prior to an estuary opening. The parameters collected at the nine sites are represented in Table 2 below.

Table 2. Parameters collected prior to and after opening

Parameter	Unit
Dissolved oxygen	mg/l & % saturation
Salinity	Parts per thousand
Electrical conductivity	mS/cm
Temperature	Degrees centigrade
Turbidity	NTU

Dissolved oxygen is a key parameter essential for a healthy and diverse water body. It enters estuarine waters by mixing with air at the surface and from estuarine plants photosynthesizing during the day.

Dissolved oxygen is used by animals, most microbes and plants (during the night). Without enough dissolved oxygen, estuarine animals will die or move elsewhere, as highlighted by fish death events throughout western Victoria. At times it is possible for the freshwater layer in a stratified estuary to blanket the saltwater layer. If this occurs for long enough, animals and microbes living in the lower waters and sediments can use all the oxygen in the bottom layer. At such times, there is a particularly high risk of a fish death event if the estuary is artificially opened draining the surface oxygenated water.

Figures 2 and 3 show levels of dissolved oxygen as percent saturation. These graphs have been developed from water quality monitoring collected prior to artificial openings at the Aire River estuary in September (spring) and December (summer) 2014.

Measurements of per cent saturation of dissolved oxygen will typically range from 0% to 100%, but can exceed 100% at times when large amounts of oxygen are being produced by plants and algae. Most animals and plants can grow and reproduce unimpaired when dissolved oxygen levels exceed 80%. When levels drop to less than 80% living organisms can become stressed.

Figures 2 and 3 show the water quality profile for the Aire River estuary in September 2014 and December 2014 respectively. It can be seen that the dissolved oxygen levels throughout the water column are much lower in December. Lower levels of dissolved oxygen are a common occurrence in the summer months with higher temperatures and less flow in the estuary. This increases the risk of an artificial or estuary opening causing a fish kill as the surface oxygenated water can be completely lost to the sea.

In 2011, Water Technology completed a report analysing water quality data collected pre and post artificial openings of the Aire River estuary. Parks Victoria funded the data collection carried out by Deakin University and other providers between 2002 and 2011. This report contained a series of recommendations considered in preparing the management action list in this plan.



6.3 Condition reporting

In order to gauge estuary condition it is important to have the ability to assess water quality against a standard set(s) of data. As all estuaries behave differently and can have extreme variability, a range of measures have been developed for use in the Aire River estuary.

The Index of Estuary of Condition (IEC), currently under development, is designed to complement the existing Index of Stream Condition (ISC) for estuaries. This provides a consistent state-wide assessment every eight years of the environmental condition of estuaries.

IEC has six themes:

- water quality
- physical form
- hydrology
- sediment
- flora, and
- fauna.

This enables the condition of the Aire River estuary to be reported at regional, state and national levels, prioritising resource allocation, and providing a way to assess estuary management interventions.

Given the IEC is essentially a snap shot of condition, it is important to have long term datasets to allow estuary conditions to be established under different hydrological states.

The Corangamite CMA EstuaryWatch program collects data for this reason allowing comparison against IEC in regard to mouth condition monitoring and depth profiling.

The Environment Protection Authority (EPA) water quality guidelines provide a framework and tools for assessing the environmental condition of riverine estuaries. The guideline values describe the condition of quality estuaries, and these can be used as an indicator for assessment of other estuaries.



Aire River estuary

6.4 Current condition

The 2010 ISC listed the upstream sections of the Aire River as being in excellent condition with the lower reaches of the river considered in moderate condition (above the estuary).

The Aire River estuary is predominately brackish – rarely as saline as sea water, and only entirely fresh in a riverine flood event. There is generally a salt wedge that stretches up to the Great Ocean Road bridge, with the water column exhibiting variable salinity depending on river flow volume and extent to which tides, winds and waves push sea water into the estuary.

The working group discussed the current condition of the Aire River estuary during the development of this plan. The consensus of the representatives from the range of backgrounds and opinions was the Aire River estuary is a modified system that still has multiple values to stakeholders.

It was highlighted that the fragile landscape has changed over the years, with the natural environment existing alongside historical land management practices, presenting challenges for future management.

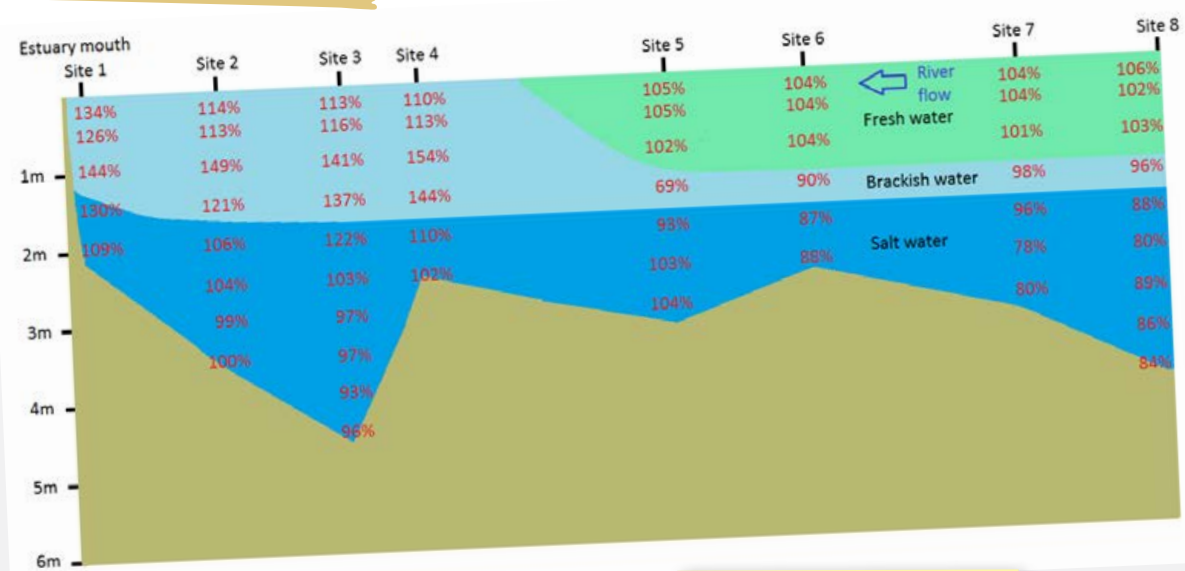


Figure 2. September 2014, percentage of dissolved oxygen water quality profile of the Aire River estuary

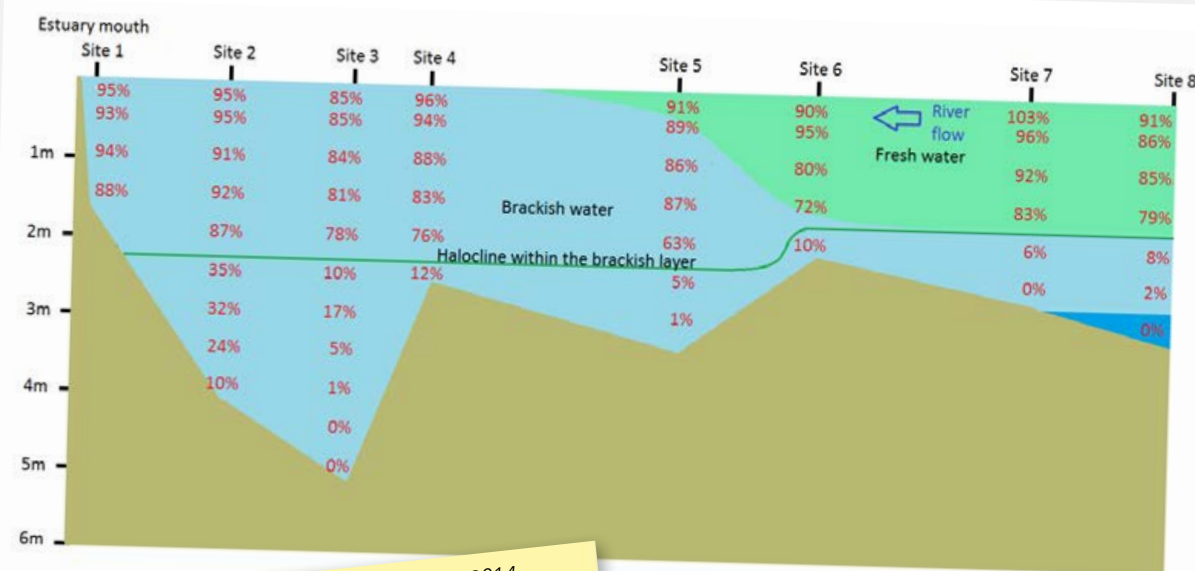


Figure 3. December 2014, percentage of dissolved oxygen water quality profile of the Aire River estuary

7. Estuarine values

7.1 Fish species

Fish are managed throughout Victoria for various reasons. Broadly speaking the Victorian guide to native fish management prioritises the following:

- Freshwater and estuarine species recognised as threatened (listed under *EPBC Act*, or *FFG Act*).
- Freshwater and estuarine species that are targeted by recreational and commercial fishers (information derived from DELWP resources and the Scientific Advisory Panel) or are of cultural significance.
- Remaining freshwater species for which we have good knowledge.

Beyond these priority groups, estuarine fish are prioritised according to their level of dependence on estuarine environments, with greater emphasis placed on species heavily reliant on estuarine environments to complete life cycles. Native fish that occur in estuaries divided into three groups:

- freshwater species
- estuarine species usually further divided into permanent or seasonal
- marine stragglers – visitors to the estuary environment.

Fish species are highly valuable assets in the Aire River estuary and provide a tangible ecological association for estuary and river users, as well as managers. Black bream are the flagship species for the area, and along with mullet, salmon, estuary perch and flounder provide focus for recreational angling in the estuary.

Australian Grayling (*Prototroctes maraena*)

The fish species with the greatest conservation status within the Otway region is the Australian grayling (*Prototroctes maraena*) with a status of Vulnerable under the *Commonwealth Environment Protect and biodiversity Conservation Act 1999 (EPBC Act)*.

The Australian grayling is known to occur in the Aire River estuary and is a small to medium-sized, slender, laterally compressed fish, with soft-rayed fins lacking any spines. The colour is generally greyish-bronze, slightly darker on the dorsal surface, fading to silvery white below. The Australian grayling has a National Recovery Plan that has been considered in developing this plan.



Australian grayling
(*Prototroctes maraena*)

Australian Mudfish (*Neochanna cleaver*)

The Australian mudfish (*Neochanna cleaver*) is recognised for its significance at the Aire being listed under the *Flora and Fauna Guarantee Act 1988 (FFG Act)*. The Australian mudfish is a small elongate, tubular and scaleless. It grows to 140 mm in length. Features that distinguish this species from other galaxias are the presence of large, long tubular nostrils, a small head and eyes, large round pectoral fins and small pelvic fins, large flanges on the caudal peduncle, and a low, rounded to ovoid dorsal fin, elongated posterior.

The presence of the Australian mudfish and actions in the State Government Action Statement underpin several of the recommended actions in this plan.

Short-finned Eel (*Anguila australis*)

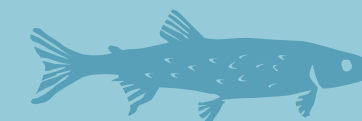
Short-finned adult eels predominantly live in freshwater streams and lakes. Once reaching sexual maturity (14-24 years) they migrate to the sea where they travel to deep oceanic breeding sites to spawn. The larvae travel back on ocean currents to coastal waters before metamorphosing into glass eels and migrating back into estuaries.



Electro fishing on the
Aire River floodplain



Australian mudfish on the
Aire River floodplain



7.2 Birds

While populating the EEMSS database in 2010, the Corangamite CMA commissioned a bird survey of the region's estuaries, where bird occurrence data could assist management.

The purpose was "to obtain information on the distribution and abundance of birds, focusing on waterbirds and other estuarine specialists, in order to make an assessment of bird use in the context of estuary entrance openings" (Hanson 2010), with species classified into lists according to those pre-determined in the EEMSS. Surveys were conducted at the Aire between May and July 2010. The Aire River estuary was surveyed from a canoe and supplemented, where possible, with foot-based counts from the shore.

The method of survey for the Aire River estuary was as follows:

- Estuary was broken in lower, middle and upper.
- Bird counts of the channel and riparian zone were conducted by two observers, either from a vessel or on foot, by traversing the estuary from the lower reaches to the upper reaches.
- Sections were divided into sequential 200 m transects (recorded using a hand held GPS unit) and birds were counted separately in each transect.
- All bird species were recorded, including waterbirds, riparian passerines, raptors, parrots and introduced species.
- The only species not recorded during surveys were seabirds e.g. Australian gannet, shearwaters and albatross.

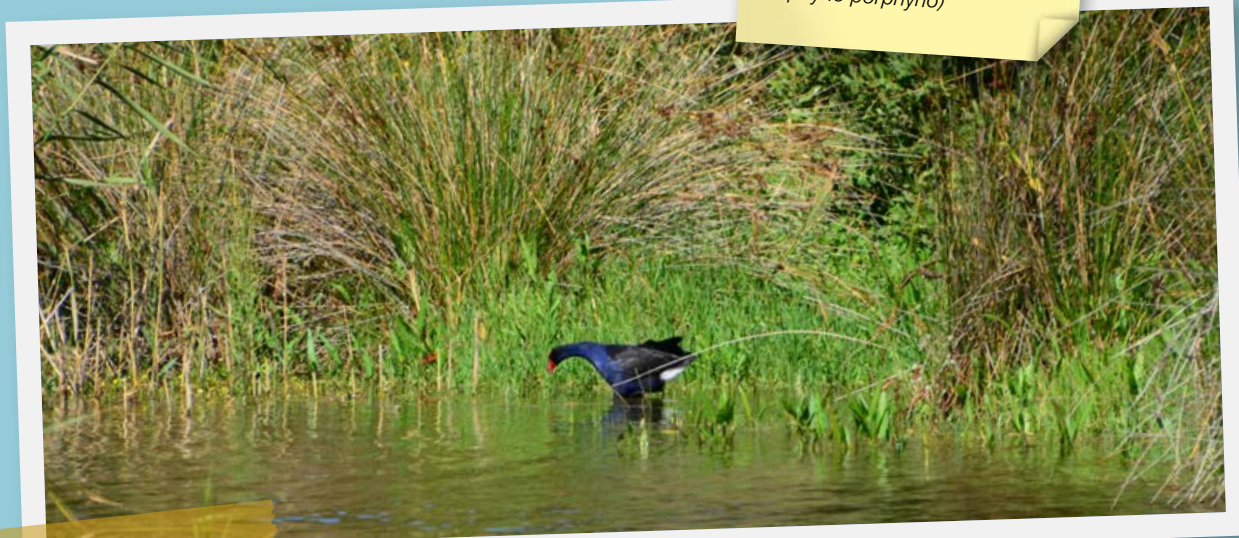
Due to the seasonality of the survey, many species were absent, particularly trans-equatorial migratory waders. Waders are a specialist group of waterbirds that use intertidal areas of south-eastern Australia during their non-breeding season (Bamford et al. 2008). Other notable absences were seasonally-transient species like hardhead, pink-eared duck, whiskered tern and Australian reed-warbler. Some resident shorebird species like oyster catchers were under-represented.

There was also a notable absence of a number of waterbirds, most likely due to inland water availability during the winter months, which attracts birds away from the coast. Surveys conducted during mid-late summer would be informative in determining waterbird habitat use in these estuaries.

Rare and threatened species that were absent were the orange-bellied parrot, ground parrot, freckled duck and Australian painted snipe. Their absence from surveys is more likely to be due to their general rarity which is reflected in their national conservation status.



Purple Swamphen
(*Porphyrio porphyrio*)



7.3 Vegetation

Ecological Vegetation Classes (EVCs) have been used to map and record vegetation for the Aire River estuary. This process is consistent across Victoria.

An EVC is a component of a vegetation classification system, grouping vegetation communities based on floristic, structural, and ecological features.

Individual EVCs within a bioregion can be assigned a conservation status or significance, to indicate its degree of alteration since European settlement in Australia. To assist with the assessment of an EVC within a bioregion, benchmarks have been established to ensure that assessments are carried out in a standard fashion across Victoria.

Information about the Aire River estuary vegetation has been sourced from studies in 2010 (Australian Ecosystems) as well as the *Caring for Country: Otways and You Management Plan (2009)*.

Thirteen EVCs were used to describe the estuary vegetation at the Aire River estuary and are represented in the Aire River estuary ecological vegetation class map (page 28).

They are:

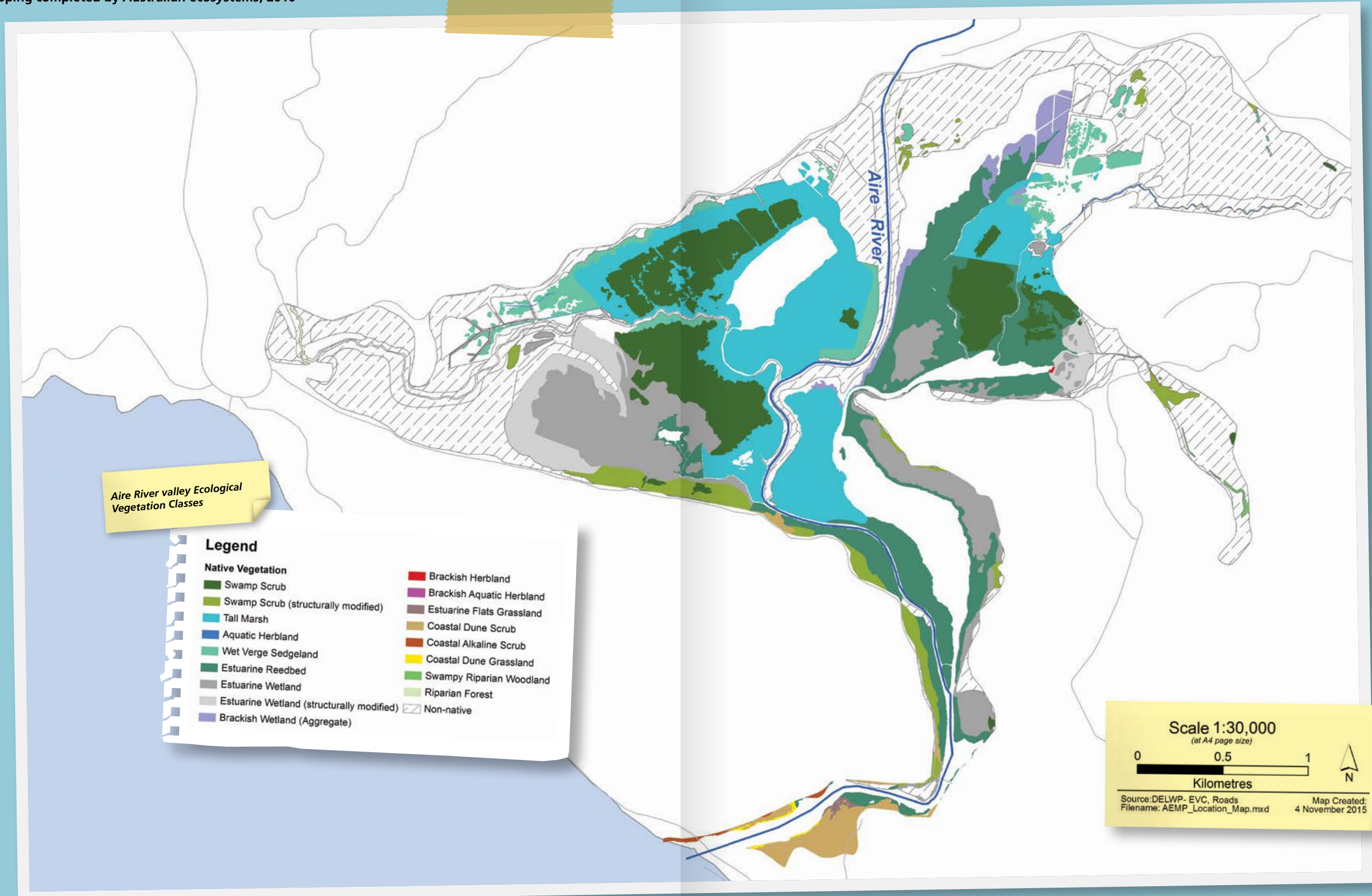
- Aquatic Herbland
- Brackish Aquatic Herbland
- Brackish Herbland
- Brackish Wetland
- Coastal Dune Grassland
- Coastal Dune Scrub
- Cool Temperate Rainforest
- Estuarine Reed Bed
- Estuarine Wetland
- Riparian Forest
- Swamp Scrub
- Swampy Riparian Woodland
- Tall Marsh Wet Verge Sedgeland.

The floristic assets of the Aire River are identified as significant and provide a sound indicator of overall river and estuary health. Unfortunately the project reach comprised few remnants or indicators of large intact cool temperate rainforest or significant riparian forest upstream of the Great Ocean Road.

Importantly, it is noted in the EVC mapping within the Aire River estuary in 2010 that the largest areas of intact vegetation occur on those lands which are reserved such as the Great Otway National Park, Lake Horden and Lake Costin, which are not grazed.



Leafy Twig-sedge (*Cladium procerum*)



Aire River valley Ecological Vegetation Classes

Legend

Native Vegetation	Brackish Herbland
Swamp Scrub	Brackish Aquatic Herbland
Swamp Scrub (structurally modified)	Estuarine Flats Grassland
Tall Marsh	Coastal Dune Scrub
Aquatic Herbland	Coastal Alkaline Scrub
Wet Verge Sedgeland	Coastal Dune Grassland
Estuarine Reedbed	Swampy Riparian Woodland
Estuarine Wetland	Riparian Forest
Estuarine Wetland (structurally modified)	Non-native
Brackish Wetland (Aggregate)	

Scale 1:30,000
(at A4 page size)

0 0.5 1
Kilometres

Source: DELWP- EVC, Roads
Filename: AEMP_Location_Map.mxd

Map Created:
4 November 2015

7.4 Socio-economic values

Information from the working group and survey data make it clear the community values the estuary highly. The data also shows the Aire River estuary supports a diverse range of socio-economic values for different users.

Tourism

The Aire River estuary, being located on the Great Ocean Road, provides a number of opportunities and possible threats to the Aire River estuary. Tourism in the Great Ocean Road region captures around 7 million visitors, contributes over 7,000 jobs and has a direct economic output of approximately \$1.1 billion per annum (Ruzzene and Dunn 2012).

Land Management

The Corangamite Waterway Strategy suggests the catchment of the Otway Coast basin, which includes the major towns of Beech Forest and Lavers Hill, is made up of a number of different land uses.

These include:

- Forestry..... 40%
- Conservation..... 37%
- Grazing (non-dairy)..... 16%
- Dairy..... 5%
- Other..... 2%

More specific to the Aire River estuary is a series of recently completed landholder interviews to inform the Estuary Entrance Management Support System (EEMSS). The results showed all land managers on the Aire valley floodplain were grazing beef cattle with some landholders also grazing sheep. The importance of these flats in the summer months to primary production was a common theme through the interviews.

Recreational Fishing

There is a variety of fishing experiences along the Great Ocean Road, and the Aire River estuary is a favourite for highly skilled catch-and-release bream fishers and children/families looking for easy fishing access points. Generally people target bream, yellow-eyed mullet, salmon, flounder or even mulloway.

Facilities at the Aire River estuary provide great access for all abilities including, fishing platform as well as boat and canoe launching facilities.

8. Estuary Entrance Management Support System (EEMSS)

An asset is a spatially defined component of the environment that provides values to the community e.g. a river reach, an estuary reach, an individual wetland or a wetland complex. An asset may provide social, environmental, cultural and economic values. Action planning to manage these assets, includes identifying any threats to the values, and following this, the risk of the threat affecting the values.

The Estuary Entrance Management Support System (EEMSS) is a computer based decision support tool used by estuary managers when choosing whether or not to artificially open an estuary (image below shows an artificial opening). Originally developed as a database in 2006, it has been redeveloped as a web-based tool and can be found at: www.victorianestuaries.com.au

The EEMSS provides estuary managers with a powerful tool for considering impacts on the estuary's environmental, social and economic value. And properly accounting for all of the likely risks involved with decisions to artificially open (or not open) an estuary. In addition it contains important baseline data such as records of estuary openings, water levels, water quality data, and species lists.

The EEMSS has also recently had agricultural data populated for the Aire River estuary. This has involved extensive consultation with the local community around understanding assets and threats in relation to the estuary water level for particular times of year.



Entrance on the eastern side of the Aire River estuary



Artificial opening at the Aire River estuary

9. Management actions table

Management actions have been developed with the community and management agencies responsible for managing the Aire River estuary through the working group. The actions have been devised to address threats to the estuary's identified values. There is a strong emphasis on collecting further information to help meet the objectives of this plan and address the conflict between the requirements of current land use (grazing) and environmental outcomes.

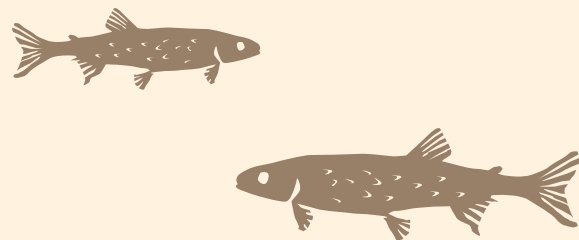
Many documents have been reviewed to ensure the actions build on all previous works. A list of further reading can be found at the back of this plan in section 10. Discussions and a survey of community interest have also shaped the priorities.

Delivery and timing of the actions outlined in the table below are subject to funding availability.

Action	Detail of Action	Who leads implementation	Partners	Success measure and outputs
Biodiversity – Protect and enhance the natural features and living components of the estuary				
1	Install riparian fence (<i>Corangamite Waterway Strategy</i>).	CCMA	SOLN, LH	
2	Establish native indigenous vegetation (<i>Corangamite Waterway Strategy</i>).	CCMA/PV	SOLN, LH	
3	Establish stewardship/management agreement (<i>Corangamite Waterway Strategy</i>).	Land manager, CCMA	PV, SOLN	
4	Establish terrestrial pest animal control - fox control (as part of a large scale coordinated program) (<i>Corangamite Waterway Strategy</i>).	Land manager, CCMA, DELWP	All	
5	Develop an EstuaryWatch group for the Aire River estuary.	CCMA	Community	Formation of the EstuaryWatch group
6	Implement actions within the Australian Mudfish Action Plan where appropriate.	CCMA, DEWLP	Land managers	
Land use / agriculture – Ensure management of agricultural land on the Aire River floodplains is undertaken in sustainable way				
7	Incorporate key findings of the Statewide Drainage Strategy (currently draft) that contribute to the management of the estuary.	DELWP, COS	CCMA	Statewide standard/guidelines
8	Investigate opportunities for other potential sources of income for stewardship of the floodplain. For example carbon credits for land that is inundated.	CCMA, DEWLP	DELWP, COS	
9	Respond to the new <i>Marine and Coastal Act</i> when developed.	All		
Tourism and recreation – Ensure management considers the aspirations and goals of estuary users; management considers both passive and active users and maintains estuary health to allow tourism and recreational values to continue				
10	Consider sustainable opportunities for tourism development projects that have in minimal impact on the biodiversity of the estuary.	COS, PV	WCB	
11	Ensure recreation (passive and active) within the Aire valley occurs in a manner that is environmentally sustainable.	All		
Heritage – Conserve Cultural and European heritage values of the Aire River estuary				
12	Ensure future planning and strategies consider Indigenous and European heritage values for the Aire River estuary.	All		
13	Ensure future works consider the Indigenous and European significance of the area.	All		
Management – Future management strives to protect and enhance the environmental condition of the Aire River estuary, and preserve the social, cultural and economic values associated with the estuary				
14	Investigate opportunities to improve communication around the estuary water level status. For example use of Victorian Estuaries website, media releases, EstuaryWatch.	CCMA	PV, COS	Data to be stored and available to the public
15	Develop an Memorandum of Understanding outlining the roles and responsibilities for artificial openings of the estuary.	CCMA	All	Agreement from all stakeholders flood levels
16	Manage EEMSS as a risk based approach which protects community values - social, economic and environmental.	CCMA	PV	EEMSS being used at the Aire River
17	Develop an implementation committee to oversee plan implementation and report on plan progress annually.	CCMA	All	Relevant agencies appoint representative
18	Repeat survey of EVCs in 2018 as part of continual monitoring of estuary vegetation across the region.	DEWLP, CCMA		Mapping and reporting completed and layers updated
19	Repeat Index of Estuary Condition (IEC) monitoring.	DELWP		Improved IEC score
20	Review flood overlays (LSIO & FO) as significant information on climate change sea level rise becomes available.	COS, CCMA		Updated information incorporated into planning scheme
21	Continue to monitor and store estuary water quality conditions for a continuous long term record in accordance with agreed roles and responsibilities.	CCMA, PV		
22	Replacement of current gauge board to the bridge. Move to new pole separate to the bridge.	CCMA		
23	Investigate opportunities for a permanent data monitoring station within the estuary.	CCMA		
24	Investigate opportunities to upgrade infrastructure that becomes inundated with high estuary water level, including Parks Victoria camp grounds, Sand Road...	All		
Research (knowledge gaps) – Research gaps are identified and addressed to help maintain or improve the environmental condition of the Aire River estuary				
25	Continue to develop and use the best available information relating to climate change and sea level rise and its impacts on coastal vulnerability.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management
26	Investigate further the carbon blue & green carbon sequestration on the Aire valley floodplain.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management
27	Gain a greater understanding of estuary mouth dynamics in relation to natural versus artificial openings of the estuary.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management
28	Investigate the economic viability of changing land management practices to farming for environmental assets with payments funded through carbon credit accumulation.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management
29	Investigate influences the lake system has on estuary water quality in relation to artificial openings of the estuary.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management
30	Investigate acid sulphate soils distribution on the Aire River floodplain.	CCMA, DELWP	Research institutions, COS	Various relating to integrated management

10. References / List of further reading

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- Australian Grayling *Prototroctes maraena* National Recovery Plan. (2008) Victorian Government former *Department of Sustainability and Environment (DSE)*.
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- Western Regional Coast Plan (2015-2020) DRAFT. *Western Coastal Board*.
- Victorian Waterway Management Strategy Improving our Waterways (2013). *Department of Environment and Primary Industries*.



11. Glossary

- Acid:** Water with a pH lower than 7.
- AHD:** Australian Height Datum is the standard measure for height with zero being a mean sea level.
- Alkaline:** Water with a pH higher than 7.
- Anaerobic:** Living or active in an environment where oxygen is absent.
- Anoxic:** Areas of marine or freshwater that are depleted of dissolved oxygen.
- Asset Values Identified and Risk Assessment (AVIRA):** A spatial tool for assessing the values and threats to river reaches, wetlands and estuaries.
- Bathymetry:** The terrain beneath the water's surface, which could be marine, riverine or wetland.
- Berm:** The sand accumulated at the mouth of a waterway (river or creek).
- Catchment:** An extent of land where water from precipitation drains into a waterway.
- Dissolved Oxygen:** Oxygen dissolved in water. Usually measured in milligrams per litre (mg/l or ppm) but can also be presented as percent saturation.
- Electrical conductivity (EC):** A measure of how well a material accommodates the transport of electrical charge. EC is used to estimate the concentration of dissolved salts.
- Estuary:** Semi-enclosed body of water where salt from the sea mixes with freshwater flowing from the land.
- Estuary Management Support System (EEMSS):** A decision support database tool to inform artificial estuary mouth openings by considering the risks to social, environmental and economic assets or values.
- Ecological Vegetation Class (EVC):** A component of a vegetation classification system, grouping vegetation communities based on floristic, structural, and ecological features.
- Estuary Water Level (EWL):** Refers to the surface height of water within the estuary.
- Freshwater:** Looking at estuaries, water with a low salinity. Not necessarily potable or clear.
- Halocline:** An area of transition from lower to higher salinity with increasing depth.
- Hydraulic:** Operated by, moved by, or employing water or other liquids in motion. Studying the hydraulics of the estuary will explain where the water moves and the way it does within the estuary.
- Hydrodynamics:** The branch of science concerned with the hydraulic properties of water and in this context, how the water within the estuary moves based upon the physical boundaries within the system such as bank steepness and roughness, depth (bathymetry) and bank width.
- Index of Stream Condition (ISC):** Standard measure of river health in Victoria reported every six years.
- Index of Estuary Condition (IEC):** Still at draft stage the IEC will have a similar state-wide measure of estuary health as that for wetlands (IWC) and rivers (ISC).
- Land Subject to Inundation Overlay (LSIO):** A flood related town planning control.
- Longshore sediment transport:** The general direction of sand and sediment transport along the Victorian coastline in west to east.
- Marine:** Of or pertaining to the sea; existing in or produced by the sea.
- Parameters:** The different types of qualities that estuary water is tested for can be termed parameters.
- pH:** A measure of how many H⁺ and OH⁻ ions are in solution giving us a measure of acidity or alkalinity on a scale of 1-14, where less than 7 is acid, 7 is neutral, and greater than 7 is alkaline.
- Terrestrial:** Belonging to the land rather than the sea or air living or growing on land.
- Saline:** Water containing significant content of salt.
- Salt wedge:** The physical separation of marine and riverine water within an estuary with the denser salty marine water sitting beneath the riverine water and forming a wedge.
- Stratification:** Water stratification occurs when water masses with different properties such as salinity (halocline), oxygen (chemocline), density (pycnocline) temperature (thermocline) form layers that act as barriers to water mixing.
- Threats:** Something which may do harm to a value or assets.
- Turbidity:** Visible cloudiness due to suspended material in water causing a reduction in the transmission of light.
- Tributary:** A stream that flows to a larger stream or other body of water.
- Values:** Things important to the community and stakeholders.

12. List of maps, figures, tables and images

Type	Description	Source	Page
Image	Aire River estuary entrance	CCMA	Cover
Map	Aire River valley	CCMA	2 & 3
Image	Eastern Great Egret (<i>Ardea alba</i>)	CCMA	4
Image	Aire River estuary upstream of Great Ocean Road bridge	CCMA	6
Table	Roles and responsibilities of key stakeholders	CCMA	7
Image	Localised flooding at the Aire River estuary	CCMA	7
Map	Aire River Land Managers' Map	CCMA	8 & 9
Image	Shell midden adjacent to the Aire River estuary	CCMA	10
Image	Parliamentary Public Works Committee inspecting the Aire River estuary in 1965	CCMA	11
Image	Aire River estuary bridge at the Great ocean Road	CCMA	12
Image	The new Sand Road bridge	CCMA	12
Figure	Estuary management strategy and planning arrangements in Victoria	DEWLP	13
Image	The Sand Road bridge at the Aire River estuary	CCMA	14
Image	Livestock access to waterways can erode banks, damage riparian vegetation and reduce water quality	CCMA	15
Map	Aire River valley flood extent and depth – 3 February 2015 at 4 pm	CCMA	16 & 17
Image	Aire River estuary camp ground	CCMA	18
Image	Paddling on the estuary	CCMA	18
Image	Historical photo of the Aire River estuary	Ros Denney	18
Image	Gauge board for reading the estuary water level at the Sand Road bridge	CCMA	19
Image	The Aire River estuary	CCMA	20
Table	Parameters collected prior to and after opening	CCMA	21
Figure	September 2014, percentage of dissolved oxygen water quality profile of the Aire River estuary	Catchment Ecology Services	22
Figure	December 2014, percentage of dissolved oxygen water quality profile of the Aire River estuary	Catchment Ecology Services	22
Image	Aire River estuary	CCMA	23
Image	Australian grayling (<i>Prototroctes maraena</i>)	CCMA	24
Image	Electro fishing on the Aire River floodplain	CCMA	25
Image	Australian mudfish on the Aire River floodplain	CCMA	25
Image	Purple Swamphen (<i>Porphyrio porphyrio</i>)	CCMA	26
Image	Leafy Twig-sedge (<i>Cladium procerum</i>)	CCMA	27
Map	Aire River valley Ecological Vegetation Classes	Australian Ecosystems	28 & 29
Image	Entrance on the eastern side of the Aire River estuary	CCMA	30
Image	Artificial opening at the Aire River estuary	Ed Sloane Photography	31
Table	Management actions table	CCMA	32 & 33

Appendix 1: Community values and aspirations

An online survey was created to capture broader community and stakeholder input into the development of the Estuary Management Plan. The survey was made publicly available via Survey Monkey and distributed through representatives from the Department of Environment, Land, Water and Planning (DELWP), the Department of Economic Development, Job, Transport, and Resources (DEDJTR - Fisheries), Parks Victoria, the Conservation Ecology Centre, Colac Otway Shire (COS), Field and Game, VRFish, the Corangamite CMA and the four community representatives on the working group. The survey asked respondents what they value about the Aire River estuary, what they perceive to be the greatest threats and the most important management responses.

In total, there were 36 respondents from a diversity of groups including community members, rural land managers, local volunteers, local government and state government/authority or agency representatives as seen in Figure 1.

Results from the survey reiterated that the Aire River estuary is a high use area, with many social, economic and environmental values, as well as multiple threats (including those that occur within the immediate estuarine areas, as well as those that are catchment based as noted in Figure 2).

The responses around the most important management actions were grouped into the following key themes:

- Tourism and people management
- Land use
- Environmental protection
- Management of estuary openings and flooding
- Climate change
- Cultural heritage and community.

The survey showed that 96% of respondents were interested in learning more about the system. The survey also highlighted a strong interest in the establishment of an EstuaryWatch group for the Aire River estuary with 40% of respondents informing they would be interested in volunteering through the EstuaryWatch program.

Figure 1. Sectors of the community represented in the survey

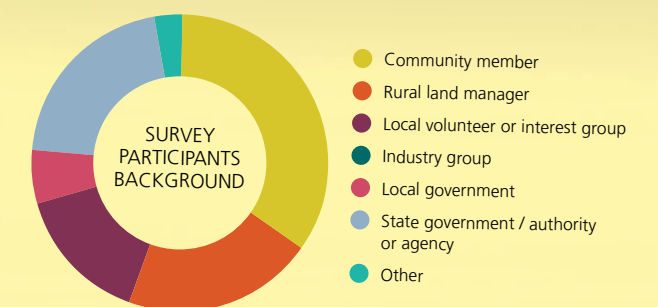
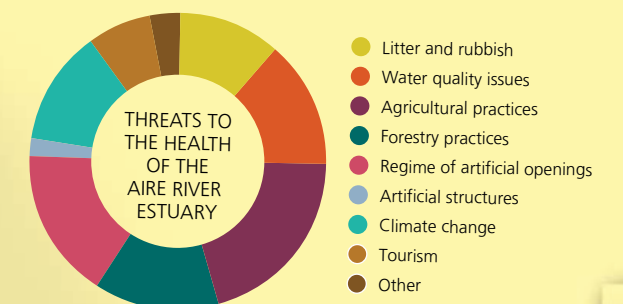


Figure 2. Potential threats to the health of the Aire River estuary

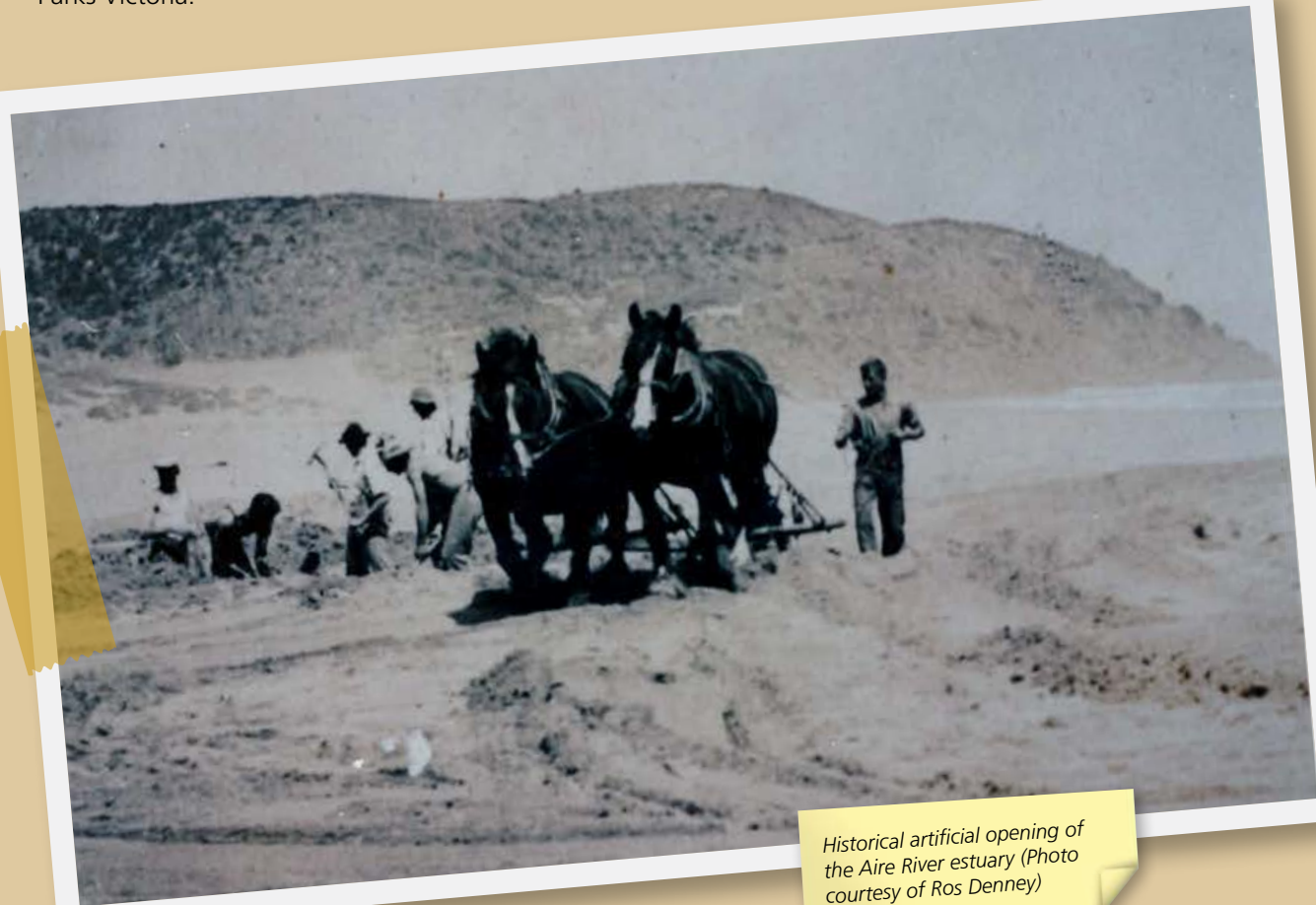


Appendix 2: History of artificial estuary openings

Periodically a sand bar forms at the mouth of the Aire River and the river becomes blocked, causing inundation of the Aire valley, including the privately owned agricultural land. Since the 1950s until 2000, the Aire River Drainage Committee, consisting of 17 rate paying members, had been responsible for the mechanical removal of the sandbar to reduce the threat of floodwaters inundating the agricultural lands.

In 2001 the responsibility for authorising works on waterways in the Aire valley was vested with the Corangamite CMA. A permit to manage the opening of the Aire River mouth has since been issued to Parks Victoria.

In 2013 the release of the Victorian Waterway Management Strategy required waterway managers to develop a Memorandum of Understanding (MOU) to identify the roles and responsibilities and the process for artificial estuary openings. Work is currently underway to prepare a MOU for the Aire River estuary.



Historical artificial opening of the Aire River estuary (Photo courtesy of Ros Denney)

Appendix 3: EstuaryWatch



The EstuaryWatch Program is coordinated through the Corangamite CMA (on behalf of the Victorian Waterway Management Program) and implemented through regional waterway managers in partnership with the community.

The EstuaryWatch Program will continue to build on its established and valued role as a key community engagement program, connecting local communities with waterway management. It will also continue to enhance its program to provide credible, relevant and accessible data to increase knowledge and inform management decisions.

Over the next eight years, the management objective for the EstuaryWatch Program is to increase the knowledge of the community and waterway managers to inform estuary management decisions and encourage waterway stewardship.

It will achieve this by:

- increasing community participation in estuary based engagement events and monitoring activities
- increasing community knowledge and skills on how to monitor estuary condition
- increasing the availability of reliable and relevant estuary condition data and information to the community and waterway managers
- increasing community awareness and knowledge of estuary management and condition.

The EstuaryWatch Program will undertake the following activities:

- establish, maintain and review estuary monitoring sites, monitoring plans, information management systems and partnerships in collaboration with the community and waterway managers
- engage the community through estuary monitoring, events and a variety of media including publications, interpretative information and displays.

The EstuaryWatch Program will be sustained into the future through the ongoing implementation of planning, monitoring, reporting, evaluation, research, capacity building activities and coordination of standards and processes.

EstuaryWatch activities will contribute to engaging the community and collecting data and information within priority estuaries across various waterway management issues including:

- recreational use of waterways
- environmental water management
- riparian management
- water quality
- the river channel
- wetlands
- waterways in urban areas
- extreme events of flood and bushfire
- invasive species management in waterways.

These waterway management issues and their related policies and actions are defined in the VWMS.

Appendix 4: Adapting the Corangamite Region for Climate Change

The Corangamite CMA is managing a project that is working to address the impact of climate change on the regions natural ecosystems. This project will also guide adaptation and mitigation actions, as well as identify priority landscapes for carbon sequestration.

Background

The Corangamite CMA is working in consultation with a range of stakeholders to develop the Corangamite Natural Resource Management Planning for Climate Change project. This Australian Government funded three-year project is due for completion in June 2016. It provides direction for managing the impacts of climate change on the regions natural assets.

The project will:

- Provide regional information on the predicted changes in climate and its likely impact on the region's natural assets
- Provide guidance to the Corangamite CMA and other regional NRM agencies to develop adaptation and mitigation actions to address the impact of climate change on our region's natural ecosystems
- Identify priority landscapes for carbon plantings and other methods, as well as strategies to build landscape integrity
- Provide guidance for regional decision-making, community engagement and research needs, to improve understanding of the impact of climate change.

Project Outcomes

The key output of this project will be an easy to access web portal that hosts project information, will include geographic and topic search filters and have the ability for regular updates as new information becomes available. The portal will provide community groups and stakeholders the ability to plan and develop projects based on current climate change information.

What will the region look like under climate change?

The Corangamite region's natural assets are unique – but what will they look like in the future?

- It is expected that temperature will continue to increase in all seasons – including more how days
- There is likely to be less rainfall – but with more intense rainfall events
- Sea levels are expected to rise, and
- There is expected to be an increase in extreme natural events such as bush fires and floods (Gorse, M. et al, 2015).

This creates the need for us to know exactly how vulnerable the region's natural assets are to the potential impacts of climate change. Decision making for this project will be based on a recently completed spatial climate change impact assessment that considers multiple natural assets and threats using current research.

Birds eye view of Aire River estuary



Appendix 5: The Distribution and Abundance of 'Blue Carbon' within the Corangamite Region

Along with carbon sequestration options using revegetation, the Corangamite CMA is also looking at new and emerging options such as soil carbon (e.g. biochar) and blue carbon.

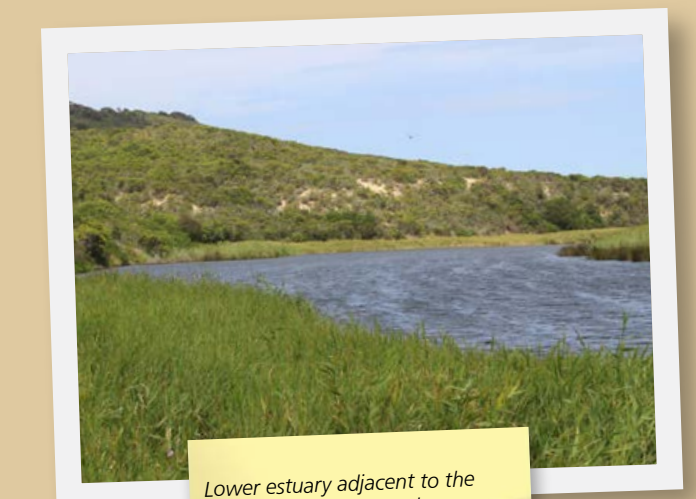
Blue carbon habitats, including saltmarsh, mangroves and seagrass meadows present a promising option for the region. Corangamite CMA is working closely with Deakin University to explore these opportunities and build knowledge in this area.



Seagrass (*Zostera nigra*)
(Photo courtesy of Peter Macreadie)



Carbon in sediment on the estuarine floodplain (Photo courtesy of Peter Macreadie)



Lower estuary adjacent to the Aire River camp ground



Cover: Aire River estuary entrance

Corangamite CMA worked in partnership with multiple agencies drafting this eight-year estuary management plan. This group will work together to guide its release and implementation.