Aquatic Value Identification and Risk Assessment (AVIRA) Manual

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- James Todd (Manager, Ecosystem Services Projects – DSE, BES) – Significant EVCs metric
- Tamara Boyd (State Ecological Water Manager - Parks Victoria) – Victorian Parks and Reserves metric

Acronyms

2ISC	The second round of ISC assessments (undertaken in 2004)
3ISC	The third round of ISC assessments (due in 2010)
ABC	Actions for Biodiversity Conservation
ANRA	Australian Natural Resources Atlas
ARI	Arthur Rylah Institute
ASL	Above Sea Level
AusRivAS	Australian River Assessment System
AVIRA	Aquatic Value Identification and Risk Assessment
BES	Biodiversity and Ecosystem Services
BIRD	Biodiversity Information Resources and Data
BMID	Bacchus Marsh Irrigation District
CMA	Catchment Management Authority
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry
DEWHA	Department of the Environment, Water, Heritage and the Arts
DNRE	Department of Natural Resources and Environment
DPI	Department of Primary Industries
DELWP	Department of Environment, Land, Water and Planning
DSE	Department of Sustainability and Environment
EEFAM	Estuary Environmental Flows Assessment Methodology
EEMSS	Estuary Entrance Management Support System
EEU	Environmental Economics Unit
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPT	Ephemeroptera, Plecoptera, Trichoptera
EVC	Ecological Vegetation Class
FFG Act	Flora and Fauna Guarantee Act 1988
GMW	Goulburn Murray Water
HEVAE	High Ecological Value Aquatic Ecosystem
IBA	Important Bird Area
IBRA	Interim Biogeographic Regionalisation for Australia
IEC	Index of Estuary Condition
ISC	Index of Stream Condition
IUCN	International Union for Conservation of Nature

IWC	Index of Wetland Condition
LCC	Land Conservation Council
LWRRDC	Land and Water Resources Research and Development Corporation
MDBC	Murray Darling Basin Commission
MID	Macalister Irrigation District
NLWRA	National Land and Water Resources Audit
NWI	National Water Initiative
RFMP	Regional Fishery Management Plan
RiVERS	River Values and Environmental Risk System
RRHS	Regional River Health Strategy
RWS	Regional Waterway Strategy
SedNet	Sediment River Network Model
SEPP (WoV)	State Environment Protection Policy – Waters of Victoria
SIGNAL	Stream Invertebrate Grade Number - Average Level
SISC	Social Index of Stream Condition
SRA	Sustainable Rivers Audit
SRW	Southern Rural Water
SWE&ID	Sustainable Water, Environment & Innovation Division
SWSC	Special Water Supply Catchment
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VWQMN	Victorian Water Quality Monitoring Network
VRHS	Victorian River Health Strategy
WES	Water Entitlements and Strategies
WID	Werribee Irrigation District

1 Introduction

Riverness Pty Ltd was engaged by the Department of Sustainability and Environment (DSE), now the Department of Environment, Land, Water and Planning (DELWP) to provide the framework and risk assessment processes to assist the development of an updated RiVERS decision support tool. This updated tool, named AVIRA (Aquatic Value Identification and Risk Assessment) has been used in the development of the Regional Waterway Strategies across Victoria.

1.1 Background

The Victorian Waterway Management Strategy, 2013, outlines the regional planning process for waterway management. As part of that process, Regional Waterway Strategies (RWSs) were required to be developed by Catchment Management Authorities (CMAs) by 2014.

The RWSs identify:

- regional goals for waterway management;
- high value waterways;
- a subset of priority waterways for an eight-year planning period; and
- a strategic regional work program of management activities for priority waterways to guide investment over the eight-year period.

As with the previous Regional River Health Strategies (RRHSs), the RWSs applied an asset-based approach to planning. Unlike the RRHSs, the RWSs brought together planning for rivers, estuaries and wetlands.

1.2 Review of Regional River Health Strategies

The RRHSs were completed by all nine Catchment Management Authorities (CMAs) and Melbourne Water between November 2004 and October 2006. The RiVERS decision tool was used to manage data on the values and threats to river reaches.

An analysis of values and threats allowed a risk assessment to be undertaken for each river reach, and from this management actions were then determined and prioritised. Each CMA developed its own risk assessment process outside of RiVERS, which led to some inconsistencies in the application of RiVERS.

Although the RRHSs have been successful documents for providing a framework for managing river health across the state (and particularly for prioritising management effort), it was recognised that improvements could be made.

To plan for the development of the RWSs, DSE commissioned GHD to review the current RRHSs – *Report for Review of Regional River Health Strategies* (GHD 2007). One of the key recommendations from this review was the need to improve the RiVERS database. Particular issues identified included:

- Social and economic data not as well represented in RiVERS as environmental data.
- Threat identification not as robust as value identification, with issues raised including:
  - Lack of clarity between ‘threats’ and ‘threatening processes’.
  - Use of realised threats or impacts only, with no recognition of potential threats.
  - Threats often occur in reaches upstream of the high value reach, whereas RiVERS focuses on threats to values within a reach.
  - Climate change related threats were not represented.

- RiVERS was not good at undertaking risk assessment. This is not to say that the risk assessment process in RiVERS was flawed (the module covered likelihood and consequence as well as a number of other useful variables such as trajectory), but that CMAs found it to be too time consuming to enter data. As a result, CMAs developed and utilised risk assessment spreadsheets that were automated and hence, more time efficient.

1.3 Development of the AVIRA Framework and Risk Assessment Process

Based on the recommendations from GHD's review (GHD 2007), DSE commissioned Riverness Pty Ltd to undertake a formal review of RiVERS and outline a preferred approach to the development of an improved RiVERS database - AVIRA.

In order to determine the purpose of AVIRA and present a prioritised listing of its desired functionalities, the following tasks were undertaken:

- review the purpose and use of RiVERS;
- review other natural resource management prioritisation approaches to find background for, and synergies with, the development of AVIRA; and
- seek comment and input from end-users in the purpose, scope and functionalities of AVIRA.

The final report *Determining the Purpose of RiVERS (II)* (Peters 2008) presented 20 recommendations on the purpose and functionalities of AVIRA. These recommendations guided the development of:

- the AVIRA framework and risk assessment processes, and
- the AVIRA software application.

1.4 Methodology

Development of the framework included a review of the:

- Environmental Values and Threats to River Reaches;
- Social Values of Waterways; and
- Economic Values of Waterways.

and identification of:

- Environmental Values and Threats to Wetlands; and
- Environmental Values and Threats to Estuaries.

A total of seven discussion papers were drafted and subsequent expert workshops held to inform the development of the AVIRA framework and risk assessment process. The topics were:

1. Environmental Values of River Reaches
2. Threats to River Reaches
3. Environmental Values and Threats for Wetlands
4. Environmental Values and Threats for Estuaries
5. Social Values
6. Economic Values
7. Risk Assessment Processes

A list of workshop participants is provided in Appendix A.

The key outputs from the papers and workshops were:

- the development of a set of values and threats for each asset class (river reach, wetland and estuary). This included:
  - defining categories for each value type (environmental, social and economic);
  - developing a complete set of measures and metrics for each category; and
  - locating data sources to populate the metrics.
- the development of a risk assessment process to prioritise assets and threats.

1.5 Report Structure

This report provides an outline of the AVIRA Framework, the AVIRA software application and then presents the waterway values, threats and risk assessment process included in AVIRA, under the following parts:

- Part A – Environmental Values
- Part B – Social Values
- Part C – Economic Values
- Part D – Threats
- Part E – Summary of Values and Threats
- Part F – Risk Assessment Process

2 AVIRA Conceptual Framework

Annett and Adamson (2008) describe a conceptual framework for an asset-based approach to natural resource management investment (refer to Figure 2.1).

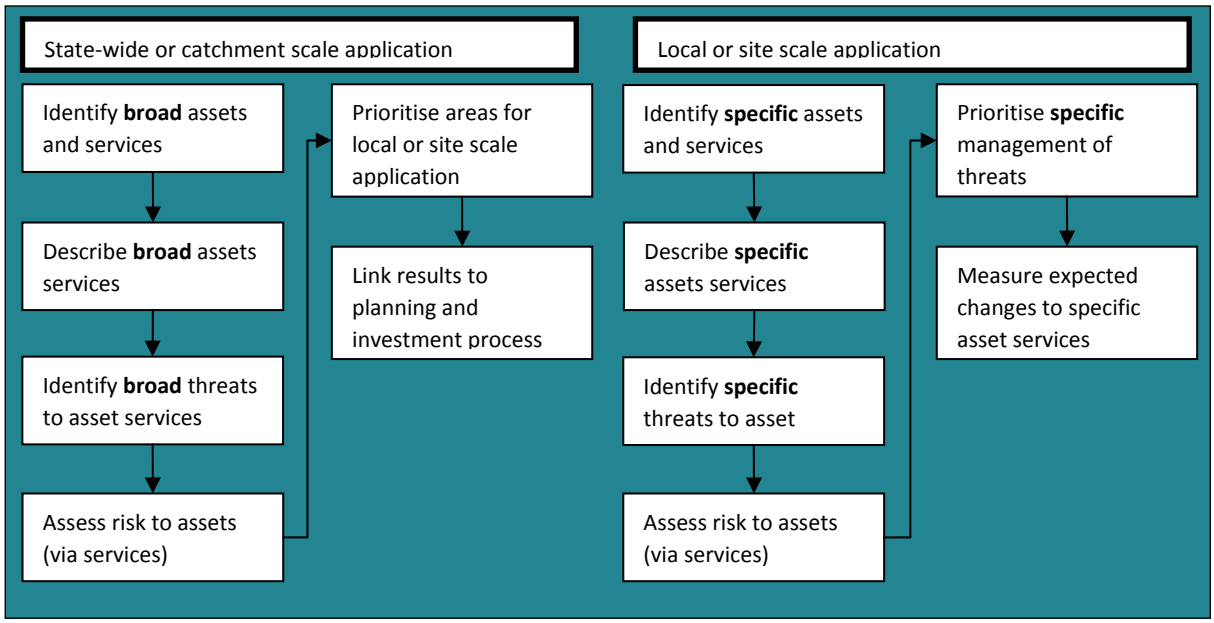

Figure 1 - The Asset-Based Approach Conceptual Framework

The conceptual framework for AVIRA has been adapted from this framework and covers the first four stages. The first three stages are described in the following sections (and detailed in Figure 2.2 and Table 2.1). The fourth stage (risk assessment) is described in *AVIRA Risk Assessment Process* (Peters 2009) and summarised in Part F of this report.

The final two stages (covering prioritisation, planning and investment) were undertaken outside of AVIRA for the RWSs.

2.1 Defining Assets

Assets are described as the biophysical elements of our environment that are valued by people for a variety of reasons. To determine the assets and associated values of waterways, the following asset categorisation steps have been adopted.

2.1.1 Asset Classes

Aquatic asset classes can be divided into river reaches, wetlands, estuaries, groundwater and marine.

Ocean waters are considered outside the scope of AVIRA and hence are not considered any further. In addition, due to the current lack of knowledge and information regarding groundwater, this asset class will only be considered as it relates to the condition of river reaches, wetlands and estuaries.

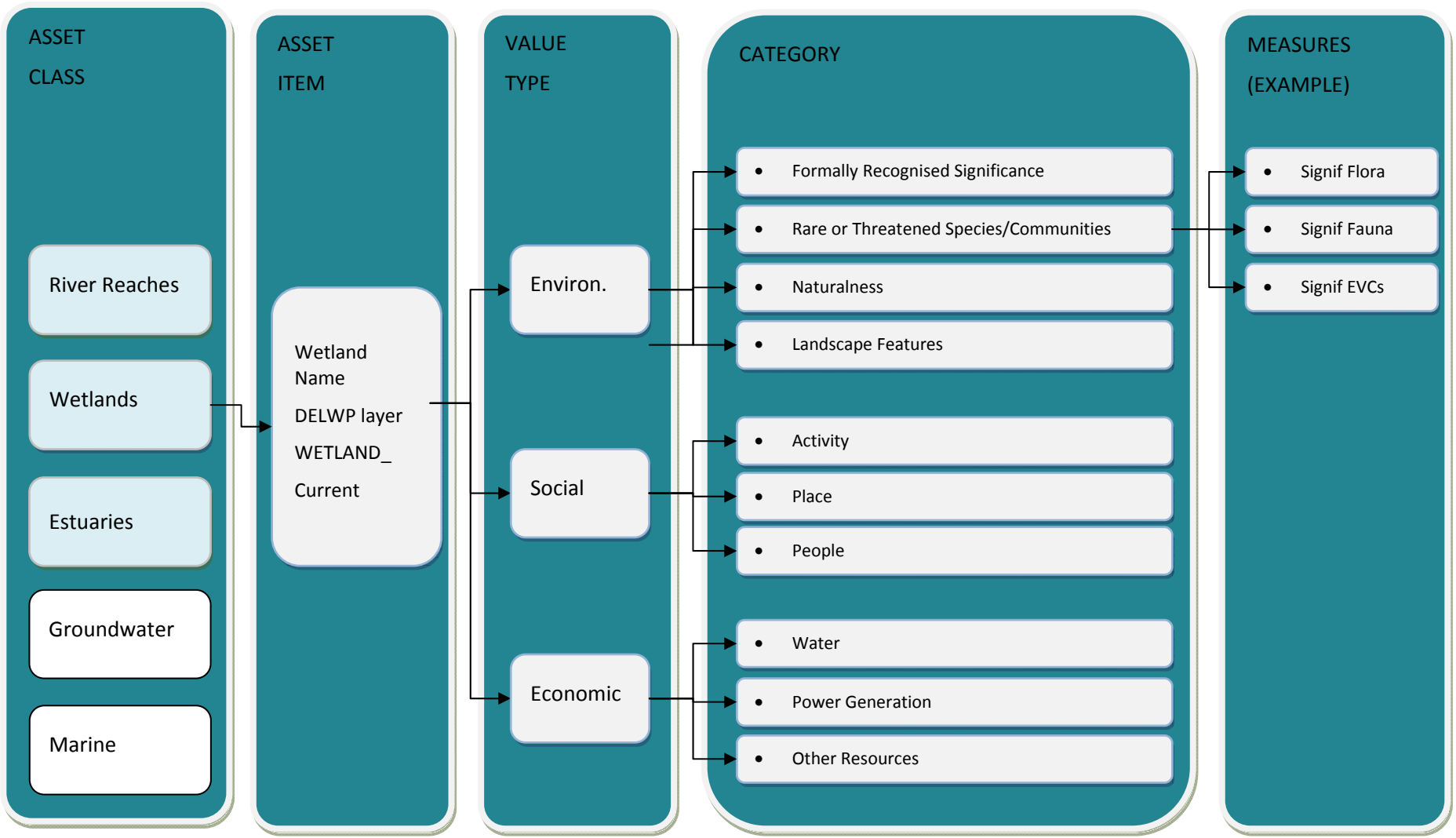

Figure 2 - AVIRA Conceptual Framework

3 Asset Items

Assets will be geographically identifiable as physical element of our environment, e.g. a specific area of land, a river reach or a particular wetland. AVIRA will identify assets by name and by a unique number as follows:

- River reaches (ISC Reach Number);
- Wetlands (Wetland Number from DELWP's WETLAND_Current layer)
- Estuaries (Estuary ID Number from DELWP's estuary spatial layer)

River Reaches

The first round of RRHSs utilised data from the 1999 ISC. A second round of ISC assessments was undertaken in 2004; known as 2ISC and a third round of ISC assessments was undertaken in 2011; known as 3ISC. 3ISC was a substantial change from previous assessments as it used remote sensing methods to capture data for many of the sub-indices. This allowed analysis across entire river reaches, enabling a more accurate interpretation of condition than limited field inspections.

As AVIRA relies on data provided by the ISC to value river reaches and identify threats, the ISC river reaches were included as key asset items.

Wetlands

The wetlands in AVIRA include all of the wetlands assessed by the IWC in the two rounds of statewide assessments (high value wetlands and represesntative wetlands) and major water storages (see Appendix P) which were assessed as a wetland asset. CMAs were also asked to provide a list of wetlands that they would like uploaded to AVIRA, these were added in October 2012. CMAs also have the option to add wetlands individually to AVIRA, using the*Request New Wetland* tool.

Estuaries

The estuaries in AVIRA are the systems that were included in the IEC pilot program and additional estuaries identified by CMAs as being important systems. Appendix B lists the estuaries included in AVIRA and indicates if they were included in the IEC pilot program. The data collection for the IEC pilot program was delivered in January 2013. Wherever possible information collected as part of the IEC was used to inform the estuary metrics in AVIRA.

3.1 Valuing Asset Items

For each asset item described above, a valuation process can be undertaken as follows.

3.1.1 Value Types

To maintain consistency with the triple bottom line approach to asset management, AVIRA considers environmental, social and economic values for each asset item.

3.1.2 Categories

For each value type, categories have been determined that describe the assets key characteristics by grouping related values.

The environmental categories have been based on various approaches to determining freshwater ecosystems including:

- Draft Guidelines for Applying the Criteria for the Proposed HCVAE Assessment Process (Dunn 2007);
- Identifying and Protecting Rivers of High Ecological Value (Dunn 2000); and

- Conserving Freshwater Ecosystem Values in Tasmania, Australia: Identification and Application of Freshwater Conservation Management Priority Areas (Hardie and Davies 2007).

The social and economic categories have been adapted from the original RiVERS database.

For each asset class (river reach, wetland, estuary), these categories are the same.

3.1.3 Measures

Under each category, one or more measures have been identified that represent particular waterway characteristics. For each measure (or combination of measures) a metric has been developed that assigns both descriptive and numerical values. An example is shown in

Table 1.

Table 1 – Describing and valuing assets

Value Type	Category	Measure	Metric	
			Descriptor	Value Score
Social	Activity	Recreational Fishing	Listed as a priority/key/popular fishery in a Regional Fishery Management Plan OR Rated as a 'best fishing water' in *A Guide to the Inland Angling Waters of Victoria*	5
			Some recreational fishing occurs	3
			Not known to be used for recreational fishing	1
			Not suitable for recreational fishing	0

For AVIRA, value scores range from 5 (very high value) to 1 (very low value). A score of 0 is sometimes used to signify 'no value'.

3.2 Defining Threats

The threats identified for AVIRA have been categorised under the following groupings:

- Altered Water Regimes;
- Altered Physical Form;
- Poor Water Quality;
- Degraded Habitats;
- Invasive Flora and Fauna; and
- Reduced Connectivity.

Under each grouping, a number of individual threats have been identified (including, for example, changes to zero flow frequency, changes to flow seasonality, changes to bankfull flow frequency under Altered Water Regimes). The level of each of these individual threats can be quantified by specific metrics/measures. This enables an assessment of threat severity, ranging from 5 (very high threat) to 1 (very low threat). Where there is 'no evidence' of a threat impacting on a value a severity score of 1 is applied as a precautionary measure. Where there is evidence that there is 'no threat' a score of 0 is used.

4 The AVIRA Software Application

4.1 Background

The AVIRA tool is a desktop application accessible from a Citrix environment using a web browser. It is developed as a plug-in to the Open Source GIS product, MapWindow.

Access to the application requires authentication on two levels: to the Citrix server and to the application itself. Users authenticate in the Citrix environment. This gives them access to the Axapta Desktop. DELWP maintain and manage access to the AVIRA software application.

The AVIRA interface is shown below. The AVIRA user manual is provided in Appendix C.

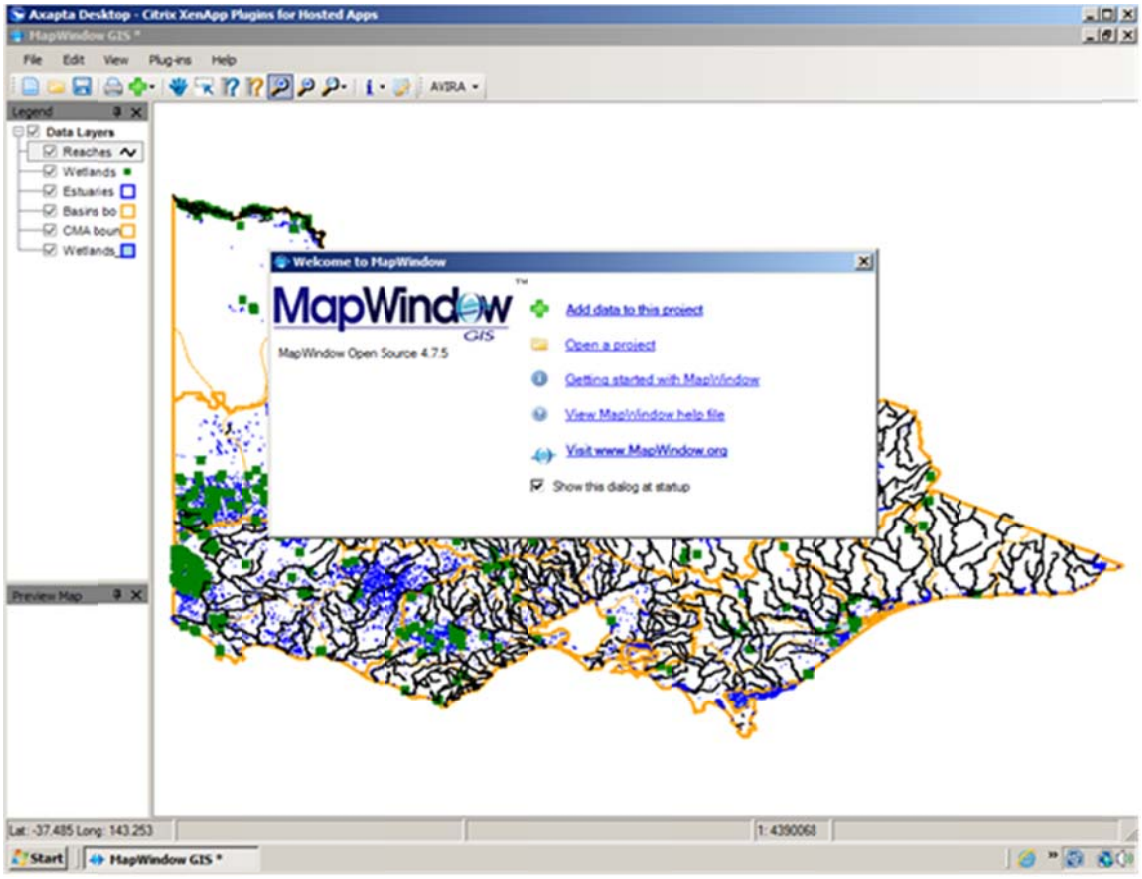

Figure 3 - AVIRA software application user interface

4.2 Population and Use of the AVIRA Software Application

AVIRA was populated within each catchment management authority region between 2011 and late 2013. Data was either provided by DELWP sourced from statewide data sets or developed by CMAs using local knowledge or data. Appendix D provides the instructions for the creation of data files for the AVIRA and the AVIRA data import file names. The data currently within AVIRA will be used as a resource during the implementation of the RWSs over the next eight years. Along with value and threats scores, significant additional information is recorded as the rationale for the score.

Part A Environmental Values

Environmental values have been grouped under the following categories:

- Formally Recognised Significance;
- Representativeness;
- Rare or Threatened Species/Communities;
- Naturalness; and
- Landscape Features.

These categories are presented in the following sections.

5 Formally Recognised Significance

This category considers waterway-related sites with international, national or state agreements; specifically:

- International Significance
  - Ramsar Sites
  - East Asian-Australasian Flyway Sites
  - World Heritage Sites
- National Significance
  - Nationally Important Wetlands
  - Living Murray Icon Sites
  - High Ecological Value Aquatic Ecosystems
  - National Heritage Sites
- State Significance
  - Heritage Rivers
  - Icon Rivers
  - Essentially Natural Catchments
  - Victorian Parks and Reserves
  - Victorian Heritage Sites

Any waterway that has been recognised as being of international, national or state significance has automatically been assigned 'high value waterway' status in the RWSs. Therefore, no value ratings are required (as risk assessments on status is not appropriate) and instead, a binary 'yes or no' rule-set has been adopted.

5.1 International Significance - Ramsar Sites

5.1.1 Background

The Ramsar Convention on Wetlands is an inter-governmental treaty that provides the framework for international cooperation for the conservation of wetlands, one of the most threatened habitats in the world. As a contracting party to the Ramsar Convention, Australia is required to meet a number of obligations including the maintenance of the ecological character of its Ramsar sites through conservation and wise use (DNRE 2002a).

There are 57 sites in Australia that are listed under the Convention with 11 sites occurring in Victoria, namely:

- Barmah Forest;
- Corner Inlet;
- Edithvale-Seaford Wetlands;
- Gippsland Lakes;
- Gunbower Forest;
- Hattah-Kulkyne Lakes;
- Kerang Wetlands;

- Lake Albacutya;
- Port Phillip Bay and Bellarine Peninsula;
- Western District Lakes; and
- Western Port.

5.1.2 Valuing Ramsar Sites

To be listed as a wetland of International Importance, or a 'Ramsar site', wetlands must meet one or more internationally accepted criteria in relation to their zoology, botany, ecology, hydrology or limnology and importance to waterfowl.

Therefore, only those waterways specifically listed in a Ramsar Site Strategic Management Plan as key features of a Ramsar site will be considered.

AVIRA Metric - International Significance (Ramsar Sites)

Based on the above, International Significance (Ramsar Sites) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	International Significance – listed as a key feature of a Ramsar site	Listed
No	Not listed as a key feature of a Ramsar site	Not Listed
Data Sources: Ramsar Site Strategic Management Plans Australian Wetlands Database http://www.environment.gov.au/water/publications/environmental/wetlands/database		

5.2 International Significance - East Asian-Australasian Flyway Sites

5.2.1 Background

Australia provides critical non-breeding habitat for millions of migratory waterbirds each year. Migratory waterbirds include species such as plovers, sandpipers, stints and curlews. The corridor through which these waterbirds migrate is known as the East Asian-Australasian Flyway.

To ensure their conservation, the Australian Government has fostered international cooperation through the recently launched East Asian-Australasian Flyway Partnership. Under the Flyway Partnership, the site network for shorebirds has been combined into a single network, referred to as the East Asian–Australasian Flyway Site Network.

There are 17 sites in Australia that are listed in the East Asian–Australasian Flyway Site Network with five sites occurring in Victoria, namely:

- Corner Inlet;
- Western Port;
- Port Phillip Bay (Western Shoreline) and Bellarine Peninsula;
- Shallow Inlet Marine and Coastal Park; and
- Discovery Bay Coastal Park.

These sites mainly cover wetland and coastal areas. In addition the eight bird species identified as significant within these sites have preferred habitats that are either coastal, estuarine or wetland.

5.2.2 Valuing East Asian-Australasian Flyway Sites

To ensure that only those waterways providing critical non-breeding habitat for migratory waterbirds are recognised in AVIRA, only those waterways specifically listed within their respective management plans will be considered.

AVIRA Metric – International Significance (East Asian-Australasian Flyway Sites)

Based on the above, International Significance (East Asian-Australasian Flyway Sites) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	International Significance – listed as a key feature of an East Asian-Australasian Flyway Site	Listed
No	Not listed as a key feature of an East Asian-Australasian Flyway Site	Not Listed

Data Sources:

Corner Inlet Ramsar Site – Strategic Management Plan (DNRE 2002)

Western Port Ramsar Site – Strategic Management Plan (DSE 2003)

Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site – Strategic Management Plan (DSE 2003)

Shallow Inlet Marine and Coastal Park – Park Notes (Parks Victoria ~2008)

Discovery Bay Parks Management Plan (Parks Victoria 2004)

5.3 International Significance - World Heritage Sites

5.3.1 Background

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community.

The World Heritage Convention aims to promote cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations. It is intended that, unlike the seven wonders of the ancient world, properties on the World Heritage List will be conserved for all time (DEWHA ~2008a).

5.3.2 Valuing World Heritage Sites

The World Heritage List includes 878 properties forming part of the cultural and natural heritage which the World Heritage Committee considers as having outstanding universal value. These include 679 cultural, 174 natural and 25 mixed properties (UNESCO ~2009).

Australia has 17 properties currently listed on the World Heritage List with one property being in Victoria – the Royal Exhibition Building and Carlton Gardens – listed for its cultural values.

As no waterway sites are currently listed in the World Heritage List, no measure is proposed. However, should a Victorian waterway site be listed in the future, it will automatically be assigned 'high value waterway' status in AVIRA.

5.4 National Significance - Nationally Important Wetlands

5.4.1 Background

In addition to the wetlands identified as internationally important, Victoria has a number of waterways of National importance as described in *A Directory of Important Wetlands in Australia* (Environment Australia 2001).

There are 159 wetlands in Victoria listed in the Directory, with a number containing more than one asset class. In summary: 21 are linked with river reaches; 19 with estuaries; and 133 with wetlands.

5.4.2 Valuing Nationally Important Wetlands

The wetland classification system used in the Directory to determine nationally important wetlands is the same as that used by the Ramsar Convention in describing International importance.

Therefore, to ensure that only those waterways meeting nationally accepted criteria are recognised in AVIRA, only those waterways specifically listed as key features of the wetland sites will be considered.

AVIRA Metric - National Significance (Nationally Important Wetlands)

Based on the above, National Significance (Nationally Important Wetlands) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	National Significance – listed as a key feature of a Nationally Important Wetland	Listed
No	Not listed as a Nationally Important Wetland	Not Listed
Data Sources: *A Directory of Important Wetlands in Australia* (Environment Australia 2001) Australian Wetlands Database http://www.environment.gov.au/water/publications/environmental/wetlands/database		

5.5 National Significance - Living Murray Icon Sites

5.5.1 Background

The Living Murray was established in 2002 in response to evidence that the health of the River Murray system is in decline. The Living Murray's first stage focuses on improving the environment at six 'icon sites' along the River:

- Barmah-Millewa Forest;
- Gunbower-Koondrook-Perricoota Forest;
- Hattah Lakes;
- Chowilla Floodplain and Lindsay-Wallpolla Islands;
- Lower Lakes, Coorong and Murray Mouth; and
- River Murray Channel.

The sites were chosen for their high ecological value—most are listed as internationally significant wetlands under the Ramsar convention—and also their cultural significance to Indigenous people and the broader community (MDBC 2006a).

5.5.2 Valuing Living Murray Icon Sites

Five of the Living Murray Icon Sites occur (wholly or partly) in Victoria.

Barmah-Millewa Icon Site

The Barmah-Millewa Icon Site, composed of the Barmah Forest in Victoria and the Millewa group of forests in New South Wales, is the largest River Red Gum (*Eucalyptus camaldulensis*) forest in Australia. It covers approximately 66,000 ha of floodplain between the townships of Tocumwal, Deniliquin and Echuca and contains a diverse range of wetland environments (MDBC 2006b).

Hattah Lakes Icon Site

The Hattah Lakes Icon Site encompasses the whole of the Hattah Lakes and adjoining floodplain system. The Hattah Lakes have been listed under the Directory of Important Wetlands in Australia, and 12 of the lakes have been listed under the International Ramsar Convention on Wetlands (MDBC 2006c).

Chowilla Floodplain and Lindsay-Wallpolla Islands

The Chowilla Floodplain and Lindsay–Wallpolla icon site spans South Australia, New South Wales and Victoria, with Chowilla in South Australia and New South Wales, and Lindsay–Wallpolla Islands in Victoria. The Lindsay–Wallpolla Islands include three separate anabranch systems within the Murray–Sunset National Park: Wallpolla Island, Mulcra Island and Lindsay Island. Wallpolla Island, Lindsay Island and Lake Wallawalla are listed in A Directory of Important Wetlands in Australia (Environment Australia 2001).

The Chowilla Floodplain and anabranch system falls within NSW and SA.

Gunbower-Koondrook-Perricoota Icon Site

The River Red Gum forests of Koondrook-Perricoota (NSW) and Gunbower (Victoria) cover approximately 50,000 ha of River Murray floodplains to the west of the town of Echuca. This combined forest is second only in size to the Barmah-Millewa Forest (MDBC 2006d).

River Murray Channel Icon Site

The River Murray is 2,530km long from its source in the Australian Alps to its mouth on Encounter Bay in South Australia. For some 1,880 km of its length, the river marks the boundary between New South Wales and Victoria. The length of the River Murray Channel from Hume Dam to Wellington is 2,152km (MDBC 2006e).

The longitudinal extent of the River Murray Channel Icon Site is defined as the River Murray from Hume Dam to Wellington (MDBC 2006e).

The lateral extent of the River Murray Channel Icon Site is defined as:

- the physical River Murray channel – its bed and banks, in-stream habitat, and those parts of the riparian zone that directly influence in-stream habitat condition for flora and fauna; and
- anabranches and wetlands not already included as part of another Icon Site that are affected by regulated flows or can be opportunistically managed in delivering outcomes at other Icon Sites (MDBC 2006e).

From these definitions, the entire length and width of the River Murray's riparian zone (and floodplain) within Victoria (from Hume Dam to the South Australian border) is recognised as part of the River Murray Channel Icon Site.

AVIRA Metric – National Significance (Living Murray Icon Sites)

Based on the above, National Significance (Living Murray Icon Sites) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	National Significance – listed as a key feature of a Living Murray Icon Site	Listed
No	Not listed as a key feature of a Living Murray Icon Site	Not Listed
Data Sources: Living Murray Icon Site Environmental Management Plans The Living Murray http://www.thelivingmurray.mdbc.gov.au		

5.6 National Significance - National Heritage Sites

5.6.1 Background

National Heritage System

The National Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation (DEWHA ~2008a).

5.6.2 Valuing National Heritage Sites

There are 27 places listed in the National Heritage List in Victoria with six listed for their natural values, namely:

- Australian Alps National Parks and Reserves - Alpine National Park;
- Australian Alps National Parks and Reserves - Avon Wilderness;
- Australian Alps National Parks and Reserves - Baw Baw National Park;
- Australian Alps National Parks and Reserves - Mt Buffalo National Park;
- Australian Alps National Parks and Reserves - Snowy River National Park; and
- Grampians National Park (Gariwerd).

AVIRA Metric – National Significance (National Heritage Sites)

Based on the above, National Significance (National Heritage Sites) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	National Significance - key feature of a place listed in the National Heritage List	Listed
No	Not a key feature of a place listed in the National Heritage List	Not Listed
Data Source: *Australia's National Heritage List* http://www.environment.gov.au/topics/heritage/heritage-places/national-heritage-list		

5.7 State Significance - Heritage Rivers

5.7.1 Background

In 1991, Victoria reviewed the values of all its rivers and put in place a system of heritage rivers. Eighteen river reaches were designated as Heritage Rivers because of their very high nature conservation, recreational, social or cultural value or because of a combination of these values. These rivers are protected under the *Heritage Rivers Act 1992* (DNRE 2002a).

5.7.2 Valuing Heritage Rivers

Heritage Rivers have:

- One or more values of national or international significance, where those values are strongly associated with a substantial section of the watercourse; or
- An aggregation of at least four values, generally of State or greater significance, which together create a corridor of Victorian heritage status (DNRE 2002a).

The following river corridors are designated as Heritage Rivers in Victoria:

- Mitta Mitta River
- Ovens River
- Howqua River
- Big River
- Goulburn River
- Wimmera River
- Genoa River
- Bemm, Goolengook, Arte and Erinundra Rivers
- Snowy River
- Suggan Buggan and Berrima Rivers
- Upper Buchan River
- Mitchell and Wonnangatta Rivers
- Thomson River
- Yarra River
- Lerderderg River
- Aire River
- Glenelg River
- Aberfeldy River

Of these, five include estuarine reaches, namely:

- Sydenham Inlet - part of Bemm River and its tributaries, Goolengook, Arte and Errinundra Rivers;
- Snowy River estuary - part of Snowy River;
- Mitchell River estuary - part of Mitchell and Wonnangatta Rivers;

- Aire River estuary - part of Aire River; and
- Glenelg River estuary - part of Glenelg River.

AVIRA Metric – State Significance (Heritage Rivers)

Based on the above, State Significance (Heritage Rivers) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance - forms part of a Heritage River	Listed
No	Does not form part of a Heritage River	Not Listed
Data Source: *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991)		

5.8 State Significance - Icon Rivers

5.8.1 Background

Of the existing Heritage Rivers, two particularly stand out because of their:

- high level of conservation value;
- high level of naturalness of flow;
- relative intactness of the entire river system; and
- significance for larger systems.

These are the Ovens River and the Mitchell River.

5.8.2 Valuing Icon Rivers

The Ovens and Mitchell rivers represent the only two large rivers in Victoria that are in good condition and relatively intact throughout their entire river systems. Because of this, both provide vital inputs into larger scale systems – the Mitchell River to the Gippsland Lakes and the Ovens River to the Murray-Darling system (DNRE 2002a).

For these reasons, the VRHS (DNRE 2002a) recognised the Ovens and Mitchell Rivers as river systems of very high value.

Therefore, the Ovens and Mitchell Rivers were rated as High Value Waterways of State Significance in AVIRA.

AVIRA Metric – State Significance (Icon Rivers)

Based on the above, State Significance (Icon Rivers) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance – listed as an Icon River in the VRHS	Listed
No	Not listed as an Icon River	Not Listed
Data Source: *Victorian River Health Strategy* (DNRE 2002)		

5.9 State Significance - Essentially Natural Catchments

5.9.1 Background

In addition to the Heritage Rivers describes in Section 3.8, the Land Conservation Council (LCC) Rivers and Streams Special Investigation (1991) identified 26 Essentially Natural Catchments. These catchments were considered important and were afforded protection under the *Heritage Rivers Act 1992*.

5.9.2 Valuing Essentially Natural Catchments

An essentially natural catchment is one with no urbanisation, clearing, intensive agriculture, mining, extractive industries, water diversions, river engineering works, or roads parallel and immediately adjacent to streams (DNRE 2002a). As such, the physical and biological processes are essentially unimpaired, giving them high ecological value.

AVIRA Metric – State Significance (Essentially Natural Catchments)

Based on the above, State Significance (Essentially Natural Catchments) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance – ≥50% of the waterway lies within an Essentially Natural Catchment	>=50% within ENC
No	<50% of the waterway lies within an Essentially Natural Catchment OR Waterway does not lie within an Essentially Natural Catchment	<50% within ENC
Data Source: *Rivers and Streams Special Investigation: Final Recommendations*		

Note: Some waterways will not be linked to ISC reaches.

5.10 State Significance - Victorian Parks and Reserves

5.10.1 Background

There are a number of park types in Victoria including:

- Gardens;
- Heritage Properties and Historic Places;
- Marine and Coastal Parks/Marine Reserves. An area of coastal, intertidal or subtidal land that because of its natural environment or the nature of the waters that cover it, is of conservation or scientific significance.
- National Parks. An extensive area of land of nationwide significance because of its outstanding natural environments and features, scenic landscapes and diverse land types.
- State Parks. An area of land containing natural environments and features, scenic landscapes and one or more land types complementing those found in national parks to provide a system representing the major land types of the State.

- Wilderness Parks. A large area with landforms and native plant and animal communities relatively unaltered or unaffected by the influence of the European settlement of Australia.
- Wildlife Sanctuaries;
- Metropolitan Parks;
- Reserves;
- Reservoir Parks;
- Regional Parks. An area of land containing indigenous or non-indigenous vegetation readily accessible from urban centres or major tourist routes and capable of providing opportunities for informal recreation for large numbers of people.
- Marine National Parks. Highly protected areas which represent the range of marine environments in Victoria, in which no fishing, extractive or damaging activities are allowed.
- Marine Sanctuaries. Smaller, highly protected area designated to protect their special values, in which no fishing, extractive or damaging activities are allowed. These areas complement Marine National Parks.

Parks Victoria currently undertakes planning and objective setting for environmental management across this network using the Levels of Protection framework. A key principle of the framework is that protected area planning and management is conducted in a bioregional context with the value, and hence priority, of biodiversity attributes assessed on the basis of:

- conserving the range of ecosystems and existing biotic diversity;
- the occurrence of attributes that depend on a particular park for their security;
- conserving ecosystem structure and function through addressing high risk threats; and
- higher ecological viability and integrity of populations.

This framework uses this basis to assess the relative contribution a park (or area of a park) makes to biodiversity conservation in a landscape (Victorian bioregional) context. This allows parks to be classified (or grouped) according to composition and representation of attributes classified at the ecological vegetation class and species scale.

Data used in this process is currently available for terrestrial parks.

5.10.2 Valuing Victorian Parks and Reserves

Using the framework described above, Parks Victoria has prioritised all parks and reserves into six Park Groups:

- A1 - 20 parks
- A2 - 27 parks and reserves
- B - 106 parks and reserves
- C - 249 parks and reserves
- D - 495 parks and reserves
- E - 1922 reserves

The highest priorities are those parks and reserves in Park Groups A1 and A2 (refer to Appendix E).

To determine which waterways within these Park Groups should be considered as key features, it is recommended that CMAs and Melbourne Water consult with regional Parks Victoria staff (using the waterways cited in park management plans as a preliminary list).

AVIRA Metric – State Significance (Victorian Parks and Reserves)

Based on the above, State Significance (Victorian Parks and Reserves) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance - key feature of a park or reserve listed within Park Groups A1 or A2 *	Park A1 or A2
No	Not a key feature of a park or reserve listed within Park Groups A1 or A2	Not Park A1 or A2
Data Sources: Parks Victoria MS Access Database Parks Victoria Management Plans, Parks Notes, etc. Local knowledge		

* Some waterways will not be linked to ISC reaches.

5.11 State Significance - Victorian Heritage Sites

5.11.1 Background

Places and objects included in the Heritage Register are generally considered to be of 'state-wide' significance. In other words, of importance to the understanding of Victorian history.

The types of places included on the Victorian Heritage Register include:

- buildings and places;
- objects;
- gardens and trees;
- cemeteries;
- precincts;
- archaeological places and relics; and
- shipwrecks, relics and protected zones.

5.11.2 Valuing Victorian Heritage Sites

There are 1,783 places listed in Victoria. Of these places, no attempt has been made to identify the number with waterways listed as key features. Therefore, it is recommended that the CMAs and Melbourne Water access the Heritage Victoria website to determine which places are relevant to their management regions and, of these, only consider those places listed for their natural values and where waterways are identified as a key feature (i.e.cited in the place title or described within a corresponding management plan).

AVIRA Metric – State Significance (Victorian Heritage Sites)

Based on the above, State Significance (Victorian Heritage Sites) value was scored using the following metric:

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance - key feature of a place listed in the Victorian Heritage Register	Listed
No	Not a key feature of a place listed in the Victorian Heritage Register	Not Listed
Data Source: *Victorian Heritage Database* http://vhd.heritage.vic.gov.au/vhd/heritagevic		

6 Representativeness

Representativeness is a critical component for ecosystem and species conservation and a foundation of the Comprehensive, Adequate and Representative (CAR) approach to conservation planning (Dunn 2007).

DNRE (2002a) stated that one of the major values to be considered in the regional river health planning process was the need to have a series of representative rivers across the State i.e.rivers in an ecologically healthy condition that can be used to represent the major river classes that once occurred naturally across Victoria.

The same could be said for wetlands and estuaries.

The following sections detail approaches to determining representative river reaches, wetlands and estuaries for Victoria.

6.1 Representative Rivers

6.1.1 Background

The *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991) identified 16 river catchment types for Victoria based on geomorphic and hydrologic criteria. For each river catchment type, a representative river was identified based on factors such as how 'typical' they were and their condition compared with others of that type.

Since 1991, there has been a considerable increase in our understanding of river ecology and considerably more data on riverine and terrestrial biodiversity. Doeg (2001) reviewed the LCC approach and updated the major river types for Victoria based on land type and system, fish and aquatic invertebrate communities, and terrestrial biodiversity. Ecologically healthy rivers (or rivers as close as possible to ecologically healthy) were then nominated within each type as being representative. This work resulted in the classification of 19 river types and the identification of 21 representative rivers for Victoria (covering 59 river reaches) (refer to Appendix F).

6.1.2 Valuing Representative Rivers

Based on Doeg (2001), the VRHS (DNRE 2002a) contains a list of representative rivers for the major river types in Victoria. These representative rivers were identified as an interim list and are open for review in light of new knowledge.

AVIRA Metric – Representative Rivers

Based on the above, Representative River value was scored using the following metric:

Value	Descriptor	Data Descriptor
Listed	Listed as a Representative River in the VRHS	Listed
Not Listed	Not listed as a Representative River in the VRHS	Not Listed
Data Source: *Victorian River Health Strategy* (DNRE, 2002a) Doeg (2001)		

6.2 Representative Wetlands

6.2.1 Background

The first criterion for determining nationally important wetlands in Australia is that a wetland is a good example of a wetland type (i.e.wetlands that are unique or representative) occurring within a biogeographic region in Australia (Environment Australia 2001).

The Interim Biogeographic Regionalisation for Australia (IBRA) is used as the framework for applying this criterion. Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. There are 28 bioregions currently described for Victoria.

The *Directory of Important Wetlands in Australia* has identified 132 wetland sites in Victoria as meeting this criterion (refer to Table 11.3 in Environment Australia, 2001 p94).

Victoria has used a wetland classification system commonly known as the Corrick system since the late 1970s. The Corrick system was developed between 1976 and 1982, and applied to the wetlands in the previous wetland spatial layer (Wetland 1994).

A new Victorian wetland classificiation system will be consistent with the Australian National Aquatic Ecosystem (ANAE) Classification Framework and is due to be completed in 2014. The updated system was required to:

- facilitate consistent reporting at the national level;
- incorporate better information about wetlands; and
- overcome limitations of the Corrick system.

There are two steps involved in developing a list of representative wetlands for Victoria

1. The new classification system and typology must be finalised and applied to all Victorian wetlands
2. Condition information must be available across the state

6.2.2 Valuing Representative Wetlands

Further work is required once the new classification system and typology is finalised and applied to Victorian wetlands, to determine the best examples (i.e. wetlands of sufficiently good condition) of the different wetland types.

Whilst good progress has been made on wetland classification and condition assessment in Victoria, a system for identifying representative wetlands has not been determined. Therefore this metric was not accessed in AVIRA at this time.

6.3 Representative Estuaries

6.3.1 Background

Classification

Classifying estuaries into different categories can aid condition assessments and enable the preparation of realistic management plans and restoration activities.

Barton (2003) reviewed a number of existing approaches to estuary classification in Australia. This review revealed that estuary classifications were commonly defined with reference to physical and salinity characteristics. However, the lack of available data for most Victorian estuaries (particularly salinity characteristics) limited the number that could be classified.

As a result, Barton (2003) proposed a 'working' classification for Victorian estuaries where the salinity regime and inland extent is not known. This classification was based on:

1. whether the estuary is known to be intermittently closed or permanently open;
2. whether it connects with the sea into a open oceanic coast with high wave energy and micro-tides, or into an embayment or sheltered coast with low wave energy and meso-tides; and
3. the four of the five biological regions defined by Metzeling et al (2004). These incorporate a lot of the variability in flow and water quality in fresh waters and so provide a useful third level of hierarchy.

This classification was further refined by Barton (2006), based on whether the estuary was in an embayment or open coast and for the latter, the direction of the coastline (refer to Figure 4).

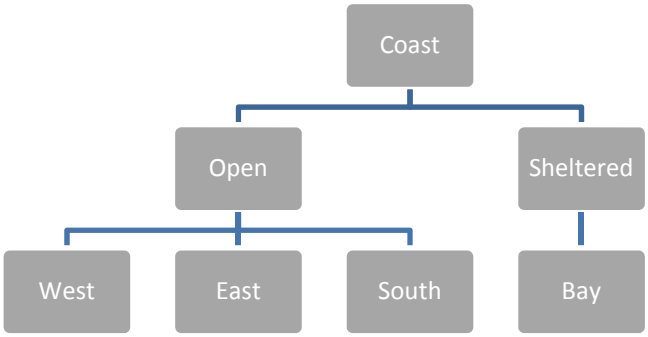

Figure 4 - Classification of Victoria's Estuaries (from Barton (2006))

Condition

As for estuary classification, a number of approaches to assessing the condition of estuaries have been developed e.g.Edgar et al 1999, NLWRA 2002, Arundel et al 2008.

The NLWRA (2002) assessed the condition of estuaries across Australia using a number of variables, including: catchment natural cover; land use; catchment hydrology; tidal regime; floodplain; estuary use; pests and weeds; and estuary ecology.

Sixty-three estuaries were assessed by the NLWRA in Victoria with the following results:

- near pristine – 13;
- largely unmodified – 20;
- modified – 24;
- extensively modified – 4; and
- not assessed – 2.

The IEC is designed to evaluate the condition of Victorian estuaries. The IEC identified six themes for assessing estuarine condition (refer to Arundel et al 2008):

- **Physical form**. The physical structure of an estuary includes depth, bed, banks and the presence of structures that alter connectivity to marine and freshwater and connectivity of the estuary to riparian areas and any associated wetlands.
- **Hydrology**. The hydrological regime of an estuary includes timing and volume of freshwater, marine and groundwater inputs, these in turn affect stratification patterns in the estuary.

- **Water quality**. The naturalness of water quality includes parameters such as dissolved oxygen, nutrients, suspended matter, salinity and temperature.
- **Sediment**. The sediment of an estuary includes features of sediment quality such as nutrients, toxicants and dissolved oxygen; and aspects of physical structure such as particle size, erosion, sedimentation and sediment transport.
- **Flora**. The flora of an estuary includes microphytes and macrophytes associated with the water column and sediment in the subtidal, intertidal and riparian areas. This theme also includes microbial communities.
- **Fauna**. The fauna of an estuary includes fish and birds as well as meiofauna and macrofauna associated with the sediment, water column and plants.

6.3.2 Valuing Representative Estuaries

Whilst good progress has been made on estuary classification and condition assessment in Victoria, a system for identifying representative estuaries has not been determined. Therefore this metric was not accessed in AVIRA at this time.

7 Rare or Threatened Species/Communities

Protection of biodiversity has focussed in a significant way on rare and threatened species (Dunn, 2000).

It is vital we maintain and sustain our biodiversity for a number of reasons:

- biodiversity provides us with many natural products including food, medicines and timber;
- ecosystems underpin many of our natural resources and provide services such as clean water, healthy soil and pollination of crops; and
- many people find enjoyment from the range of leisure activities undertaken in the natural environment (CSIRO ~2008).

This category considers species and communities identified as rare or threatened at an international, national or state level; specifically:

- Significant Fauna;
- Significant Flora; and
- Significant EVCs.

The following sections detail approaches to measuring and valuing rare or threatened species/communities in Victoria.

7.1 Significant Fauna

7.1.1 Background

There are number of international, national and state approaches to listing significant fauna. The following provides an overview of these approaches for the hierarchical metric to value significant fauna.

Actions for Biodiversity Conservation

The traditional approach to priority setting for threatened species is based on the conservation status of a species alone i.e.critically endangered species tends to take precedence over vulnerable species, and so on.

More recently, however, DSE has reassessed the approach to prioritising threatened species and developed a system known as the Actions for Biodiversity Conservation (ABC). The ABC requires priorities to be set between locations for a species and between actions at each location. A high priority location is one which is most likely to persist in the long-term, usually because the population of the species concerned is large, healthy and/or genetically diverse or because the habitat it occupies is secure, extensive and/or in good condition (DSE 2007a).

IUCN Red List

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species provides taxonomic, conservation status and distribution information on taxa that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction (i.e.those listed as Critically Endangered, Endangered and Vulnerable).

EPBC Act 1999

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (DEWHA ~2008b).

The EPBC Act website contains a database that provides information about species and ecological communities listed under the EPBC Act.

Advisory Lists of Threatened Fauna in Victoria

The advisory lists of threatened vertebrate and invertebrate fauna that are considered threatened, poorly known, near threatened or extinct in Victoria is maintained by the Department of Environment, Land, Water and Planning. The advisory list also identifies *Flora nd Fauna Guarantee Act 1988* threatened status. This information is provided in Appendix H.

Waterway dependent significant fauna species are identified in Appendix H. Only waterway dependent species are included in the significant fauna measures within AVIRA. These waterway dependent species were identified through expert advice and were defined as any animal species that relied, for at least some part of their lifecycle on rivers, wetlands or estuaries. There were some species included that are not strictly dependent on waterways, but whose habitat now only occurs in remnants surrounding waterways. The buffer used in the GIS query associated with the dataset for significant flora is included in Appendix G.

7.1.2 Valuing Significant Fauna

Measure 1 - Actions for Biodiversity Conservation

Descriptor	Data Descriptor
High priority threatened species are associated with the waterway (as determined by ABC database)	High Priority
Medium priority threatened species are associated with the waterway (as determined by ABC database)	Medium Priority
Low priority threatened species are associated with the waterway (as determined by ABC database)	Low Priority
No fauna surveys have been undertaken post 1980	No data

Measure 2 – IUCN Red List

Descriptor	Data Descriptor
Supports waterway dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered	Endangered
Supports waterway dependent species listed under the IUCN Red List as Vulnerable	Vulnerable
Supports waterway dependent species listed under the IUCN Red List as Data Deficient	Data Deficient
Supports waterway dependent species listed under the IUCN Red List as Near Threatened	Near Threatened
No species listed under the IUCN Red List are known to occur	None Known
No fauna surveys have been undertaken post 1980	No Data

Measure 3 – EPBC Act 1999

Descriptor	Data Descriptor
Listed under the EPBC Act as Presumed Extinct or Endangered	Endangered
Listed under the EPBC Act as Vulnerable	Vulnerable
Not listed under the EPBC Act	None Known
No fauna surveys have been undertaken post 1980	No data

Measure 4 – Advisory List of Threatened Vertebrate Fauna in Victoria (DEPI 2013)

Descriptor	Data Descriptor
Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered	Endangered
Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Vulnerable	Vulnerable
Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Data Deficient	Data Deficient
Listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Near Threatened	Near Threatened
Not listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria*	None Known
No fauna surveys have been undertaken post 1980	No data

Measure 5 – Draft Advisory List of Threatened Invertebrate Fauna in Victoria (DEPI 2009)

Descriptor	Data Descriptor
Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered	Endangered
Listed under *Advisory List of Threatened Invertebrate Fauna in Victoria* as Vulnerable	Vulnerable
Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Data Deficient	Data Deficient
Listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Near Threatened	Near Threatened
Not listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria*	None Known
No fauna surveys have been undertaken post 1980	No data

Based on the above, Significant Fauna value was scored using two metrics:

- Significant Fauna (Invertebrates); and
- Significant Fauna (Vertebrates).

The ABC database has been utilised as the primary measure to value significant fauna in AVIRA. However, as the ABC database is still being developed, not all threatened species have been recorded and ranked. In these instances, the other measures will be utilised to identify fauna significance.

AVIRA Metric – Significant Fauna (Invertebrates)

Value Score	Descriptor
5	Supports high priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Act as Critically Endangered or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Threatened Invertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered
4	Supports medium priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Vulnerable
3	Supports low priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Data Deficient
2	Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the Advisory List of Threatened Invertebrate Fauna in Victoria as Near Threatened
1	Not known to support waterway-dependent threatened species
no data	No fauna surveys have been undertaken post 1980

Data Sources:

ABC database - DSE

IUCN Red List http://www.iucnredlist.org

EPBC Species http://www.environment.gov.au/epbc/index.html

Advisory List of Threatened Invertebrate Fauna in Victoria (DSE 2009a)
http://www.dse.vic.gov.au/__data/assets/pdf_file/0016/103390/Advisory_List_of_Threatened_Invertebrate_Fauna_2009_FINAL_Sept_2009.pdf

In addition, to more adequately assess impacts to specific invertebrate fauna, this metric was used to value three distinct faunal groups as follows:

Significant Fauna - River	Significant Fauna - Wetland	Significant Fauna- Estuary
Invertebrates – Aquatic	Invertebrates	
Invertebrates – Riparian		

AVIRA Metric – Significant Fauna (Vertebrates)

Value Score	Descriptor
5	Supports high priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Act as Presumed Extinct or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Threatened Vertebrate Fauna in Victoria* as Extinct, Regionally Extinct, Extinct in the Wild, Critically Endangered or Endangered
4	Supports medium priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Vulnerable
3	Supports low priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Data Deficient
2	Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the Advisory List of Threatened Vertebrate Fauna in Victoria as Near Threatened
1	Not known to support waterway-dependent threatened species
no data	No fauna surveys have been undertaken post 1980

Data Sources:

ABC database - DSE

IUCN Red List http://www.iucnredlist.org

EPBC Species http://www.environment.gov.au/epbc/index.html

Advisory List of Threatened Vertebrate Fauna in Victoria (DSE 2007b) http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/996B0477753A4204CA256DD4007F1CA5DFEF2E4B890BDECECA256DDD0015D632

In addition, to more adequately assess impacts to specific vertebrate fauna, this metric was used to value 18 distinct faunal groups as follows:

Significant Fauna - River	Significant Fauna - Wetland	Significant Fauna - Estuary
Fish – Migratory	Fish	Fish – Resident
Fish – Non-migratory	Birds	Fish – Dependent
Birds – Riparian	Amphibians	Birds
Birds – Waterway	Reptiles – aquatic	Reptiles
Amphibians	Reptiles – riparian	
Reptiles – aquatic	Mammals	
Reptiles – riparian		
Mammals		

7.2 Significant Flora

7.2.1 Background

As for fauna, a number of Victorian flora species have been listed as threatened under various international, national and state lists. The list of waterway dependent significant flora is provided in Appendix H.

As with significant fauna, only waterway dependent species are included in the significant flora measures within AVIRA. Waterway dependent species were identified through expert advice and were defined as any plant species that relied, for at least some part of their lifecycle on rivers, wetlands or estuaries. There were some species included that are not strictly dependent on waterways, but whose habitat now only occurs in remnants surrounding waterways. The buffer used in the GIS query associated with the dataset for significant flora is included in Appendix H.

7.2.2 Valuing Significant Flora

Measure 1 - Actions for Biodiversity Conservation

Descriptor	Data Descriptor
High priority threatened species are associated with the waterway (as determined by ABC database)	High Priority
Medium priority threatened species are associated with the waterway (as determined by ABC database)	Medium Priority
Low priority threatened species are associated with the waterway (as determined by ABC database)	Low Priority
No flora surveys have been undertaken post 1980	No data

Measure 2 – IUCN Red List

Descriptor	Data Descriptor
Listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered	Endangered
Listed under the IUCN Red List as Vulnerable	Vulnerable
Listed under the IUCN Red List as Data Deficient	Data Deficient
Listed under the IUCN Red List as Near Threatened	Near Threatened
Not listed under the IUCN Red List	None Known
No flora surveys have been undertaken post 1980	No data

Measure 3 – EPBC Act 1999

Descriptor	Data Descriptor
Listed under the EPBC Act as Presumed Extinct or Endangered	Endangered
Listed under the EPBC Act as Vulnerable	Vulnerable
Not listed under the EPBC Act	None Known
No flora surveys have been undertaken post 1980	No data

Measure 4 – Advisory List of Rare or Threatened Plants in Victoria

Descriptor	Data Descriptor
Listed under the *Advisory List of Threatened Plants in Victoria* as Presumed Extinct or Endangered	Endangered
Listed under the *Advisory List of Threatened Plants in Victoria* as Vulnerable	Vulnerable
Listed under the *Advisory List of Threatened Plants in Victoria* as Poorly Known	Poorly Known
Listed under the *Advisory List of Threatened Plants in Victoria* as Rare	Rare
Not listed under the *Advisory List of Threatened Plants in Victoria*	None Known
No flora surveys have been undertaken post 1980	No data

Using the same approach as significant fauna, the ABC database will be utilised as the primary measure to value significant flora in AVIRA with other measures utilised where species are not currently recorded or ranked on the ABC database.

In addition, to ensure that only those species dependent on waterways are identified a buffer was used in a GIS query around waterways to encompass the pre 1750 riparian, floodplain, wetland and/or estuarine EVCs associated with each waterway.

AVIRA Metric – Significant Flora

Value Score	Descriptor
5	Supports high priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Extinct, Extinct in the Wild, Critically Endangered or Endangered OR Supports waterway-dependent species listed under the EPBC Act as Presumed Extinct or Endangered OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Presumed Extinct or Endangered
4	Supports medium priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Vulnerable OR Supports waterway-dependent species listed under the EPBC Act as Vulnerable OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Vulnerable
3	Supports low priority waterway-dependent threatened species (as determined by ABC database) IF NOT LISTED IN ABC THEN Supports waterway-dependent species listed under the IUCN Red List as Data Deficient OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Poorly Known
2	Supports waterway-dependent species listed under the IUCN Red List as Near Threatened OR Supports waterway-dependent species listed under the *Advisory List of Rare or Threatened Plants in Victoria* as Rare
1	Not known to support waterway-dependent threatened species
no data	No flora surveys have been undertaken
Data Sources: ABC database - DSE IUCN Red List http://www.iucnredlist.org EPBC Species http://www.environment.gov.au/epbc/index.html *Advisory List of Rare or Threatened Plants in Victoria* (DSE 2005a) http://www.dse.vic.gov.au/DSE/nrenpa.nsf/LinkView/996B0477753A4204CA256DD4007F1CA5DFEF2E4B890BDECECA256DDD0015D632	

In addition, to more adequately assess impacts to flora in specific landscape settings, this metric will be used to value four flora groups as follows:

Significant Flora - River	Significant Flora - Wetland	Significant Flora - Estuary
Aquatic	Wetland dependent flora	Aquatic
Terrestrial		Terrestrial

7.3 Significant EVCs

7.3.1 Background

Vegetation is typically described by reference to one or more of its attributes i.e.floristic composition, structure and important environmental determinants. In Victoria, the principal unit for vegetation circumscription and mapping for land-use planning and management is the Ecological Vegetation Class (EVC) (Parkes et al 2003).

Appendix I provides a list of waterway dependent EVCs linked to river reaches, wetlands and estuaries.

7.3.2 Valuing Significant EVCs

Victoria's Native Vegetation Management Framework (DNRE 2002c) states that the conservation significance of vegetation should be determined according to:

- the conservation status of vegetation types present;
- the quality of the vegetation;
- the conservation status of species present (and the potential habitat value);
- the strategic location in the local landscape; and
- other recognised criteria (e.g.commitments under international conventions).

Based on the above, two measures were selected to describe and value riparian, wetland and estuarine EVCs:

- conservation status; and
- condition.

The other determinants were excluded from further assessment as they form part of other categories (i.e.Formally Recognised Significance) or metrics (i.e.Significant Flora and Fauna) within AVIRA.

Measure 1 – Conservation Status

Assessment of the conservation status of vegetation types is traditionally based on the broad concepts of inherent rarity, degree of threat and importance for supporting other significant features. These concepts have been used to assign a conservation status for each combination of EVC and bioregion in Victoria (DNRE 2002c).

Descriptor	Data Descriptor
Endangered	Endangered
Vulnerable	Vulnerable
Depleted	Depleted
Rare	Rare
Least Concern	Least Concern

For the purposes of valuing waterways within AVIRA, the existence of a significant EVC is deemed to be more important than its size. Therefore, where a river reach, wetland or estuary supports more than one EVC, the EVC with the highest status was used.

Measure 2 – Condition

For riparian EVCs, vegetation quality was assessed using the Streamside Zone Sub-Index of 3ISC. This sub-index uses a value score system (ranging from 0 to 10) as follows:

Riparian Vegetation Condition

Descriptor	Data Desciptor
Excellent Condition (9-10)	3ISC Streamside Zone Score
Good Condition (7-8)	
Moderate Condition (5-6)	
Poor Condition (3-4)	
Very Poor Condition(0-2)	

For wetland EVCs, vegetation quality is assessed using the IWC Biota Sub-Index. This sub-index uses a value score system (ranging from 0 to 20) as follows:

Wetland Vegetation Condition

Descriptor	Data Descriptor
Excellent Condition (17-20)	IWC Biota Score
Good Condition (13-16)	
Moderate Condition (9-12)	
Poor Condition (5-8)	
Very Poor Condition(0-4)	

These values score systems were used to describe the EVC condition for riparian and wetland EVCs.

For estuarine EVCs, work is underway to develop a state-wide approach to assessing the quality of estuarine vegetation (as per wetlands and rivers); however at this stage no information is available.

AVIRA Metric – Significant EVCs

Based on the rule sets for conservation status and habitat scores detailed in Victoria's Native Vegetation Management Framework (DNRE 2002c), three metrics have been developed to score significant EVC value.

AVIRA Metric –Significant Riparian EVCs

Conservation Status	Streamside Zone Sub-Index Score					
	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10	no data
Endangered	4	4	5	5	5	5
Vulnerable	3	4	4	5	5	4
Depleted	3	4	4	4	5	3
Rare	1	3	3	3	4	2
Least Concern	1	1	1	1	3	1
Not Applicable*	0	0	0	0	0	0

Data Sources:

EVC Benchmarks
http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C

3ISC Streamside Zone Sub-Index

* Riparian vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

AVIRA Metric –Significant Wetland EVCs

Conservation Status	Biota Sub-Index Score					
	0 - 8	9-13	14-16	17-18	19-20	no data
Endangered	4	4	5	5	5	5
Vulnerable	3	4	4	5	5	4
Depleted	3	4	4	4	5	3
Rare	1	3	3	3	4	2
Least Concern	1	1	1	1	3	1
Not Applicable*	0	0	0	0	0	0

Data Sources:

EVC Benchmarks
http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C

IWC Biota Zone Sub-Index

* Wetland vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

AVIRA Metric –Significant Estuarine EVCs

Value Score	Descriptor	Data Descriptor
5	Endangered	Endangered
4	Vulnerable	Vulnerable
3	Depleted	Depleted
2	Rare	Rare
1	Least Concern	Least Concern
0	Not Applicable*	

Data Source:

EVC Benchmarks
http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/43FE7DF24A1447D9CA256EE6007EA8788062D358172E420C4A256DEA0012F71C

Estuarine Vegetation Sub-Index Score to be developed

* Estuarine vegetation described as cleared or heavily modified i.e.EVC 58 (cleared/disturbed) or EVC 997 (private land).

8 Naturalness

This category uses the condition of specific waterway-dependent flora and fauna to act as surrogates for the naturalness of a particular waterway. Three naturalness values have been determined for AVIRA:

- Aquatic Invertebrate Community Condition;
- Native Fish; and
- Vegetation Condition.

These values are discussed in the following sections.

8.1 Aquatic Invertebrate Community Condition

8.1.1 Background

River Reaches

Aquatic invertebrates are small animals, generally less than 1 cm long, and include mayfly and dragonfly nymphs, beetles, snails, worms, shrimp, and the like. They are very abundant in streams, occurring in all aquatic habitats. They can be found burrowed in mud, in or on woody debris (snags), on the surface of stones in fast flowing riffles and among macrophyte beds. As well as being important in their own right, invertebrates are critical to stream ecosystem functioning, both in the processing of energy, and as a food supply to yabbies, fish, platypus, and some birds (Metzeling et al 2004).

The Environment Protection Authority (EPA) Victoria has an extensive database of aquatic invertebrates covering the entire State, which has been crucial in delineating five bioregions across Victoria and developing biological objectives for each of these regions. These objectives have been designed to maintain the quality of the better sites in the regions and set goals for improvement for other sites within the regions.

To develop biological objectives, Metzeling et al (2004) chose five aquatic macro-invertebrate indicators under three categories:

- diversity
  - number of families;
- biotic indices (indicators of disturbance)
  - SIGNAL (Stream Invertebrate Grade Number - Average Level)
  - EPT (Ephemeroptera, Plecoptera, Trichoptera)
- community composition
  - number of key families
  - Australian River Assessment System (AusRivAS)

Wetlands

Victoria has a wide variety of inland lakes (defined by EPA Victoria as wetlands with >70% open water) including billabongs, volcanic lakes, sand-dune lakes and reservoirs. Some of these lakes have naturally high salinities and animal and plant communities that make them very different from lakes elsewhere in the world (EPA Victoria ~2008a).

EPA Victoria's lakes project aims to develop a better understanding of how Victoria's lakes work and develop guidelines to help protect them. The guidelines are being developed through detailed studies of five lakes in the western district of Victoria – Bullen Merri, Purrumbete, Surprise, Colac

and Modewarre. The project will set the course for future environmental condition assessment of Victorian lakes and support the evaluation and ongoing management of these ecosystems (EPA Victoria ~2008a).

At present, interim biological objectives have only been developed for lakes. These objectives will be released in 2009 and although trialled in a number of lakes, will require further verification. There are currently no plans to revise the State Environment Protection Policy – Waters of Victoria (SEPP (WoV) to incorporate them. There are no biological objectives for other wetland types at this stage.

Estuaries

Estuaries may be permanently or periodically open to the sea with salinities that vary from almost fresh to very saline. Environmental condition may be stable over long periods of time or change frequently or rapidly. Estuaries are, therefore, complex and highly variable environments that often appear to be unpredictable (EPA Victoria ~2008b).

In 2011, EPA Victoria released Environmental Water Quality Guidelines for Victorian Riverine Estuaries (EPA Victoria 2011). The guidelines include requirements for water quality parameters, including oxygen stress and nutrient and sediment impacts, which have sufficient data for analysis and good understanding of impact. However, at this stage, there are inadequate data and understanding to set biological guidelines for riverine estuaries. Therefore, there is no metric for Aquatic Invertebrate Community Condition (Estuaries) in AVIRA.

8.1.2 Valuing Aquatic Invertebrate Community Condition

As biological objectives have only been developed for river reaches, it is currently not possible to adopt numeric values for aquatic invertebrate community condition for wetlands or estuaries.

However, provision should be made in AVIRA for inclusion of these values if/when the appropriate studies and guidelines are completed.

Appendix J outlines the rules for applying the Aquatic Invertebrate Community Condition measure to river reach assets within AVIRA.

AVIRA Metric – Aquatic Invertebrate Community Condition (River Reaches)

Value Score	Descriptor	Data Descriptor
5	Meets all biological objectives for rivers and streams *	Meets All
4	Fails to meet 1 objective where 4 indicators are used for rivers and streams *	Fails 1 from 4
3	Fails to meet 1 objective where 3 indicators are used for rivers and streams *	Fails 1 from 3
1	Fails to meet 2 or more objective for rivers and streams *	Fails 2 or More
no data	No aquatic invertebrate surveys have been undertaken and/or assessed	No Data
Data Source: *Biological Objectives for Rivers and Streams – Ecosystem Protection* (Metzeling et al 2004)		

* Indicators are AusRivAS, SIGNAL, EPT, No. of Families and No. of Key Families. The use of multiple indicators was deemed desirable as it improves the robustness and reliability of the assessment.

8.2 Native Fish

8.2.1 Background

As part of the development of the RiVERS database, DSE's Arthur Rylah Institute (ARI) developed the following datasets:

- native freshwater fish observed v expected (based on collected fish data (observed) and expert opinion on species distribution (expected); and
- proportion native freshwater fish (based on the number of native fish (observed) compared with the number of exotic fish (observed).

More recently, the Murray Darling Basin Commission (MDBC) has identified 13 fish indicators as part of the Sustainable Rivers Audit (SRA).

8.2.2 Valuing Native Fish

River Reaches

Based on the SRA, the following subset of indicators may be considered useful in valuing native fish for river reaches:

- Native Freshwater Fish Observed/Expected;
- Species Richness (the total species richness (native and alien) at each site to a predicted maximum species richness (native and alien));
- Percentage Native Freshwater Fish Biomass (the proportion of the total biomass (weight) caught that has been contributed by native species of fish);
- Percentage Native Freshwater Fish Abundance (the proportion of individual fish caught in each site that were native species); and
- Percentage Native Freshwater Fish Species (the proportion of fish species in each site that were native species).

ARI combined the five SRA scores to produce a single fish index score.

Wetlands

A similar approach to the above is recommended for wetlands, but is yet to be developed or applied.

Estuaries

While some estuaries have been surveyed for fish, there is currently no established sampling protocol or regular monitoring. These need to be developed to standardise sampling and allow comparison of estuaries (Arundel et al 2008).

In addition, Arundel et al (2008) state that Victorian fish assemblage data needs to be examined before an expected pattern of distribution of fish trophic guilds (i.e.estuarine use and feeding mode) can be established.

Therefore, it is proposed to develop a metric for estuarine fish following collection, collation, analysis and review of Victorian data for the IEC.

AVIRA Metric – Native Fish

The single index score, produced from combining the five SRA scores was used for the following metric:

Value Score	Descriptor	Data Descriptor
5	Fish Index Score 80 – 100 (Good)	Fish Index Score
4	Fish Index Score 60 – 79 (Moderate)	
3	Fish Index Score 40 – 59 (Poor)	
2	Fish Index Score 20 – 39 (Very Poor)	
1	Fish Index Score 0 – 19 (Extremely Poor)	
no data	No native fish surveys have been undertaken and/or assessed	-1
Data Source: SRA data ARI developed Fish Index Score (based on the SRA methodology)		

8.3 Vegetation Condition

8.3.1 Background

River Reaches

Riparian land with intact vegetation is vitally important to the health of a waterway because it provides:

- organic matter to a river – a major food source for aquatic fauna;
- a supply of woody debris within the river, which forms key habitat areas for many fish and invertebrates;
- a source of shade in upland areas which influences water temperature and light penetration producing suitable conditions for aquatic flora and fauna; and
- assistance in bank stabilisation, reducing erosion in many areas.

Wetlands

Wetland biota depend on wetlands for all or part of their lifecycle. They include phytoplankton, wetlands plants (e.g.herbs, ferns, shrubs, trees), aquatic invertebrates, vertebrates (such as fish, amphibians, birds, mammals and reptiles) and micro-organisms (e.g.fungi, diatoms and microbes) (DSE 2006b).

Estuaries

Important habitat types identified as habitat extent indicators in the national State of the Environment reporting (see Ward et al 1998) were:

- **Algal beds**. Subtidal beds of macroalgae are important elements of shallow waters in estuaries. Apart from their intrinsic floral values as a diverse suite of species, algal beds have important ecological roles such as harbouring many species of fauna.
- **Intertidal reef areas**. Intertidal reefs are key aspects of Australia's coastal environment; hosting a substantial diversity of flora and fauna that are adapted to withstand the harsh salt-enriched and desiccating environment.
- **Intertidal sand/mudflat areas**. Intertidal sand and mudflats are important habitats for species of fish, crustaceans and some species of seagrasses; and they support other important species such as migratory wading birds that are the subject of a number of international agreements.
- **Mangrove areas**. Mangrove habitats are important elements of estuaries. They are species-rich habitats, and they shelter numerous species of fish and invertebrates.
- **Saltmarsh areas**. As habitat, saltmarshes are presumed to be highly productive, to have important roles as fish nurseries and to support other species of aquatic fauna. They are very important feeding and roosting areas for birds, including migratory waders covered by international agreements and locally rare species (including the Orange-bellied Parrot (Neophema chrysogaster) in Victoria).
- **Seagrass areas**. Seagrasses are highly valued for their intrinsic biodiversity.

The vegetation of estuaries is largely a function of inundation in relation to vertical elevation, made more complex by variable salinity. The Estuary Entrance Management Support System (EEMSS) project (Arundel 2006) identified 14 EVCs from the sub-group 'estuaries' (refer to Table 6.1).

Table 6.1- Estuarine EVCs

EVC Name	EVC Number
Coastal saltmarsh	EVC 009
Estuarine wetland	EVC 010
Brackish sedgeland	EVC 013
Mangrove shrubland	EVC 140
Seasonally inundated sub-saline herbland	EVC 196
Brackish herbland	EVC 538
Saline aquatic meadow	EVC 842
Sea-grass meadow	EVC 845
Estuarine flats grassland	EVC 914
Brackish grassland	EVC 934
Estuarine reedbed	EVC 952
Estuarine scrub	EVC 953
Mud flats	EVC 990
Littoral rainforest	no number

8.3.2 Valuing Vegetation Condition

AVIRA Metric – Riparian Vegetation Condition

The Streamside Zone Sub-Index of 3ISC was used to measure the degree of riparian vegetation naturalness, with Riparian Vegetation Condition value scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Streamside Zone Sub-Index Score: 9 - 10	3ISC SZ Score
4	Streamside Zone Sub-Index Score: 7 - 8	
3	Streamside Zone Sub-Index Score: 5 - 6	
2	Streamside Zone Sub-Index Score: 3 - 4	
1	Streamside Zone Sub-Index Score: 0 - 2	
no data	Riparian vegetation condition has not been assessed under 3ISC	-1
Data Source: 3ISC Streamside Zone Sub-Index		

AVIRA Metric – Wetland Vegetation Condition

The key ecological component of the IWC Biota Sub-Index is wetland plants. To determine the condition of wetland plants, the IWC Field Assessment Sheet lists the following key steps:

1. Determine the wetland EVCs present at the wetland.
2. Estimate the proportion (e.g.0.1, 0.2 etc.) of the wetland area covered by each EVC.
3. Assess each EVC by undertaking wetland vegetation quality assessments based on:
    - critical lifeforms;
    - presence of weeds;
    - indicators of altered processes; and
    - vegetation structure and health.
4. Determine the Biota Sub-Index score.

To maintain consistency with the Riparian Vegetation Condition metric, the Biota Sub-Index was used to measure the condition of wetland plants, with Wetland Vegetation Condition value scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	IWC Biota Sub-Index Score: 17- 20	IWC Biota Score
4	IWC Biota Sub-Index Score: 13 - 16	
3	IWC Biota Sub-Index Score: 9 - 12	
2	IWC Biota Sub-Index Score: 5 - 8	
1	IWC Biota Sub-Index Score: 0 - 4	
no data	Wetland plant condition has not been assessed under IWC	-1
Data Source: IWC Biota Sub-Index		

AVIRA Metric – Estuary Vegetation Condition

A metric for estuary vegetation condition has not been determined. A metric for degraded estuarine vegetation was included in AVIRA, which utilised data from the IEC. This data could be used in future assessments to determine a metric for estuary vegetation condition.

9 Landscape Features

This category identifies three additional landscape features of waterways:

- Drought Refuges;
- Important Bird Habitats; and
- Biosphere Reserves.

These values are discussed in the following sections.

9.1 Drought Refuges

9.1.1 Background

The essential components of a refuge are:

- it is a physical place secure from one or more disturbances; and
- it is a source of colonists for the wider landscape after disturbance has ceased (Robson et al 2008).

The need for refuges therefore implies that there is a disturbance, natural or anthropogenic, that threatens aquatic life and also that the disturbance will end so that there are opportunities for recolonisation.

Two types of places are clearly discernible as providing a refuge for a wide range of plants and animals:

- places where the natural water regime is maintained; and
- places where natural water-riparian zone interactions are maintained (Robson et al 2008).

9.1.2 Valuing Drought Refuges

DSE recently engaged Monash University to develop predictive models that explain historical freshwater fish species distributions in Victorian rivers, and to apply these models to explore potential distributional changes expected under four different climate scenarios:

- step change (continuation of the last 13 years of drought (1997-2010); and
- low, median and high CSIRO climate-change scenarios for 2030 (Bond et al 2010).

Based on the modelled fish distributions under the step change (drought) scenario, Thompson and Bond (2011) have identified and classified:

- 243 ISC reaches as having a high likelihood of acting as refuge habitat during drought for at least one threatened species1; and
- 701 ISC reaches as having a high likelihood of acting as refuge habitat during drought for non-threatened species.

Whilst these results can be used to value those rivers providing drought refuge to native fish, no comparable or consistently adopted approach currently exists in Victoria to identify:

- drought refuges within river systems for other native fauna/flora species; or
- drought refuges within wetland or estuarine systems.

[1] Silver Perch, Barred Galaxias and the Upper Wannon form of River Blackfish could not be included in the modelling due to the lack of suitable data. However, expert opinion could be used to add reaches with a high likelihood of acting as refuge habitat during drought for these species e.g.information is available on critical habitats for Barred Galaxias.

It is therefore recommended that for these circumstances, regional organisations nominate an interim set of drought refuge areas using the definitions as described in Section 9.1.1 in combination with local knowledge.

AVIRA Metric – Drought Refuges

Based on the above, Drought Refuge value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Modelled drought refuge for one or more significant fish species OR Nominated drought refuge for significant fauna and/or significant EVCs	Significant Refuge
3	Modelled drought refuge for one or more other fish species OR Nominated drought refuge for other fauna and/or EVCs	Other Refuge
1	Not a modelled drought refuge OR Not considered to be a drought refuge	No Refuge
no data	Value of waterway as a drought refuge has not been assessed or considered	No data
Data Sources: *Interpreting Species Distribution Models to Identify Drought Refuges for Native Fish in Victorian Streams* (Thompson and Bond 2011). CMA Dry Inflow Contingency Plans Australian Wetlands Database (specifically, wetlands meeting criterion 3) http://www.environment.gov.au/water/publications/environmental/wetlands/database Regional Wetland Strategies Local knowledge		

9.2 Important Bird Habitats

9.2.1 Background

Effective conservation of Australia's birds requires that we focus our activities at a regional scale, to particular bird species, or to specific sites of interest (Birds Australia ~2009). For AVIRA, the following bird habitats have been determined as important for prioritisation:

- Important Bird Areas;
- Migratory Shorebird Sites; and
- Colonial Nesting Bird Sites.

9.2.2 Valuing Important Bird Habitats

Measure 1 - Important Bird Areas

Important Bird Areas (IBAs) are sites of global bird conservation importance and are priority areas for bird conservation. Each IBA meets one of four global criteria used by BirdLife International. The following IBAs are located in Victoria:

- Cheetham & Altona
- Anderson's Inlet
- Werribee & Avalon
- Avoca Plains
- Barmah - Millewa
- Bellarine Wetlands
- Victorian Box-Ironbark
- Carrum Wetlands
- Corner Inlet
- Discovery Bay to Picanninnie Ponds
- Gabo & Tullaberga Island
- Gippsland Lakes
- Lake Buloke
- Lake Corangamite Complex
- Lawrence Rocks
- Little Desert
- Lower Snowy & Brodribb Rivers
- Murray-Sunset, Hattah & Annuello
- Nadgee to Mallacoota Inlet
- Natimuk-Douglas
- North Victorian Wetlands
- Otway Ranges
- Patho Plains
- Phillip Island
- Port Fairy to Warrnambool
- Pukapunyal
- Riverland
- Shallow Inlet
- Swan Bay & Port Phillip Bay Islands
- Terrick Terrick woodlands
- Wandown
- Westernport Bay
- Wilson's Prom Islands
- Wyperfeld, Big Desert & Ngarkat
- Yambuk
- Victorian Alps

Descriptor	Data Descriptor
Important bird area	Important
Not considered to be an important bird area	Not Important

Measure 2 - Migratory Shorebird Sites

In addition to the five internationally significant shorebird sites occurring in Victoria (refer to Section 4.2), Birds Australia have listed an additional 12 sites considered important to migratory shorebirds (Birds Australia ~2009), namely:

- Lough Calvert
- Lake Martin
- Lake Murdeduke
- Ocean Grove to Barwon Heads
- Gippsland Lakes
- Port Fairy to Warrnambool coast
- Lake Tutchewop, Kerang
- Lake Buloke
- Edithvale-Seaford Wetlands
- Anderson Inlet
- Hazelwood Cooling Pond
- Lake Hindmarsh

Descriptor	Data Descriptor
Important habitat for migratory shorebirds	Important
Not considered to be an important habitat for migratory shorebirds	Not Important

Measure 3 - Colonial Nesting Bird Sites

Colonial nesting waterbirds (e.g.ibis, egrets, herons and spoonbills) are widespread throughout much of Australia, particularly in the south east and along coastal regions. These waterbirds are found in a variety of habitats, including terrestrial wetlands, grasslands and sheltered marine habitats. Breeding occurs in groups in either fresh or brackish water, often in wetlands surrounded with reeds and trees which are used for nest building. Feeding usually occurs in shallow waters, or along the margins of deep water bodies.

Descriptor	Data Descriptor
Important breeding habitat for colonial nesting birds	Important
Not considered to be an important breeding habitat for colonial nesting birds	Not Important

AVIRA Metric – Important Bird Habitats

Based on the above, the Important Bird Habitat value was scored using the following metric:

Value Score	Descriptor
5	Important bird area OR Important habitat for migratory shorebirds OR Important breeding habitat for colonial nesting birds
1	Not considered to be an important bird habitat
Data Source: Birds Australia (~2009) http://www.birdsaustralia.com.au	

9.3 Biosphere Reserves

9.3.1 Background

A Biosphere Reserve is an international designation made by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) on the basis of nominations submitted by countries participating in the Man and the Biosphere Program (DEWHA ~2008c). However this designation does not alter the legal status of the land and there are no internationally legally binding requirements regarding their management (MDBC 2006c).

Australia has 14 Biosphere Reserves with four occurring in Victoria, namely:

- Croajingolong National Park;
- Hattah-Kulkyne National Park;
- Mornington Peninsula and Western Port; and
- Wilsons Promontory Marine Park & Marine Reserve.

Two of these reserves (Croajingolong National Park and Hattah-Kulkyne National Park) specifically include freshwater ecosystems within their respective management plans.

9.3.2 Valuing Biosphere Reserves

Biosphere Reserves have been nominated based on a mosaic of ecological systems. To ensure that only those waterways considered significant in the Biosphere nomination process are recognised, only those waterways listed as key features of the Biosphere Reserves should be considered (i.e.described within a corresponding management plan).

AVIRA Metric –Biosphere Reserves

Based on the above, Biosphere Reserve value was scored using the following metric:

Value	Descriptor	Data Descriptor
Listed	Listed as a key feature of a Biosphere Reserve	Listed
Not Listed	Not listed as a key feature of a Biosphere Reserve	Not Listed

Data Sources:

Croajingolong National Park Management Plan (DNRE 1996)

Hattah-Kulkyne Lakes Ramsar Site Strategic Management Plan (DSE 2003)

Wilsons Promontory National Park Management Plan (Parks Victoria 2002)

Part B Social Values

Social values have been grouped under the following categories:

- Activity;
- Place; and
- People.

These categories are presented in the following sections.

10 Activity

This category considers the recreational use of waterways; specifically:

- recreational fishing;
- non-motor boating;
- motor boating;
- camping;
- swimming;
- beside water activities; and
- game hunting.

The following sections detail approaches to measuring and valuing the recreational uses of waterways.

10.1 Recreational Fishing

10.1.1 Background

Recreational fishing is popular in rivers, lakes and estuaries and can take place:

- from the bank (including fishing platforms);
- in the water (e.g.fly fishing); and
- on the water (from a boat).

Over 500,000 Victorians go fishing each year (DPI 2007a); some for the relaxation, others for the sport. Although some anglers are happy just to catch any fish, the species most freshwater anglers target are trout, redfin, golden perch, and Murray cod (Tunbridge and Rogan ~2008).

10.1.2 Valuing Recreational Fishing

Valuing fishing waters can be very subjective. For example, a remote trout fishery may be considered very high value to some keen fly-fishers; just as an easily accessed estuary could be highly valued by the occasional weekend fisher. Therefore, whilst local knowledge is believed to be a key source of information, its use in valuing recreational fishing waters can lead to subjective interpretations of what constitutes a 'popular' location.

Therefore, to describe recreational fishing value for Victorian waterways, four data sources were identified:

- Regional Fishery Management Plans;
- *A Guide to the Inland Angling Waters of Victoria* (Tunbridge and Rogan ~2008);
- Victorian Social Benchmarking of River Health Project; and
- Improving Inland Recreational Fishing, DEPI: Fisheries Victoria, July 2012.

Regional Fishery Management Plans

The purpose of Regional Fishery Management Plans (RFMPs) is to specify the objectives, strategies and performance measures for managing recreational fishing activities in rivers and impoundments across a specific fishery.

The RFMPs describe:

- key recreational fishing waterways and target species;
- current management arrangements for fishing activities and for other relevant issues that may impact on fisheries resources;
- strategies, goals, objectives, performance indicators and actions for management of fishing activities; and
- a process for addressing other resource management issues that can impact recreational fisheries.

The following RFMPs have been completed in Victoria:

- Bendigo Regional Fishery Management Plan (DNRE 2002d);
- Glenelg Hopkins Fishery Management Plan (DPI 2006a);
- Goulburn-Eildon Fishery Management Plan (DNRE 2002e);
- North East Fishery Management Plan (DPI 2006b);
- West Gippsland Fishery Management Plan (DPI 2008a); and
- Corangamite Fishery Management Plan (draft) (DPI 2008b).

Appendix K provides information on waterways identified as priority, key or popular fisheries within each of the above RFMPs.

Guide to the Angling Waters of Victoria.

A Guide to the Inland Angling Waters of Victoria (Tunbridge and Rogan ~2008) is an on-line guide that provides valuable information to recreational fishers including:

- best fishing waters within each basin;
- a list of recreational fishing waters within each basin; and
- fish species known to occur in each water.

Victorian Social Benchmarking of River Health Project

In late 2006, the Victorian River Health Program commissioned the River Health Social Benchmarking project. This project sought to add a social component to the ISC (referred to as the Social Index of Stream Condition - SISC).

The key aims of the SISC are to provide:

- a benchmark of the social condition of communities' attitudes, values, understanding and behaviours in relation to river health;
- an information resource for developing priorities (both social and environmental) for action for river managers; and
- an assessment of the long-term effectiveness of community education and engagement activities in achieving changes in attitudes, values, understanding and behaviours in relation to river health.

The second dot point is of particular relevance to AVIRA as this information can assist in identifying social values of waterways at a local level (including recreational fishing).

Improving Inland Recreational Fishing, DEPI: Fisheries Victoria, July 2012

Fisheries Victoria surveyed 3,025 Recreational Fishing Licence holders to better understand what lake, river and estuary locations are most important to recreational fishers.

AVIRA Metric – Recreational Fishing

Based on the above, Recreational Fishing value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	More than six recreational fishing licence holders identified this reach as their most preferred fishing location OR Listed as a priority/key/popular fishery in a Regional Fishery Management Plan OR Rated as a 'best fishing water' in *A Guide to the Inland Angling Waters of Victoria*	Popular Fishery
3	Some recreational fishing occurs	Some Fishing
1	Not known to be used for recreational fishing	Not known
0	Not suitable for recreational fishing	No Fishing
Data Sources: Fisheries Victoria Survey *Improving Inland Recreational Fishing (DEPI:Fisheries Victoria)* Regional Fishery Management Plans (refer to Appendix K) *A Guide to the Inland Angling Waters of Victoria* (Tunbridge and Rogan ~2008) http://www.dpi.vic.gov.au/angling Victorian Social Benchmarking of River Health Project Local knowledge		

10.2 Non-Motor Boating

10.2.1 Background

Waterways are popular locations for a number of non-motor boating activities including:

- canoeing/kayaking;
- white-water rafting;
- rowing; and
- sailing.

10.2.2 Valuing Non-Motor Boating

Many peak bodies exist for non-boating activities e.g.Canoeing Victoria, Rowing Victoria. These organisations hold annual events at specific locations and also have considerable knowledge as to which waterways are utilised for specific water-based activities. As such, it was recommended that peak bodies be consulted to identify:

- waterways used for annual events; and
- waterways considered popular for non-motor boating.

AVIRA Metric – Non-Motor Boating

Based on the above, Non-Motor Boating value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway used for annual (or more frequent) non-motor boating event	Annual Events
4	Waterway is popular for non-motor boating	Popular
3	Waterway is occasionally used for non-motor boating	Some Boating
1	Not known to be used for non-motor boating	Not Known
0	Not suitable for non-motor boating	No Boating
Data Sources: Peak body e.g.Canoeing Victoria, Rowing Victoria (refer to Appendix L) Victorian Social Benchmarking of River Health Project Local knowledge		

10.3 Motor Boating

10.3.1 Background

Motor boating is a popular activity associated with:

- water skiing;
- recreational fishing;
- sight-seeing; and
- power boat racing.

Motor boating generally occurs in lowland river reaches, estuaries, lakes and impoundments. The key facilities required include access (specifically boat launching ramps) and parking (for car and boat trailer).

10.3.2 Valuing Motor Boating

As for non-motor boating, it was recommended that peak bodies and clubs were consulted as the primary source in identifying:

- waterways used for annual events; and
- waterways considered popular for motor boating.

AVIRA Metric – Motor Boating

Based on the above, Motor Boating value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway used for annual (or more frequent) motor boating event	Annual Events
4	Waterway is popular for motor boating with accessible formal boating facility (i.e.boat ramp and car/trailer parking)	Popular
3	Waterway is occasionally used for motor boating but has no formal boating facility available	Some Boating
1	Not known to be used for motor boating	Not Known
0	Not suitable for motor boating	No Boating
Data Sources: Peak body e.g.Ski Racing Victoria, Victorian Speed Boat Club, Boating Victoria, Club Marine (refer to Appendix M) Victorian Social Benchmarking of River Health Project Local knowledge		

10.4 Camping

10.4.1 Background

There are many camping opportunities available to Victorians including National Parks, State Parks, State Forests, Scenic Reserves and Foreshore Reserves.

The banks of rivers, lakes and estuaries are popular destinations because of their scenic value and also for opportunities for fishing, swimming, boating or water-skiing, particularly in the summer (LCC 1991).

10.4.2 Valuing Camping

To identify and value waterways associated with camping locations, a metric based on the following main types of camping area was developed:

- serviced campgrounds;
- campgrounds with basic facilities; and
- bush camping areas.

Serviced campgrounds generally have flush toilets, tap water, picnic tables, barbecues and hot showers. These areas are managed by either local or private authorities. Some examples include foreshore reserve campgrounds along the Great Ocean Road (e.g. Cumberland River), Wilsons Promontory National Park, and Lake Eildon National Park. To assist with the maintenance of these areas, camping fees usually apply.

Campgrounds with basic facilities are generally less popular than serviced campgrounds but can offer a more natural camping experience. Facilities in these areas generally include fireplaces, picnic tables, a water supply and usually non-flushing toilets.

Bush camping areas are generally more difficult (i.e.rough tracks, by foot or boat) and remote. These areas have no formal facilities and campers must be entirely self-sufficient.

AVIRA Metric – Camping

Based on the above, Camping value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Serviced campground adjacent to waterway* OR Multiple campsites with basic facilities adjacent to waterway	Serviced or Multiple Basic
4	Campground with basic facilities adjacent to waterway OR Multiple bush camping areas adjacent to waterway	Basic or Multiple Bush
3	Bush camping area adjacent to waterway	Bush
1	Not a known camping area	Not Known
0	Not suitable for camping	No Camping
Data Sources: Camping guides e.g.*Camping in Victoria* (Lewis and Savage 1998), Parks Notes, etc. Victorian Social Benchmarking of River Health Project Local knowledge		

* Does not include caravan parks occupied by permanent residents

10.5 Swimming

10.5.1 Background

Swimming is a popular recreational activity of waterways, particularly in the warmer months. The most popular locations for swimming are:

- estuaries;
- lowland rivers;
- upland rivers (particularly those adjacent to camping areas); and
- lakes.

10.5.2 Valuing Swimming

Whilst local knowledge is believed to be the most appropriate source for determining value scores for swimming, it is acknowledged that this approach is open to considerable interpretation e.g.what would constitute a 'popular' swimming location.

Therefore, it was recommended that some evidence must be supplied in order to value a waterway as a popular swimming location. One option is to cite the information source e.g.camping guides, park notes etc.

AVIRA Metric – Swimming

Based on the above, swimming value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Popular swimming location	Popular
3	Some swimming	Some Swimming
1	Not a known swimming location	Not Known
0	Not suitable for swimming	No Swimming
Data Sources: Camping guides, Park notes Victorian Social Benchmarking of River Health Project Local knowledge		

10.6 Beside Water Activities

10.6.1 Background

Many low-impact activities occur along waterways including:

- walking, hiking, cycling;
- sightseeing; and
- picnics and barbecues.

10.6.2 Valuing Beside Water Activities

The recent trial of DSE's River Health Social Benchmarking Project revealed a strong correlation between recreational 'beside water use' and good river health behaviour. Therefore, understanding specific beside water uses of waterways was seen as particularly advantageous (both for priority setting and engagement activities).

Based on the above, Beside Water Activities value was scored using three metrics:

- tracks;
- sightseeing; and
- picnics and barbecues.

It is recommended that a buffer of 100m be placed around each waterway to ensure that only those activities strongly linked to waterways are identified.

AVIRA Metric – Beside Water Activities (Tracks)

Value Score	Descriptor	Data Descriptor
5	Sealed or formed tracks follow waterway* and are mapped or sign-posted	Formal
3	Unformed tracks follow waterway* but are not mapped or sign-posted	Informal
0	No tracks are present	No Tracks

Data Sources:

Bushwalking guides e.g.*Walking the Otways* (Rose 2001), camping guides e.g.*Camping in Victoria* (Lewis and Savage (1998), Parks Notes, local government

Victorian Social Benchmarking of River Health Project

Local knowledge

AVIRA Metric – Beside Water Activities (Sightseeing)

Value Score	Descriptor	Data Descriptor
5	Identified waterway feature of interest with high visitor numbers*	High Numbers
3	Identified waterway feature of interest with low visitor numbers*	Low Numbers
1	No known waterway features of interest.	Not Known

Data Sources:

Parks Notes, local government

Local knowledge

* Definition of high and low visitor numbers to be determined at a regional level.

AVIRA Metric – Beside Water Activities (Picnics and Barbecues)

Value Score	Descriptor	Data Descriptor
5	Designated picnic/barbecue areas present*	Present
0	No designated picnic/barbecue areas present*	Not Present

Data Sources:

Parks Notes, local government

Victorian Social Benchmarking of River Health Project

Local knowledge

10.7 Game Hunting

10.7.1 Background

In Victoria, licenses can be obtained for recreation game hunting of the following game species:

- Ducks (Pacific Black Duck, Chestnut Teal, Grey Teal, Hardhead (White-eyed Duck), Australian Shelduck (Mountain Duck), Pink-eared Duck, Maned Duck (Wood Duck) and Blue Wing Shoveler);
- Stubble Quail; and
- Deer (Sambar, Hog, Red and Fallow).

10.7.2 Valuing Game Hunting

Game Hunting in Victoria (DSE 2005b) lists the following locations as available for hunting:

- **State forest and other unoccupied Crown land**. Game species may be hunted during the open season only. Pest animals may be hunted at any time.
- **State Game Reserves**. Game species may be hunted, but only during the open season. Sixteen State Game Reserves are available for quail hunting and six for Hog Deer hunting. Pest animals may not be hunted at any time, unless specifically authorised by the Department.
- **Sanctuaries.** Game species may not be hunted at any time. Pest animals may be hunted.
- **National Parks, State Parks, Coastal Parks, Wilderness Parks**. Generally, hunting of any type is not permitted at any time; however, there are some exceptions.
- **Leased Crown land**. Game (only during the open season) and pest animals may be hunted, but only with the permission of the lessee.
- **Licensed Crown land**. Generally, game (only during the open season) and pest animals may be hunted at any time, unless the land is licensed under the Land Act 1958.
- **Private land**. Game (only during the open season) and pest animals may be hunted, but only with the permission of the land owner/manager.

AVIRA Metric – Game Hunting

Based on the above, Game Hunting value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Game hunting is permitted	Permitted
0	Game hunting is not permitted	Not Permitted
Data Source: *Game Hunting in Victoria* (DSE 2005b)		

11 Place

This category considers the intrinsic values of waterways; specifically:

- heritage; and
- landscape.

The following sections detail approaches to measuring and valuing heritage and landscape.

11.1 Heritage

11.1.1 Background

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community.

This section considers only those places listed for their cultural and/or social values. Heritage places listed for their natural values are described and assessed under environmental values (refer to Sections 4.3 and 4.7).

11.1.2 Valuing Heritage

Knowing the location of social and cultural heritage values is considered critical in the planning and implementation of protection and rehabilitation works.

However, attempting to score heritage for the purpose of risk assessment within AVIRA is believed to be inappropriate. A more specific, site-based risk assessment approach needs to be adopted to ensure protection of heritage values.

Therefore, no scoring has been recommended for this value; only whether a site is known to exist.

In addition, two measures have been identified to define heritage:

- Pre-European (Indigenous) Heritage; and
- Post-European Heritage.

AVIRA Metric – Pre-European (Indigenous) Heritage

Value	Descriptor	Data Descriptor
Known	Listed as a key feature of a site in the National Heritage List OR Listed as a key feature of a site in the Victorian Heritage Register OR Listed as an area of Cultural Sensitivity	Listed
Unknown	No sites listed	Not Listed
Data Sources: *Heritage Places in Victoria* (DEWHA ~2008a) http://www.environment.gov.au/heritage/places/vic/index.html *Victorian Heritage Database* (Heritage Victoria ~2008) http://vhd.heritage.vic.gov.au/vhd/heritagevic Aboriginal Affairs Victoria – Areas of Cultural Significance database		

AVIRA Metric – Post-European Heritage

Value	Descriptor	Data Descriptor
Known	Listed as a key feature of a site in the National Heritage List OR Listed as a key feature of a site in the Victorian Heritage Register	Listed
Unknown	No sites listed	Not Listed

Data Sources:

Heritage Places in Victoria http://www.environment.gov.au/heritage/places/vic/index.html

Victorian Heritage Database (Heritage Victoria ~2008)
http://vhd.heritage.vic.gov.au/vhd/heritagevic

11.2 Landscape

11.2.1 Background

The key sources of information available to determine significant landscapes are Local Government Planning Schemes (particularly Significant Landscape Overlays).

11.2.2 Valuing Landscape

The Significant Landscape Overlay provisions are set out at Clause 42.03 within all Victorian Planning Schemes. The purposes of the Significant Landscape Overlay are:

- To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- To identify significant landscapes.
- To conserve and enhance the character of significant landscapes.
- A schedule to this overlay must contain:
- A statement of the nature and key elements of the landscape.
- The landscape character objective to be achieved.

AVIRA Metric – Landscape

Based on the above, Landscape value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Covered by a Significant Landscape Overlay	SLO
3	Listed as scenic landscape in another report e.g.High Scenic Value listing in *Rivers and Streams Special Investigation: Final Recommendations* (LCC 1991)	Other Listing
0	Waterway not listed as a significant or scenic landscape	Not Listed

Data Sources:

Victoria's Planning Schemes www.dse.vic.gov.au/PlanningSchemes

Rivers and Streams Special Investigation: Final Recommendations (LCC 1991) - Table 24 and Map 15, pp 156-7

Other reports e.g.Estuaries Coastal Action Plans

12 People

This category considers the associations people have with waterways; specifically:

- community groups; and
- use of flagship species.

These associations are described in the following sections.

12.1 Community Groups

12.1.1 Background

Communities and the individuals that make up communities have a number of roles in river health. Individuals are relied upon to manage their own enterprises in ways that acknowledge their 'duty of care' and their role as stewards of natural resources. They may participate in community groups and networks, such as Waterwatch and Landcare, aimed at monitoring river health and/or undertaking restoration projects. Other community groups may take on the role of advocates for protection and/or restoration of waterways (e.g.Friends of Merri Creek). Community members may also participate in regional river health planning, priority setting and the implementation of works programs related to river management and restoration, often at a scale far broader than an individual waterway (DNRE 2002a).

12.1.2 Valuing Community Groups

To value community groups in a river health context, two measures were identified:

- presence/absence of community groups (with a river health focus); and
- level of river health advocacy.

AVIRA Metric – Community Groups

Based on the above, Community Group value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Significant and palpable community advocacy for waterway and/or campaign for increased river health works	Active Group Present
3	Notable presence of community groups engaged in supporting waterway (e.g.Waterwatch, Landcare etc.)	Group Present
2	Informal community group present with interest in waterway	Informal Group
0	No community groups present	No Group
Data Source: Local Knowledge		

12.2 Use of Flagship Species

12.2.1 Background

Flagship species are species which have public appeal, promotional and publicity value (BIRD ~2008). The concept of a flagship species is that by giving publicity to a few key species, the support given to those species will successfully leverage conservation of entire ecosystems and all species contained therein.

12.2.2 Valuing Use of Flagship Species

Flagship species can be chosen for their vulnerability (e.g.trout cod), attractiveness (e.g.Darter) or distinctiveness (e.g.platypus).

For example, local communities may identify a flagship species that currently does not reside in a particular waterway, but may use its status to promote waterway rehabilitation.

Furthermore, as current sustainability is not a mandatory requirement for determining flagship species, there is no need to include qualifiers other than presence/absence. In fact highly threatened species may be considered more relevant as flagships for a local community.

AVIRA Metric – Use of Flagship Species

Based on the above, Flagship Species value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway known to support waterway-dependent flagship species	Flagship Present
3	Waterway not known to support waterway-dependent flagship species BUT waterway condition/habitat suitable	Possible with Suitable Habitat
1	Waterway not known to support waterway-dependent flagship species AND waterway condition/habitat currently unsuitable	Possible but Unsuitable
0	Waterway does not and cannot support waterway-dependent flagship species.	Not Possible
no data	Presence and/or condition of waterway for flagship species has not been assessed or considered	No Data
Data Source: Victorian Flora and Fauna Databases Expert/Local Knowledge		

Note: Double-counting with environmental values may occur where threatened species are chosen as flagships.

It was recommended that the designation of flagship species be undertaken by the regional authorities in consultation with local communities. This approach may have resulted in flagship species designated at regional, basin, management unit and/or local scales.

Part C Economic Values

Economic values have been grouped under the following categories:

- Water;
- Power Generation; and
- Other Resources.

These categories are presented in the following sections.

13 Water

This category considers the key beneficial use of waterways; namely water. In particular:

- urban/rural township water sources;
- rural water sources for production;
- water storages;
- water carriers; and
- wastewater discharge.

13.1 Urban/Rural Township Water Sources

13.1.1 Background

Formally known as Proclaimed Water Supply Catchments, Special Water Supply Catchments (SWSCs) are the basis for catchment planning and management under the provisions of the *Catchment and Land Protection Act 1994*. Special water supply catchments provide water resources to a reservoir or water storage used primarily for domestic water supply purposes. For a complete listing of SWSCs in Victoria, refer to Appendix N.

13.1.2 Valuing Urban/Rural Township Water Sources

The condition of a SWSC is largely dependent on its catchment state i.e.whether the catchment is open or closed. Open refers to SWSCs where the land is privately managed over many titles by the rural community. Closed refers to SWSCs where the majority of land is managed by a single land manager.

AVIRA Metric – Urban/Rural Township Water Sources

Based on the above, Urban/Rural Township Water Source value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway forms part of a closed SWSC	Closed SWSC
4	Waterway forms part of an open SWSC	Open SWSC
3	Waterway is used to source water for urban/rural township but does not form part of a SWSC	Other Water Source
0	Waterway is not used to source water for urban/rural township	Not Used
Data Sources: Special Water Supply Catchments www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/landuse-water-supply-catchments Urban Water Authorities		

13.2 Rural Water Sources for Production

13.2.1 Background

Irrigation Districts

Irrigation accounts for more than 75% of consumptive water use in Victoria (DSE 2004a).

An Irrigation District is declared under the *Water Act 1989* and supplies water by channels and pipelines mainly for irrigation purposes.

Victoria's irrigation sector underpins the regional economies of many rural Victorian communities and produces $2.7 billion worth of agricultural produce (Australian Bureau of Statistics 2006 in DSE ~2008b).

For a complete listing of Irrigation Districts in Victoria, refer to Appendix O.

Other Purposes

Outside of irrigation districts, water from waterways is utilised either by:

- extraction under licence for irrigation, stock watering or other purposes; or
- direct access by stock for drinking.

13.2.2 Valuing Rural Water Sources for Production

Ryan and Marvenek (2004) noted that per megalitre of irrigation water in the Murray Darling Basin, the highest returns are obtained from those land uses that have high to moderate returns and lower water requirements per hectare including cut flowers, vegetables, fruit, grapes and tree nuts. The large water users (dairy, cotton and rice) have moderate returns per megalitre. Beef and sheep pasture, legumes, oilseeds etc. have low returns per megalitre because although they have low water requirements their returns are very low.

AVIRA Metric – Rural Water Sources for Production

Based on the above, Rural Water Source for Production value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Water source is used for horticulture (e.g.cut flowers, vegetables, fruit, grapes, tree nuts)	Horticulture
4	Water source is used for irrigated modified pastures	Irrigated Pasture
3	Water source is used for irrigated cropping, legumes, oilseeds, etc.	Crops
2	Water source is used for dryland stock watering	Stock Watering
0	Water source is not used for production	Not Used
Data Sources: Rural Water Authorities Department of Primary Industries Australian Land Use Mapping http://adl.brs.gov.au/mapserv/landuse/ Local knowledge		

13.3 Water Storages

13.3.1 Background

The high year-to-year and within-year variability of rivers in most Victorian basins means that large reservoirs are necessary to even out the fluctuations in river flow to provide a continuous and reliable water supply to towns and farms (DSE 2008c).

Surface waters are stored in a number of ways; the most common storages being:

- dams (which can be large (e.g.Lake Eildon), medium or small (e.g.farm dams)); and
- weirs (e.g.Charlton Weir).

13.3.2 Valuing Water Storages

In order to value waterways used to store water, the key measure was deemed to be the size of the storage. For a listing of Victorian storages and their capacities, refer to Appendix P.

AVIRA Metric – Water Storages

Based on the above, Water Storage value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway used to store water for rural and/or urban water supply (storage capacity >50,000ML)	Storage Capacity (ML)
4	Waterway used to store water for rural and/or urban water supply (storage capacity 10,000-50,000ML)	
3	Waterway used to store water for rural and/or urban water supply (storage capacity <10,000ML)	
0	Waterway is not used to store water for rural and/or urban water supply	Not Used
Data Source: *Victorian Water Accounts 2006-2007* (DSE 2008c) - refer to Appendix P Local knowledge		

13.4 Water Carriers

13.4.1 Background

Natural waterways are sometimes used as water carriers to distribute water to irrigation, industrial and urban users.

Irrigation reticulation systems consist of a variety of carriers including, constructed open channels (lined and unlined), natural streams and pipelines. In Victoria, 644km of natural waterways are used as carriers (ANRA 2009).

In addition, a number of rivers are used to transfer water from storages to urban townships (e.g.Moorabool River).

13.4.2 Valuing Water Carriers

The value of natural waterways as carriers is significant considering the resources that would be required to replicate their function using channels or pipe networks.

AVIRA Metric – Water Carriers

Based on the above, Water Carrier value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Natural waterway used as a carrier	Used
0	Natural waterway is not used as a carrier	Not Used
Data Sources: Rural Water Authorities Urban Water Authorities		

13.5 Wastewater Discharges

13.5.1 Background

The impact of wastewater discharges to inland waterways is attracting greater interest, particularly given predictions for a drier climate in the future. Impacts are often exacerbated by drought conditions, with low flows reducing the dilution of discharges. However, in other cases, the flow from some wastewater discharges can be an important contribution to waterway health, if they are of the right environmental quality and managed well (EPA Victoria ~2008c).

13.5.2 Valuing Wastewater Discharges

Whilst not ideal, waterways are often used to discharge a number of wastewater products including:

- treatment plant effluents;
- industrial waste; and
- irrigation runoff.

AVIRA Metric – Wastewater Discharges

Based on the above, Wastewater Discharge value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway used to discharge wastewater *	Used
0	Waterway is not used for wastewater discharge	Not Used
no data	Information on wastewater discharges is not available	No Data
Data Sources: EPA Victoria discharge licenses Rural Water Authorities – irrigation discharges		

* Stormwater discharges are not included in the above metric.

14 Power Generation

14.1 Hydro-Electricity

14.1.1 Background

Hydroelectricity is a well-developed renewable technology that uses the energy of flowing water to spin a turbine connected to a generator that produces electricity. The amount of electricity generated depends on the volume of water and the height of the water above the turbine. Large hydroelectric power stations need dams to store the water needed to produce the electricity. These dams are often built for irrigation or drinking water. Smaller hydro power stations, called mini or micro may not need dams but rely on naturally flowing water such as streams (Clean Energy Council 2007).

14.1.2 Valuing Hydro-Electricity

In order to value waterways contributing to the generation of hydro-electricity, the key measure was deemed to be the size of the generation facility i.e.the greater the electricity generated, the more valuable the feeding waterways.

For a listing of the main hydroelectric power stations operating in Victoria, refer to Appendix Q.

AVIRA Metric – Hydro-Electricity

Based on the above, Hydro-Electricity value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Waterway contributes to a large scale hydroelectric power station (>10MW capacity*)	Capacity (MW)
3	Waterway contributes to a small scale hydroelectric power station (100kW - 10MW capacity*)	
1	Waterway contributes to a micro hydro system (<100kW*)	
0	Waterway not used for hydroelectric power generation	0
Data Source: Victorian energy suppliers e.g.AGL Energy, Citipower, Powercor, TRUenergy, Origin Energy		

* Capacity rating distribution derived from Australian Institute of Energy (2003)

15 Other Resources

This category considers other resources made available from waterways; specifically:

- commercial fishing;
- extractive industries; and
- timber harvesting and firewood collection.

15.1 Commercial Fishing

15.1.1 Background

Eel Fishery

Victoria's eel industry produces on average 280 tonnes of short finned and long finned eel worth between $1.4 million and $4.7 million a year. There are 18 commercially licensed eel fishers in Victoria (DPI ~2008c). A list of the eel fishery licence locations taken from the *Eel Fishery Management Plan* (DNRE 2002f) is shown in Appendix S.

Other Fisheries

Other fisheries of relevance to AVIRA include:

- Corner Inlet - 18 Fishery Access Licences;
- Gippsland Lakes - 10 Fishery Access Licences, 10 Fishery Access Licences (Bait) and 2 Fishery Access Licences (Mussel Dive);
- Anderson Inlet and/or the lower reaches of the Tarwin River - several Fishery Access Licences (Bait – mainly pumping for sand worm) (DPI 2006c);
- Lake Tyers – 3 Fishery Access Licences (Bait – mainly prawn, shrimp and sandworm) (DPI 2007b); and
- Mallacoota Inlet – several Fishery Access Licences (Bait – mainly prawn and bass yabbies) (DPI 2006d).

15.1.2 Valuing Commercial Fishing

As commercial fishing requires the issuing of a licence, it is considered reasonable to assess commercial fishing value based on the licence information contained within the various fishery management plans.

However, commercial fishing activity should be confirmed with the local fisheries management officer (Arundel 2007).

AVIRA Metric – Commercial Fishing

Based on the above, Commercial fishing value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Commercially licensed fishery	Licensed
0	Not a commercially licensed fishery	Not Licensed
Data Sources: Fisheries Victoria *Eel Fishery Management Plan* (DNRE 2002f) *Anderson Inlet Fisheries Reserve Management Plan* (DPI 2006c) *Mallacoota Inlet Fisheries Reserve Management Plan* (DPI 2006d) *Lake Tyers Fisheries Reserve Management Plan* (DPI 2007b)		

15.2 Extractive Industries

15.2.1 Background

An extractive industry is defined as the removal or extraction of stone from land if the main purpose of that removal is for:

A. The sale or commercial use of the stone; or

B. Use in construction, building, road or manufacturing works.

Stone includes gravel, sand, building stone and clay.

Approval is required from the CMA where the extractive works will interfere with the bed or banks of a waterway, or within the floodplain inundation zone where the CMA has floodplain management functions.

Approvals are also required from Department of Primary Industries (DPI) under the *Extractive Industries Development Act 1995*, except where the depth of extraction is less than two metres below the natural surface and the total area of extraction is less than 2000 m^2 (Goulburn Broken CMA 2003).

15.2.2 Valuing Extractive Industries

Generally, extractive works within waterways will only be permitted if they are a component of a regional waterway management strategy, or it can be demonstrated to the CMA that there are clear net gains to the environment or stability of the waterway. For example, extraction may be permitted in cases where a build up of sand and gravel has occurred in a section of waterway, causing stream deviation or erosion (Goulburn Broken CMA 2003).

AVIRA Metric – Extractive Industries

Based on the above, Extractive Industry value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Sand, gravel, gypsum, salt or shellgrit extraction operations occur under CMA approval	Permitted
0	No sand, gravel, gypsum, salt or shellgrit extractions approved	Not Permitted
Data Source: CMA Works on Waterways Permits		

15.3 Timber Harvesting and Firewood Collection

15.3.1 Background

State forest is managed to balance a variety of uses and values. These include conserving flora and fauna, protecting water catchments and water supply, providing timber for sustainable forestry, protecting landscape, archaeological and historic values, and providing recreational and educational opportunities (DSE ~2008d).

VicForests is the Victorian government business with responsibility for the sustainable harvest and commercial sale of Victoria's valued forest timber in eastern Victoria. DSE remains responsible for the management and licensing of timber harvesting in State forests in western Victoria, and the sale of domestic firewood and some other minor forest produce throughout the State (DSE ~2008d).

15.3.2 Valuing Timber Harvesting and Firewood Collection

Timber harvesting is the harvesting of any tree, or part of any tree for the purpose of sale or processing and sale. This excludes harvesting firewood for personal (domestic) use (DSE ~2008d).

Permits are required for any commercial timber use and harvesting activities in Victoria's State forests. The *Sustainable Forest (Timber Harvesting) Regulations 2006* require anyone engaged in commercial timber harvesting in Victoria's State forests to hold a Timber Harvesting Operator's Licence (DSE ~2008d).

Permits are also required for domestic firewood collection.

AVIRA Metric – Timber Harvesting and Firewood Collection

Based on the above, Timber Harvesting and Firewood Collection value was scored using the following metric:

Value Score	Descriptor	Data Descriptor
5	Commercial timber harvesting operations occur under DSE permit OR within areas managed by VicForests	Commercial Harvesting
3	Firewood collection is permitted	Firewood Collection
0	No timber harvesting is permitted	No Harvesting
Data Source: DSE Forests - http://www.dse.vic.gov.au/dse/nrenfor.nsf/Home+Page/DSE+Forestry~Home+Page?open		

Part D Threats

The waterway threats identified for AVIRA have been categorised under the following groupings:

- Altered Water Regimes;
- Altered Physical Form;
- Poor Water Quality;
- Degraded Habitats;
- Invasive Flora and Fauna; and
- Reduced Connectivity.

These groupings are presented in the following sections.

16 Altered Water Regimes

Under this category, the following threats have been identified:

- For river reaches:
  - Altered Flow Regimes.
- For wetlands:
  - Changed Water Regime.
- For estuaries:
  - Altered Flow Regimes; and
  - Altered Marine Exchange.

These threats are described in the following sections.

16.1 River Reaches

16.1.1 Background

The harnessing of rivers to provide secure water supplies for towns and irrigation has had profound effects on the ecology of rivers, floodplains and estuaries. The introduction of dams and other regulating structures, of diversions from streams, of groundwater bores, and of small catchment dams have impacted on the natural flow regime of our rivers. Furthermore, water resource development is not the only activity that can impact on river hydrology. Changes in land use within catchments, such as land clearing and urbanisation, have also modified the water regimes within our rivers (DNRE 2002a).

16.1.2 Altered Flow Regimes

To determine the degree of hydrologic stress for Victorian Rivers, SKM (2005) developed a flow stress index that established a relative indication of threat to river health based on the level of water extractions by rural, urban, and industry users.

This index was derived from five (largely independent) indices:

- low flow index (the lowest and second lowest monthly flows in a year);
- high flow index (the highest and second highest monthly flows in a year);
- zero flow index (the proportion of time that the stream is dry (or nearly so));
- variability index (the variability in monthly streamflows); and
- seasonality index (the seasonal timing of when low and high flows occur).

These indices are scored between 0 (stressed) and 10 (pristine).

Analysis of these individual flow stress indicators provides useful information concerning the nature of flow stress to particular asset values. As such, five measures were selected to assess the threat of altered flow regimes as follows:

- Increase in Low Flow Magnitude;
- Reduction in High Flow Magnitude;
- Increase in Proportion of Zero Flow;
- Change in Monthly Streamflow Variability; and
- Altered Streamflow Seasonality.

These measures were then used to develop the following metrics.

AVIRA Metric – Increase in Low Flow Magnitude

Altering the magnitude of low flows changes the availability of instream habitat, which can lead to a long term reduction in the viability of populations of flora and fauna (SKM 2005). The Low Flow Index measures the change in low flow magnitude under current and unimpacted conditions (SKM 2005).

Threat Score	Descriptor	Data Descriptor
5	Low Flow Index Score 0.0 - 2.0	Low Flow Score
4	Low Flow Index Score 2.1 - 4.0	
3	Low Flow Index Score 4.1 - 6.0	
2	Low Flow Index Score 6.1 - 8.0	
1	Low Flow Index Score 8.1 – 10.0	
No data	Methodology to derive flow stress index has not been applied	-1
Data Source: 3ISC Hydrology Sub-Index		

AVIRA Metric – Reduction in High Flow Magnitude

High flows act as a natural disturbance in river systems, removing vegetation and organic matter and resetting successional processes (SKM 2005). The High Flow Index measures the change in high flows under current and unimpacted conditions (SKM 2005).

Threat Score	Descriptor	Data Descriptor
5	High Flow Index Score 0.0 - 2.49	High Flow Score
4	High Flow Index Score 2.5 - 4.49	
3	High Flow Index Score 4.5 - 6.49	
2	High Flow Index Score 6.5 - 8.49	
1	High Flow Index Score 8.5 – 10.0	
No data	Methodology to derive flow stress index has not been applied	-1
Data Source: 3ISC Hydrology Sub-Index		

AVIRA Metric – Increase in Proportion of Zero Flow

Periods of zero flow are a natural feature of ephemeral rivers and creeks; however increases in the natural duration of cease to flow periods are regarded as harmful to aquatic ecosystems (SKM 2005). The Zero Flow Index simply reflects the differences in the proportion of zero flow occurring under unimpacted and current conditions (SKM 2005).

Threat Score	Descriptor	Data Descriptor
5	Zero Flow Index Score 0.0 - 2.0	Zero Flow Score
4	Zero Flow Index Score 2.1 - 4.0	
3	Zero Flow Index Score 4.1 - 6.0	
2	Zero Flow Index Score 6.1 - 8.0	
1	Zero Flow Index Score 8.1 – 10.0	
No data	Methodology to derive flow stress index has not been applied	-1
Data Source: 3ISC Hydrology Sub-Index		

AVIRA Metric – Change in Monthly Streamflow Variability

The Variability index measures variability across all months between current and unimpacted conditions (SKM 2005).

Threat Score	Descriptor	Data Descriptor
5	Variability Index Score 0.0 - 2.0	Variability Score
4	Variability Index Score 2.1 - 4.0	
3	Variability Index Score 4.1 - 6.0	
2	Variability Index Score 6.1 - 8.0	
1	Variability Index Score 8.1 - 10.0	
No data	Methodology to derive flow stress index has not been applied	-1
Data Source: 3ISC Hydrology Sub-Index		

AVIRA Metric – Altered Streamflow Seasonality

The timing of periods of flooding and low flows has an important influence on how floodplain and riverine ecosystems respond (SKM 2005). The Seasonality Index provides a measure of the shift in the timing of the maximum flow month and the minimum flow month under both unimpacted and current conditions (SKM 2005).

Threat Score	Descriptor	Data Descriptor
5	Seasonality Index Score 0.0 - 2.49	Seasonality Score
4	Seasonality Index Score 2.5 - 4.49	
3	Seasonality Index Score 4.5- 6.49	
2	Seasonality Index Score 6.5 - 8.49	
1	Seasonality Index Score 8.5 - 10.0	
No data	Methodology to derive flow stress index has not been applied	-1
Data Source: 3ISC Hydrology Sub-Index		

16.2 Wetlands

16.2.1 Background

Hydrology is considered a key variable of wetland ecosystems, driving the development of wetland soils and leading to the development of the biotic communities (Mitsch and Gosselink 2000 in DSE 2005c).

Activities with the potential to cause a change in water regime are those that:

- change the flow regime of the water source of the wetland;
- interfere with the natural connectivity of flow to and from the wetland;
- involve disposal of water into the wetland or extraction of water from the wetland; and
- change wetland depth and, therefore, alter the duration of inundation by changing the rate of evaporation (DSE 2005c).

16.2.2 Changed Water Regime

To determine the severity of effect of activities that change the water regime of a wetland, the IWC Field Assessment Sheet lists the following key steps (refer to DSE 2008e):

1. Determine the primary water source for the wetland (river or stream, surface runoff, groundwater, artificial channel).
2. Determine activities that change the wetland's water regime.
3. Determine the severity of the effect of the activities on the water regime components (seasonality, duration, frequency).
4. Estimate the collective severity of effect of the activities.

Whilst this approach is subjective, it does provide useful information to assessing both threat type and source beyond simple evidence of flow stress.

AVIRA Metric – Changed Water Regime

Based on the above, Changed Water Regime threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	IWC Hydrology Sub-Index Score: 0	IWC Hydrology Score
3	IWC Hydrology Sub-Index Score: 5 - 15	
1	IWC Hydrology Sub-Index Score: 20	
no data	IWC methodology to identify changed water regime has not been applied	-1
Data Source: IWC Hydrology Sub-Index		

Additional Information

Whilst the above metric provides an overview of the degree of water regime change for a particular wetland, additional IWC information was available that better defines the specific activities that have changed the wetland water regime. This information can be accessed through the IWC database (website: http://iwc/iwc/dms/welcome) and includes the following:

Activities that Change the Wetland Water Regime	Present	Not Present
River regulation (applicable to wetlands fed by rivers or streams)		
Activities that change surface drainage patterns (applicable to wetlands fed by local surface runoff)		
Activities that change groundwater levels (applicable to wetlands fed by groundwater)		
Regulation not associated with maintaining or restoring reference condition (applicable to wetlands fed by artificial channels)		
Obstruction or regulation of natural water inlets		
Obstruction or regulation of natural water outlets		
Drainage of water from the wetland		
Disposal of water into wetland		
Extraction of water directly from the wetland		
Permanently raised water level		

16.3 Estuaries

16.3.1 Background

Estuaries are defined as places where fresh and marine waters meet and the salinity regime is a key physical factor that influences estuarine ecology. Changes to the relative amounts and timing of

these waters entering an estuary can alter the fundamental nature of an estuary (Arundel et al 2008).

Therefore, changes to either freshwater or marine inputs can alter many aspects of the physical and chemical environment of estuaries e.g.salinity regimes, biological connectivity.

To assess the level of threat posed to estuaries by altered hydrologic processes, two measures were used:

- Altered Flow Regimes; and
- Altered Marine Exchange.

16.3.2 Altered Flow Regimes

To describe the threat of altered flow regimes to estuaries, the same five metrics as described for river reaches were used (refer to Section 15.1.2), ie:

- Increase in Low Flow Magnitude;
- Reduction in High Flow Magnitude;
- Increase in Proportion of Zero Flow;
- Change in Monthly Streamflow Variability; and
- Altered Streamflow Seasonality.

It should be noted however, that direct translation of scores from the 3ISC should be used with caution as no specific assessment of their relationship to estuarine condition has been made (Arundel et al 2008). A Victorian method for determining freshwater flow requirements of estuaries is currently under development (the Estuary Environmental Flows Assessment Methodology – EEFAM). When available, results of EEFAM assessments should be used to inform these metrics.

Also, at present, approximately one third of estuaries do not have populated datasets for the 3ISC Hydrology Sub-Index. Therefore, to ensure consistency across all estuaries, it is recommended that the methodology to derive flow stress indices for the 3ISC Hydrology Sub-index be applied to all waterways directly linked to estuaries.

16.3.3 Altered Marine Exchange

In Victoria intermittent estuary entrances are often artificially opened to prevent inundation of low-lying land and structures. This can cause major changes to the ecology of a system over both the short and long term.

Based on the recommendations of Arundel et al (2008), two metrics for altered marine exchange were used:

- Altered Marine Exchange (Intermittently Open Estuaries)
- Altered Marine Exchange (Permanently Open Estuaries)

AVIRA Metric – Altered Marine Exchange (Intermittently Open Estuaries)

Threat Score	Descriptor	Data Descriptor
5	>50% of all estuary mouth openings* are artificial with non-environmental objectives	>50% Artificial Openings
4	25% -50% of all estuary mouth openings* are artificial with non-environmental objectives	25% -50% Artificial Openings
3	<25% of all estuary mouth openings* are artificial with non-environmental objectives	<25% Artificial Openings
0	No artificial estuary mouth openings* occur with non-environmental objectives	None OR Permanently Open
no data	Type and/or number of estuary mouth openings is unknown	No data

Data Sources:

CMA Works on Waterways Licences

Local knowledge. Data requires record of all openings (over entire reporting cycle) and whether natural or artificial.

* The height at which the mouth is opened is also a key factor. However, further work is required to determine the severity of impact at various elevations for different estuary types. Once this work is completed, the above scores may alter to combine heights in a matrix that weights artificial openings at various elevations.

AVIRA Metric – Altered Marine Exchange (Permanently Open Estuaries)

Threat Score	Descriptor	Data Descriptor
5	Dredging of the estuary mouth occurs OR Training walls have been constructed at the estuary mouth	Altered
0	Dredging of the estuary mouth does not occur AND No training walls have been constructed at the estuary mouth	Not Altered OR Intermittently Open

Data Source:

Local knowledge

17 Altered Physical Form

Under this category, the following threats have been identified:

- For river reaches:
  - Bank Instability; and
  - Bed Instability (Degradation).
- For wetlands:
  - Reduced Wetland Area; and
  - Altered Wetland Form.
- For estuaries:
  - Bank Instability; and
  - Reduced Estuary Extent.

These threats are described in the following sections.

17.1 River Reaches

Most natural streams have developed a grade, shape and planform which balance the variable inputs of water and sediment (Melbourne Water ~2009). However, as a result of European settlement and development, many streams have been destabilised, sometimes resulting in significant channel changes; most notably:

- Bank Instability; and
- Bed Instability (Degradation).

17.1.1 Bank Instability

The common causes of bank erosion and failure modes include:

- direction and velocity of stream flow causing bank failure by direct removal of bank material, undermining or by slip circle failure where the toe has been eroded;
- susceptibility of bank material to both surface water and ground water flow;
- reduction of the cohesive strength of bank material (bank slumping);
- rapid drawdown of water levels, such as after high flow conditions, causing bank slumping or slip circle failure depending on soil types;
- instream flow obstructions such as willows, fallen trees, bridge piers or culverts;
- bed deepening usually resulting in toe undermining and subsequent bank collapse;
- over bank flows leaving or re-entering the main waterway causing bank failure by the direct removal of bank material; and
- lack of bank vegetation increasing the risk of bank failure (Melbourne Water ~2009).

The 3ISC Physical Form Sub-Index includes a bank condition indicator to determine bank stability.

AVIRA Metric – Bank Instability

Based on the above, Bank Instability threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Greater than 33% of reach is eroding 3ISC Bank Condition Indicator Rating – 1	3ISC Bank Condition Score
4	19-33% of reach is eroding 3ISC Bank Condition Indicator Rating – 2	
3	10-19% of reach is eroding 3ISC Bank Condition Indicator Rating – 3	
2	2-10% of reach is eroding 3ISC Bank Condition Indicator Rating – 4	
1	Less than 2% of reach is eroding 3ISC Bank Condition Indicator Rating – 5	
Data Source: 3ISC Bank Condition Indicator		

17.1.2 Bed Instability (Degradation)

Numerous Victorian streams dramatically deepened and widened following European settlement. New channels (gullies) formed in depressions that did not have defined channels before. Also, many streams catastrophically deepened by several metres (known as valley floor incised streams). Both types of incised stream are a major source of nutrient and sediment.

Many of these incised streams have now stabilised, and are beginning to recover. Recovery is characterised by an absence of knickpoints in the bed, reducing sediment yield and stable banks that are progressively battering-back to a low angle.

AVIRA Metric – Bed Instability (Degradation)

Although streams can incise naturally, they became ubiquitous after European settlement. Stream bed incision (also known as stream bed degradation) is often a response to increases in runoff from changes in land use, or more commonly, concentration of flow by digging drains.

Incised streams are a threat to:

a) higher value upstream reaches, because knickpoints (and degradation) will migrate upstream;

b) higher value downstream reaches because coarse sediment will accumulate downstream, filling pools, and simplifying morphology;

c) higher value downstream reaches where fine grained sediment will affect water quality (e.g.algal blooms); and/or

d) the immediate reach due to widening and damage to adjoining riparian land.

DSE (2007c) cites a number of distinct stages associated with the process of channel incision. These are:

1. **Relatively stable system.** Comprises cut and fill system subject to geological timescale incision and infill processes.
2. **Initiation of instabilities.** Swamp drained, channel excavated.
3. **Degradation.** Channel bed degrades. Sediment stripped from bed and moved downstream.
4. **Degradation and widening.** Channel degradation steepens the banks, and increases their height. Banks begin to fail and collapse, and channel widens. Sediment begins to accumulate in the channel bed.
5. **Aggradation and widening.** Banks continue to fail. Channel widens by basal undercutting.
6. **Recovery.** A sinuous low-flow channel forms within the trench formed by the incision of the channel. Benches form within the trench, producing a new floodplain (grasses begin to stabilise the channel bed; sediment accumulates either side of the sinuous low flow channel). Vegetation stabilisation.

Based on the above, Bed Instability (Degradation) threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Bed instability recently initiated. *Typical Features:* recent channel disturbance, raw, vertical banks, presence of minor knickpoints (<1m deep), bed locally cut to clay or rock; incision occurs in minor floods.	Recent Bed Deg
4	Active bed degradation. *Typical Features:* channel deepening occurring with major knickpoints (>1m deep), no significant channel widening.	Active Bed Deg
3	Bed degradation and channel widening. *Typical features:* bed continues to deepen (but at a reduced rate – and during larger floods rather than minor floods), channel banks collapsing, channel widening.	Bed Deg Channel Widening
2	Bed aggradation and widening. *Typical Features:* sediment beginning to accumulate in the channel bed, no active knickpoints, banks continue to fail.	Bed Agg Channel Widening
1	Relatively stable or recovered system.	Stable
no data	Bed stability of waterway is unknown	No data
Data Sources:* Sediment River Network Model (SedNet)** Fluvial Geomorphological studies Local knowledge		

* The 3ISC does not include a bed instability measure as it was deemed to be too variable and difficult to determine in the field at a single point in time. Although no state-wide dataset exists, bed stability remains a significant impact. As such it is recommended that the metric is scored in the regions by CMAs, rather than at State level from a data base.

**SedNet identifies sources and sinks of sediment and nutrients in river networks and predicts spatial patterns of erosion and sediment load.

Note: the same sequence and scoring can be used to score potential avulsions on floodplains (these go through similar 'stages'). An example is Deep Creek on the Ovens River – a major potential source of sediment to the river.

17.2 Wetlands

Wetland area and bathymetry are the principal components of physical form (DSE 2005c). The key threats to physical form are:

- reduction in wetland area (through drainage or infilling); and
- alteration in wetland form – depth, shape, bathymetry (through excavation, landforming or sedimentation).

Such threats can result in changes to the availability of wetland habitats for biota and changes to wetland depth, which affects the duration of inundation (DSE 2005c, DSE 2006b).

The IWC includes two threat measures for physical form:

- the percentage reduction in wetland area; and
- the percentage of the wetland where activities have resulted in a change in bathymetry.

17.2.1 Reduced Wetland Area

To determine the reduction in wetland area, the IWC estimates the percentage reduction in area (by comparing original to current boundaries).

AVIRA Metric – Reduced Wetland Area

Based on the above, Reduced Wetland Area threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>75% reduction in wetland area	>75%
4	>50 to 75% reduction in wetland area	>50–75%
3	>25 to 50% reduction in wetland area	>25-50%
2	>5 to 25% reduction in wetland area	>5-25%
1	0 to 5% reduction in wetland area	0-5%
no data	IWC methodology to identify reduced wetland area has not been applied	no data
Data Source: IWC Physical Form Sub-Index		

17.2.2 Altered Wetland Form

Possible measures of 'altered wetland form' assessed by DSE (2006a) as part of the IWC included:

- Wetland bathymetry;
- Depth of wetland (maximum water depth); and
- Percentage of wetland where activities (excavation and landforming) have resulted in a change in bathymetry.

The only practical measure of altered wetland form was considered to be the percentage of wetland where activities (excavation and landforming) result in a change in bathymetry. These activities can

cause significant changes in depth (e.g.digging of channels or dams) or natural form of the bed (e.g.laser levelling, raised-bed cropping or building of mounds) (DSE 2005c).

To determine the percentage of wetland where activities have resulted in a change in bathymetry, the IWC identifies the presence of activities that change wetland bathymetry and estimates the percentage of the wetland where form has changed by such activities.

AVIRA Metric – Altered Wetland Form

Based on the above, that Altered Wetland Form threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>75% of wetland form altered by excavation or land forming activities	>75%
4	>50–75% of wetland form altered by excavation or land forming activities	>50–75%
3	>25-50% of wetland form altered by excavation or land forming activities	>25-50%
2	>5-25% of wetland form altered by excavation or land forming activities	>5-25%
1	0-5% of wetland form altered by excavation or land forming activities	0-5%
no data	IWC methodology to identify altered wetland form has not been applied	no data
Data Source: IWC Physical Form Sub-Index		

17.3 Estuaries

To assess the level of threat posed to estuaries by altered physical form, two measures were selected:

- Bank Instability; and
- Reduced Estuary Extent.

17.3.1 Bank Instability

To describe the threat of bank instability to estuaries, the 2ISC data descriptors were used.

Ultimately, scoring should be interpreted in context of the type of estuary and the influence of other sediment sources in the estuary (e.g.not just a move to a new equilibrium in response to a reduction in sediment supply).

Threat Score	Descriptor	Data Descriptor
5	Extreme erosion. Typical features: unstable toe of bank; no woody vegetation; very recent bank movement (trees may have recently fallen into stream); steep bank surface; numerous exposed roots of woody vegetation; erodible soils. (2ISC Bank Condition Indicator Rating – 0)	2ISC Bank Condition Indicator Rating
4	Extensive erosion. Typical features: mostly unstable toe of the bank; little woody vegetation many exposed roots of woody vegetation. (2ISC Bank Condition Indicator Rating – 1)	
3	Moderate erosion. Typical features: some bank instabilities that extend to the toe of the bank (which is generally stable); discontinuous woody vegetation; some exposure of roots of woody vegetation. (2ISC Bank Condition Indicator Rating – 2)	
2	Limited erosion. Typical features: some isolated bank instabilities, though generally not at the toe of the bank; cover of woody vegetation is nearly continuous; few exposed roots of woody vegetation. (2ISC Rating – 3)	
1	Stable. Typical features: very few local bank instabilities, none of which are at the toe of the bank' continuous cover of moody vegetation; gently batter; very few exposed roots of woody vegetation; erosion resistant soils. (2ISC Bank Condition Indicator Rating – 4)	
No data	The 2ISC methodology to identify the bank condition score has not been applied.	-1

Data Source:

IEC Bank Stability Rating using 2ISC

17.3.2 Reduced Estuary Extent

Artificial barriers can reduce the diversity of estuarine habitat by preventing upstream movement of salt water. The threat severity is related to presence/absence of a barrier and the distance of the barrier downstream from the 'natural' head of the estuary (Arundel et al 2008). As such, the threat of reduced estuary extent was determined from two measures:

- Barrier Characteristics; and
- Barrier Proximity.

Measure 1 – Barrier Characteristics

Descriptor	Data Descriptor
Artificial barrier completely blocks the movement of water (in a typical year)	Complete
Artificial barrier interferes (intermittently or selectively) with the movement of water (in a typical year)	Partial
No artificial barrier occurs within the estuary	None

Measure 2 – Barrier Proximity

Descriptor	Data Descriptor
>50% of the estuary is affected by an artificial barrier	Lower
>25-50% of the estuary is affected by an artificial barrier	Mid
1-25% of the estuary is affected by an artificial barrier	Upper
No artificial barrier occurs within estuary	None

Rating Table

Total Area of Estuary Affected by an Artificial Barrier	Barrier Characteristics		
	No artificial barrier exists	Artificial barrier interferes (intermittently or selectively) with the movement of water (in a typical year)	Artificial barrier completely blocks the movement of water (in a typical year)
>50%	0	4	5
>25-50%	0	3	4
1-25%	0	2	4

AVIRA Metric – Reduced Estuary Extent

Based on the above, Reduced Estuary Extent was scored using the following metric:

Threat Score	Descriptor
5	>50% of the estuary is affected by an artificial barrier that completely blocks the movement of water (in a typical year)
4	1 to 50% of the estuary is affected by an artificial barrier that completely blocks the movement of water (in a typical year) OR >50% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year)
3	>25 to 50% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year)
2	1 to 25% of the estuary is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of water (in a typical year)
0	No artificial barrier occurs within the estuary
Data Source: IEC Physical Form Sub Index Local knowledge	

18 Poor Water Quality

Under this category, the following threats have been identified:

- For river reaches:
  - Degraded Water Quality;
  - Thermal Water Pollution; and
  - Disturbance of Acid Sulfate Soils.
- For wetlands:
  - Changed Water Properties; and
  - Disturbance of Acid Sulfate Soils.
- For estuaries:
  - Degraded Water Quality; and
  - Disturbance of Acid Sulfate Soils.

These threats are described in the following sections.

18.1 River Reaches

18.1.1 Background

Key threats to riverine ecosystems from poor water quality include rising salinity, increasing sediment and nutrient loads, changing pH and temperature levels, and reduced dissolved oxygen (DNRE 2002a). Significant deviation of these parameters from 'natural' levels can result in ecosystem degradation and may impact environmental qualities and beneficial uses (EPA Victoria 2003).

To assess the threat posed to river values from poor water quality, three measures were selected:

- Degraded Water Quality;
- Thermal Water Pollution;
- Disturbance of Acid Sulfate Soils.

18.1.2 Degraded Water Quality

Six measures were identified to determine the threat severity posed by degraded water quality:

- SIGNAL objectives;
- EPA Victoria water quality objectives at Victorian Water Quality Monitoring Network (VWQMN) sites;
- EPA Victoria water quality objectives using Waterwatch data;
- Algal blooms;
- Fish kills; and
- Excessive instream plant growth.

Measure 1 – SIGNAL Objectives

SIGNAL stands for 'Stream Invertebrate Grade Number – Average Level.' It is a simple scoring system for macroinvertebrate samples from Australian rivers.

A SIGNAL score gives an indication of water quality in the river from which the sample was collected. Rivers with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorus. They are also likely to be high in dissolved oxygen.

The biotic index SIGNAL has been accepted and used nationally in stream assessments. The output is a single number, between zero and ten, reflecting the degree of water pollution - high quality sites have high SIGNAL scores. While SIGNAL is particularly good for assessing organic pollution, its usefulness for toxic impacts and other types of disturbance is less certain (Metzeling et al 2004).

EPA Victoria has developed objectives for biological indicators of environmental quality (including SIGNAL) within the SEPP WoV. Appendix J provides information on how SIGNAL data was applied to AVIRA.

Descriptor	Data Descriptor
Fails to meet SIGNAL objective in SEPP (WoV)	Fails SEPP (WoV)
Meets SIGNAL objective in SEPP (WoV)	Meets SEPP (WoV)
No SIGNAL data is available for the reach	No data

Measure 2 – EPA Victoria Water Quality Objectives at VWQMN Sites

The VWQMN was established in 1975 to collect information on the State's water resources. The VWQMN currently monitors 155 river and stream sites throughout Victoria.

The physical and chemical parameters measured most regularly at each site are discharge, dissolved oxygen, electrical conductivity, pH, total phosphorus, total nitrogen and turbidity. This data is stored on the Victorian Water Resource Data Warehouse and describes long-term water quality trends

Water quality objectives for individual indicators are set by EPA Victoria for defined segments in SEPP (WoV) according to beneficial uses. Appendix K provides information on how VWQMN site data was applied in AVIRA.

Descriptor	Data Descriptor
Fails to meet two or more EPA Victoria water quality objectives at VWQMN site	Fails 2 or More
Fails to meet one EPA Victoria water quality objective at VWQMN site	Fails 1
Meets all EPA Victoria water quality objectives at VWQMN site	Meets All
Reach does not include a VWQMN site	No data

Measure 3 – EPA Victoria Water Quality Objectives using Waterwatch Data

Waterwatch is a national community-based monitoring network that aims to involve community groups and individuals in the protection and management of waterways. Waterwatch Victoria has the dual objectives of catchment education and water quality monitoring.

The significant spatial coverage of the Waterwatch water quality monitoring value-adds to other monitoring programs such as the VWQMN.

The key water quality parameters monitored by Waterwatch volunteers are turbidity, electrical conductivity, temperature, reactive phosphorus and pH.

Waterwatch Victoria has recently developed a State-wide Data Confidence Framework and Guidelines, identifying minimum data confidence standards for a range of monitoring purposes. The framework and guidelines were developed to ensure that water quality data collected by Waterwatch groups is recognised, valued and utilised to the greatest degree possible.

There are four standards within the framework:

- Standard 1 – Education focus;
- Standard 2 – Education "Indicative" Data;
- Standard 3 – "High Quality" Data Collection Focus, Educational Benefits; and
- Standard 4 –Data Warehouse focus.

Standards 3 and 4 have strong Quality Assurance/Quality Control procedures in place and are considered to provide an accurate indication of water quality trends. Appendix K provides information on how Waterwatch data was applied in AVIRA.

Descriptor	Data Descriptor
Fails to meet two or more EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)	Fails 2 or More
Fails to meet one EPA Victoria water quality objective using Waterwatch data (standard 3 or 4)	Fails 1
Meets all EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)	Meets All
No Waterwatch data is available for the reach	No data

Measure 4 – Algal Blooms

Algae are a common seasonal occurrence in Victoria and a natural component of most aquatic systems, including streams, lakes, estuaries and the sea. However, under certain environmental conditions, numbers can increase rapidly and blooms become easily visible across the water surface. Many factors trigger algal blooms including, but not limited to, nutrient levels, low inflows, low storage volumes and warm weather conditions.

Descriptor	Data Descriptor
Algal blooms occur every 1 to 2 years (on average)	1 to 2 years
Algal blooms occur every 3 to 10 years (on average)	3 to 10 years
No algal blooms are known to have occurred in the last 10 years	More than 10 years
Algal bloom occurrence in the last 10 years is unknown	No data

Measure 5 – Fish Deaths

The deaths of large numbers of fish are reported in Victorian waterways from time to time. The cause of the deaths often relates to environmental stresses such as low flow conditions, elevated water temperatures, or on occasions, pollution (EPA Victoria ~2009).

Descriptor	Data Descriptor
Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average)	1 to 2 years
Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average)	3 to 10 years
No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years	More than 10 years
Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown	No data

Measure 6 – Excessive Instream Macrophyte Growth

Excessive emergent and submerged macrophyte growth can result when the light, temperature and nutrient levels of streams are elevated. As such, they can be a useful indicator of poor water quality, in the absence of other data.

Descriptor	Data Descriptor
>25% of the reach has excessive instream macrophyte growth	>25%
5-25% of the reach has excessive instream macrophyte growth	5-25%
<5% of the reach has excessive instream macrophyte growth	<5%
Extent of excessive instream macrophyte growth is unknown	No data

AVIRA Metric – Degraded Water Quality

Based on the above, Degraded Water Quality for river reaches was scored using the following metric:

Threat Score	Descriptor

5	Fails to meet SIGNAL objective in SEPP (WoV)
	IF NO SIGNAL DATA THEN
	Fails to meet two or more EPA Victoria water quality objectives at VWQMN site
	IF NO VWQMN SITE THEN
	Fails to meet two or more EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)
	IF NO WATERWATCH DATA THEN
	Algal blooms occur every 1 to 2 years (on average)
	OR
	Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average)
	OR
	>25% of the reach length has excessive instream macrophyte growth

3	Fails to meet one EPA Victoria water quality objective at VWQMN site
	IF NO VWQMN SITE THEN
	Fails to meet one EPA Victoria water quality objective using Waterwatch data (standard 3 or 4)
	IF NO WATERWATCH DATA THEN
	Algal blooms occur every 3 to 10 years (on average)
	OR
	Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average)
	OR
	5-25% of the reach length has excessive instream macrophyte growth

AVIRA Metric – Degraded Water Quality (cont.)

Threat Score	Descriptor

1	Meets SIGNAL objective in SEPP (WoV)
	IF NO SIGNAL DATA THEN
	Meets all EPA Victoria water quality objectives at VWQMN site
	IF NO VWQMN SITE THEN
	Meets all EPA Victoria water quality objectives using Waterwatch data (standard 3 or 4)
	IF NO WATERWATCH DATA THEN
	No algal blooms are known to have occurred in the last 10 years
	AND
	No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years
	AND
	<5% of the reach length has excessive instream macrophyte growth

no data	No SIGNAL data is available for the reach AND Reach does not include a VWQMN site AND No Waterwatch data is available for the reach AND Algal bloom occurrence in the last 10 years is unknown AND Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown AND Extent of excessive instream macrophyte growth is unknown
Data Sources: EPA Victoria databases Victorian Water Resources Data Warehouse http://www.vicwaterdata.net/vicwaterdata/home.aspx Waterwatch databases Local knowledge	

18.1.3 Thermal Water Pollution

Water temperature is a vital physical characteristic of rivers and streams.

Thermal water pollution can have a profound adverse impact on native warm water fish communities both directly and indirectly, including slower growth rates, cold water shock, disruption of breeding cycles and increased egg and fingerling mortality (DNRE 2002a).

The main causes of thermal pollution are:

- the release of cold water from dams which have offtakes or outlets set deep in the water; and
- the release of warm water (at higher temperatures than the receiving waters) from industrial cooling processes.

Three measures have been identified to assess thermal water pollution:

Measure 1 – Thermal Impact from Dam Releases (Evidence Based)

Descriptor	Data Descriptor
Clear evidence of thermal impact from dam releases (based on monitoring program)	Clear Evidence
Inconclusive thermal impact from dam releases (based on monitoring program)	Inconclusive
No thermal impact from dam releases (based on monitoring program)	No Impact

Measure 2 – Thermal Impact from Industrial Coolant

Descriptor	Data Descriptor
Clear evidence of thermal impact from industrial coolant water releases (based on monitoring program)	Clear Evidence
Industrial coolant water released but thermal impact is unknown	Unknown
No industrial coolant water is released into the reach	No Impact

Measure 3 – Thermal Impact from Dam Releases (Suspected)

Descriptor	Data Descriptor
Suspected thermal water pollution from dam release (listed as a high priority for dam release temperature research) but impact is unknown	High Priority
Suspected thermal water pollution from dam release (listed as a medium priority for dam release temperature research) but impact is unknown	Medium Priority
Suspected thermal water pollution from dam release (listed as a low priority for dam release temperature research) but impact is unknown	Low Priority
No dam OR Dam does not discharge to natural streams	No Impact

AVIRA Metric – Thermal Water Pollution

Based on the above, Thermal Water Pollution threats were scored using the following metric:

Threat Score	Descriptor
5	Monitoring program undertaken AND clear evidence of thermal impact from dam releases OR Clear evidence of thermal impact from industrial coolant water releases (based on monitoring program)
4	Monitoring program undertaken AND inconclusive thermal impact from dam releases OR Suspected thermal water pollution from dam release (listed as a high priority for dam release temperature research) AND thermal impact not assessed OR Industrial coolant water released but thermal impact is unknown
3	Suspected thermal water pollution from dam release (listed as a medium priority for dam release temperature research) AND thermal impact not assessed
2	Suspected thermal water pollution from dam release (listed as a low priority for dam release temperature research) AND thermal impact not assessed
0	No dam OR Dam does not discharge to natural streams OR Monitoring program undertaken AND no thermal impact from dam releases AND No industrial coolant water is released into the reach
Data Sources: *Temperature Monitoring of Dam Releases in Victorian Rivers 2002-2007* (SKM 2008) *Status of Cold Water Releases from Victorian Dams* (Ryan et al 2001) EPA Victoria databases	

18.1.4 Disturbance of Acid Sulfate Soils

Acid sulfate soils occur naturally in both coastal and inland settings. Left undisturbed these soils are harmless, however when sulfidic material in acid sulfate soils is disturbed and exposed to air, an oxidation process occurs and sulfuric acid is produced (Department of Sustainability and Environment 2009a).

Sulfuric acid has the potential to mobilise heavy metals such as arsenic and aluminium which may be dissolved in the soil. The combination of sulfuric acid and heavy metals can have severely detrimental effects on land and water, including:

- Acidification of waterways, wetlands, and estuaries which leads to massive fish kills. In turn, deoxygenation of the water can lead to toxic algal blooms.
- Degradation of the ecology of wetlands, shallow freshwater and brackish aquifer systems through loss of water quality, degradation of habitat and decline in dependent ecosystems.
- Adverse impacts on commercial and recreational fisheries and rural productivity.
- Corrosion of concrete and steel infrastructure, such as foundations and footings, culverts, pipes (including drinking water conduits), bridges and floodgates, reducing their functional life span.
- Immediate detrimental human health effects such as skin and eye irritations and burns.
- Loss of high recreational and environmental value.
- Irreversible change to landforms and soils (Department of Sustainability and Environment 2009a).

Identifying Risk Areas

Two reports are readily available that can assist in the identification of risk areas for acid sulphate soils:

- the Victorian Coastal Acid Sulfate Soils Strategy (Department of Sustainability and Environment 2009a): and
- the Acid Sulfate Soils in the Murray–Darling Basin report (Murray-Darling Basin Authority 2009).

The *Victorian Coastal Acid Sulfate Soils Strategy* has identified and mapped land that potentially contains coastal acid sulphate soils. Coastal acid sulphate soils are generally found in low lying areas within coastal plains and along the edges of water bodies. This includes flood plains and lower slopes, abandoned river meanders and oxbow lakes, swamps (including backswamps, peat swamps and reclaimed swamps), morasses, beaches, coastal dunes and swales and tidal flats (Department of Sustainability and Environment 2009a).

The purpose of the *Acid Sulfate Soils in the Murray–Darling Basin report* was to determine the spatial occurrence of, and risk posed by, acid sulfate soils at priority wetlands in the River Murray system, wetlands listed under the Ramsar Convention on Wetlands of International Importance (excluding the Coorong and Lower Lakes) and other key environmental sites in the Murray–Darling Basin. In Victoria, waterways found to contain acid sulfate soils at levels of concern were located in appear localised around Mildura and in some areas impacted by dryland salinity. Of the Ramsar-listed wetlands, acid sulfate soils were found at levels that present a medium to high acidification, deoxygenation and/or metal release hazard at some lakes in the Kerang Wetlands (Murray-Darling Basin Authority 2009).

AVIRA Metric – Disturbance of Acid Sulfate Soils

Based on the above, Disturbance of Acid Sulfate Soils was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Adjacent land has the potential to contain Coastal Acid Sulfate Soils OR Inland waterway is at high risk from acid sulfate soils	ASS
0	Adjacent land does not contain Coastal Acid Sulfate Soils OR Inland waterway is not at high risk from acid sulfate soils	No ASS
no data	Waterway occurs in an area where no acid sulfate soil assessments have been completed	No data
Data Sources: Areas mapped in the Victorian Coastal Acid Sulfate Soils Strategy (Department of Sustainability and Environment 2009a) *Acid Sulfate Soils in the Murray–Darling Basin* report (Murray-Darling Basin Authority 2009)		

18.2 Wetlands

18.2.1 Changed Water Properties

Poor water quality can be attributed to a range of land use activities in the wetland (e.g.livestock grazing, feral animals, aquaculture) and its catchment (e.g.clearing of vegetation, land uses such as agriculture or urbanisation, fire, poor irrigation practices, point source discharges) and may be manifested by changes in several physical and chemical water properties. Nutrient enrichment, salinisation and turbidity are of particular concern in Victoria's wetlands (DSE 2005c).

The IWC includes a Water Properties Sub-Index that considers threat measures for nutrients and electrical conductivity, in particular:

- activities leading to an input of nutrients to a wetland; and
- factors likely to lead to secondary salinisation of a wetland, in particular:
  - saline water inputs to a wetland; and/or
  - a wetland occurring in a salinity risk area.

AVIRA Metric – Changed Water Properties

Based on the above, Changed Water Regime threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	IWC Water Properties Sub-Index Score: 0 - 4 (Very Poor)	IWC Water Properties Score
4	IWC Water Properties Sub-Index Score: 5 - 8 (Poor)	
3	IWC Water Properties Sub-Index Score: 9 - 12 (Moderate)	
2	IWC Water Properties Sub-Index Score: 13 - 16 (Good)	
1	IWC Water Properties Sub-Index Score: 17 - 20 (Excellent)	
no data	IWC methodology to identify changed water properties has not been applied	-1
Data Source: IWC Water Properties Sub-Index		

Additional Information

Whilst the above metric provides an overview of the degree of change in water properties for a particular wetland, additional IWC information is available that better defines the specific activities that have changed the wetland water properties. This information can be accessed through the IWC database (website: http://iwc/iwc/dms/welcome) and includes the following:

Activities or Evidence that Change the Wetland Water Properties	Present	Not Present
Discharge of nutrient-rich water to the wetland		
Drainage of water into the wetland from an urban area		
Grazing by livestock and feral animals		
Aquaculture		
Wetland within 250 m of a salinity discharge site		
Saline water delivered to the wetland OR freshwater delivered to the saline wetland		

18.2.2 Disturbance of Acid Sulfate Soils

To describe the threat of acid sulphate soils to wetlands, the same metric as described for river reaches was used (refer to Section 17.1.4).

18.3 Estuaries

18.3.1 Degraded Water Quality

Measure 1 – EPA Victoria Water Quality Guideline Values for Estuaries

EPA Victoria has sampled 31 estuaries between 2000-2005, with varying frequency of data collection. Water quality and catchment condition information from this sampling program, and additional work carried out by Dr Jan Barton (Deakin University), have been used to determine which estuaries could be considered in reference or near reference (best available) condition. Water quality data from these reference estuaries have then been used to develop preliminary water quality guidelines in both surface and bottom waters for:

- dissolved oxygen;
- total phosphorus;
- total nitrogen;
- turbidity;
- pH; and
- chlorophyll *a.*

Summary statistics have been used to determine an annual median and a maximum and minimum level (where both are required) for individual measurements. For some parameters (dissolved oxygen, total nitrogen, total phosphorus and turbidity) statistical models and control charting were used to set limits for each individual measurement.

In 2011, EPA Victoria published the *Environmental Water Quality Guidelines for Victorian Riverine Estuaries*. These guidelines provide a framework and tools for assessing the environmental condition of riverine estuaries and document guideline values that describe the condition of reference-quality estuaries which can be used as an indicator for assessment of other estuaries.

Descriptor	Data Descriptor
Fails to meet two or more EPA Victoria water quality guideline values for estuaries	Fails 2 or More
Fails to meet one EPA Victoria water quality guideline values for estuaries	Fails 1
Meets all EPA Victoria water quality guideline values for estuaries	Meets All
No EPA water quality data is available for the estuary	No data

Measure 2 – Algal Blooms

Refer to Section 18.1.2 for background information.

Descriptor	Data Descriptor
Algal blooms occur every 1 to 2 years (on average)	1 to 2 years
Algal blooms occur every 3 to 10 years (on average)	3 to 10 years
No algal blooms are known to have occurred in the last 10 years	More than 10 years
Algal bloom occurrence in the last 10 years is unknown	No data

Measure 3– Fish Deaths

Refer to Section 18.1.2 for background information.

Descriptor	Data Descriptor
Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average)	1 to 2 years
Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average)	3 to 10 years
No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years	More than 10 years
Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown	No data

Measure 4 – Excessive Instream Macrophyte Growth

Refer to Section 18.1.2 for background information.

Descriptor	Data Descriptor
>25% of the reach has excessive instream macrophyte growth	>25%
5-25% of the reach has excessive instream macrophyte growth	5-25%
<5% of the reach has excessive instream macrophyte growth	<5%
Extent of excessive instream macrophyte growth is unknown	No data

18.3.2 Disturbance of Acid Sulfate Soils

To describe the threat of acid sulphate soils to estuaries, the same metric as described for river reaches was used (refer to Section 17.1.4).

AVIRA Metric – Degraded Water Quality

Based on the above, and including some of the measures identified for river reaches (refer to Section 17.1.2), Degraded Water Quality for estuaries was scored using the following metric:

Threat Score	Descriptor
5	Fails to meet two or more EPA Victoria water quality guideline values for estuaries IF NO MONITORING SITE THEN Algal blooms occur every 1 to 2 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 1 to 2 years (on average) OR >25% of the estuary length has excessive instream macrophyte growth
3	Fails to meet one EPA Victoria water quality guideline values for estuaries IF NO MONITORING SITE THEN Algal blooms occur every 3 to 10 years (on average) OR Fish deaths resulting from anthropogenic degradation of water quality occur every 3 to 10 years (on average) OR 5-25% of the estuary length has excessive instream macrophyte growth
1	Meets all EPA Victoria water quality guideline values for estuaries IF NO MONITORING SITE THEN No algal blooms are known to have occurred in the estuary in the last 10 years AND No fish deaths resulting from anthropogenic degradation of water quality are known to have occurred in the last 10 years AND <5% of the estuary length has excessive instream macrophyte growth
no data	No EPA water quality data is available for the estuary AND Algal bloom occurrence in the last 10 years is unknown AND Fish deaths resulting from anthropogenic degradation of water quality in the last 10 years is unknown AND Extent of excessive instream macrophyte growth is unknown
Data Sources: *Environmental Water Quality Guidelines for Victorian Riverine Estuaries (EPA Victoria, 2011)* EPA Victoria databases Deakin Great Ocean Road water quality data Index of Estuary Condition water quality data Estuarywatch databases and local knowledge	

19 Degraded Habitats

Under this category, the following threats have been identified:

- For river reaches:
  - Degraded Riparian Vegetation
  - Loss of Instream Habitat
  - Livestock Access
- For wetlands:
  - Soil Disturbance
- For estuaries:
  - Degraded Estuarine Vegetation
  - Livestock Access
  - Altered Extent of Aquatic Macrophytes
  - Sedimentation

These threats are described in the following sections.

19.1 River Reaches

19.1.1 Background

Two key ecosystems exist for river reaches: land-based and water-based. Riparian lands and their vegetation provide vital habitat for land-based plants and animals (LWRRDC 1996). Whereas the river itself provides habitat for both aquatic and terrestrial species (deep pools, logs, etc.).

To determine the threat posed to river values from degraded habitats, three measures were identified:

- Degraded Riparian Vegetation;
- Loss of Instream Habitat; and
- Livestock Access.

19.1.2 Degraded Riparian Vegetation

The 3ISC streamside zone assessment is based on a comparison between the current condition of a site compared with its EVC benchmark. It assesses seven indicators:

- width;
- fragmentation;
- overhang i.e.the percentage of streambank toe with overhanging vegetation;
- structure (2 measures);
- large trees2; and
- weeds (trees).

One of these indicators was identified for use as a measure of threat to riparian habitats, namely large trees.

[2] 3ISC will not collect information on understorey lifeforms.

AVIRA Metric – Degraded Riparian Vegetation (Large Trees)

Large trees can be a dominant feature of remnant native vegetation and are often old, making them a difficult habitat feature to replace once lost. They provide nesting and food resources (Parkes et al 2003).

Threat Score	Descriptor	Data Descriptor
5	3ISC Large Trees Value Score: 1	3ISC Large Tree Score
4	3ISC Large Trees Value Score: 2	
3	3ISC Large Trees Value Score: 3	
2	3ISC Large Trees Value Score: 4	
1	3ISC Large Trees Value Score: 5	
no data	The 3ISC methodology to identify the large tree score has not been applied, no reference available	-1
Data Source: 3ISC Large Trees Indicator		

19.1.3 Loss of Instream Habitat

Two measures were identified to assess threats to instream habitats:

- Loss of Instream Habitat (Large Wood); and
- Loss of Instream Habitat (Sedimentation).

AVIRA Metric – Loss of Instream Habitat (Large Wood)

Woody debris (snags) consists of the logs, stems and branches of trees and shrubs that fall into the stream from the side of the river (DNRE 2001a). Woody debris provides valuable habitat for fish, birds, reptiles, mammals, amphibians and insects, for example:

- fish use woody debris as sites to spawn and rear juveniles (e.g.blackfish);
- water birds use emergent woody debris as sites for roosting, preening and nesting; and
- reptiles use woody debris as vantage points to catch aquatic prey.
- The 3ISC Physical Form Sub-Index includes a Large Wood Indicator that measures large wood by assessing:
- the density of instream large wood;
- the location of large wood (e.g.stream edges, mid-stream, etc.); and
- the origin of the large wood (indigenous or exotic).

This indicator was used as a measure of instream habitat condition.

Based on the above, Loss of Instream Habitat (Large Wood) was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Very Poor Habitat. *Typical features*: No instream wood visible. (3ISC Large Wood Value Score = 1)	3ISC Large Wood Score
4	Poor Habitat. *Typical features*: Few visible pieces of instream wood in channel (either from indigenous or exotic species). (3ISC Large Wood Value Score = 2)	
3	Marginal Habitat. *Typical features*: Moderate visible pieces of instream wood from indigenous species in channel. Abundant pieces of exotic instream wood in channel. Moderate impact of desnagging. Streamside vegetation clearing evident. (3ISC Large Wood Value Score = 3)	
2	Good Habitat. *Typical features*: Numerous pieces of instream wood from indigenous species. Perhaps limited instream wood from exotic species present also. Limited impact of desnagging or streamside vegetation clearing. (3ISC Large Wood Value Score = 4)	
1	Excellent Habitat. *Typical features*: Abundant instream wood from indigenous woody vegetation taxa. Site probably never desnagged. Streamside vegetation probably never cleared. (3ISC Large Wood Value Score = 5)	
no data	The 3ISC methodology to identify the large wood score has no been applied, no reference available	-1
Data Source: 3ISC Large Wood Indicator		

AVIRA Metric – Loss of Instream Habitat (Sedimentation)

Stream beds aggrade when more sediment is delivered to a reach than can be transported through the reach. Increased sediment is delivered to streams from erosion of the bed and banks (as described in Section 15.1.2), and from sources within the catchment (erosion following fires, logging, clearing, mining). Deposited sediment is typically sand, as silts and clays are transported right through the system. Once in a stream, coarse sediment will either settle out, or be transported gradually downstream or onto floodplains. As this occurs, habitat structure is simplified as major habitat features such as pools and riffles become covered and disappear (DNRE, 2002a). Aggradation can also lead to decreased hydraulic capacity (more frequent floods).

A number of observations can be made to determine the degree of sedimentation of the streambed, particularly:

- location and distribution of sediment (from collection points at instream obstructions (e.g.large woody debris) and channel bends (e.g.point bars) to complete channel widths);
- channel shape (e.g.deep and narrow v shallow and wide); and
- substrate variability (e.g.riffles and pools v flat, uniform streambed).

Based on the above, Loss of Instream Habitat (Sedimentation) was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Extensive deposition of sediments throughout reach with no observable instream habitat features OR Floodplain/valley inundation (i.e.loss of channel) OR Reach classified as aggradational in SedNet (usually greater than 1m of net deposition)	Extensive
4	Deposition of sediments throughout reach AND Channel bed beginning to become uniform (i.e.some observable instream habitat features) OR More than half of the reach classified as aggradational in SedNet	Significant
3	Deposition of sediments above natural levels mainly at bends and/or instream obstructions	Some
1	No obvious deposition of sediments above natural levels	Negligible
no data	Bed stability of waterway is unknown	No data
Data Sources:* SedNet ** Fluvial Geomorphological studies Local knowledge		

* The 3ISC does not include a bed instability measure as it was deemed to be too variable and difficult to determine in the field at a single point in time. Although no state-wide dataset exists, bed stability remains a significant impact. As such it is recommended that the metric is scored in the regions by CMAs, rather than at State level from a data base.

**SedNet provides an estimate of aggradation based on the hydraulic capacity of the reach.

19.1.4 Livestock Access

The 2ISC included an assessment of livestock access, under the following measures:

- damage to vegetation;
- damage to banks;
- pugging;
- manure; and
- tracks.

This information was not collected under 3ISC. Therefore, livestock access was determined from information and on-ground knowledge of regional agencies.

AVIRA Metric – Livestock Access

Based on the above, Livestock Access threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>75% of waterway is affected by livestock access	>75%
3	25-75% of waterway is affected by livestock access	25-75%
1	<25% of waterway is affected by livestock access	<25%
no data	Livestock access to waterway is unknown	No data
Data Source: Local knowledge		

19.2 Wetlands

19.2.1 Background

To determine the threat posed to wetland values from degraded habitats, three measures derived from the IWC were identified - Soil Disturbance, Degraded Buffer and Livestock Access.

19.2.2 Soil Disturbance

Wetland soils provide a physical substrate for aquatic plants including macrophytes and algae and habitat for benthic invertebrates and micro-organisms. Threats to the physical properties of wetland soils are activities such as pugging by livestock and feral animals, human trampling, driving of vehicles in the wetland and carp mumbling. These activities cause soil disturbance which can reduce water storage capacity of soil, can have negative impacts on some invertebrates and increase turbidity during filling (DSE 2008e).

The IWC includes a measure of soil disturbance relating to the physical disturbance of the soil structure and profile.

Activities with the potential to cause soil disturbance include:

- pugging by livestock and/or feral animals;
- cultivation;
- carp mumbling;
- human trampling; and
- driving of vehicles in the wetland.

To determine the severity of effect of these activities, the IWC Field Assessment Sheet lists the following key steps (refer to DSE 2008e):

1. Identify the presence of activities that cause soil disturbance.
2. Estimate the percentage of wetland soil affected by these activities.
3. Estimate the collective severity of effect of the activities on wetland soils.

AVIRA Metric – Soil Disturbance

Based on the above, Soil Disturbance threats were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	IWC Soils Sub-Index Score: 0 - 4 (Very Poor)	IWC Soils Score
4	IWC Soils Sub-Index Score: 5 - 8 (Poor)	
3	IWC Soils Sub-Index Score: 9 - 12 (Moderate)	
2	IWC Soils Sub-Index Score: 13 - 16 (Good)	
1	IWC Soils Sub-Index Score: 17 - 20 (Excellent)	
no data	IWC methodology to identify degree of soil disturbance has not been applied	-1
Data Source: IWC Soils Sub-Index		

Additional Information

Whilst the above metric provides the severity of soil disturbance for a particular wetland, additional IWC information is available that better defines the specific activities that have caused the disturbance. This information can be accessed through the IWC database (website: http://iwc/iwc/dms/welcome) and includes the following:

Soil Disturbance	Not Present	Present
Pugging by livestock and/or feral animals		
Cultivation		
Carp mumbling		
Human trampling		
Driving of vehicles in the wetland		

19.2.3 Degraded Buffer Vegetation

Wetland buffer condition is collected as part of the IWC. It assesses data including the average width and percentage of perimeter of wetland with buffer. The buffer must contain >25% of native vegetation ground cover to be included as a buffer. This data is used to indicate the level of degradation to the buffer.

Threat Score	Descriptor	Data Descriptor
5	IWC Wetland Buffer Assessment Score: 0 - 5	IWC Wetland Buffer Assessment
4	IWC Wetland Buffer Assessment Score: >5 - 9	
3	IWC Wetland Buffer Assessment Score: >9 - 13	
2	IWC Wetland Buffer Assessment Score: >13 - 17	
1	IWC Wetland Buffer Assessment Score: >17 - 20	
no data	IWC assessment has not been undertaken	-1
Data Source: IWC Wetland Buffer Assessment Score		

19.2.4 Livestock Access

To describe the threat of livestock access to wetlands, the same metric as described for river reaches was used (refer to Section 18.1.4)

Threat Score	Descriptor	Data Descriptor
5	>75% of waterway is affected by livestock access	>75%
3	25 to 75% of waterway is affected by livestock access	25-75%
1	<25% of waterway is affected by livestock access	<25%
no data	Livestock access to waterway is unknown	No Data
Data Source: Local knowledge		

19.3 Estuaries

19.3.1 Background

To assess the threat posed to estuary values from degraded habitats, four measures were identified:

- Degraded Estuarine Vegetation;
- Livestock Access;
- Altered Extent of Aquatic Macrophytes; and
- Sedimentation.

19.3.2 Degraded Estuarine Vegetation

This metric refers to the condition of fringing estuarine vegetation. The IEC method for assessing fringing, estuary-associated macrophytes has not yet been developed. However, detailed mapping of fringing vegetation was undertaken at 1:50,000 scale for the following:

- seven estuaries in the Glenelg Hopkins CMA (Sinclair & Sutter 2008),
- eight estuaries in the Corangamite CMA (Osler et al. 2010) and
- state-wide for saltmarsh and mangroves (Boon et al. 2010).

These projects (Sinclair and Sutter 2008, Osler et al. 2010 and Boon et al. 2010) each made an assessment of vegetation condition. This data can be used to assess vegetation at each of the estuaries in AVIRA to assign a threat class (Highly disturbed, Modified, Near natural or No data – see below for definitions). Scoring is based on the change from historical (pre-European) condition.

Threat Score	Descriptor	Data descriptor
5	Highly disturbed: no remaining fringing macrophytes	Highly disturbed
3	Modified: fringing macrophytes present, some EVCs absent or modified from benchmark	Modified
1	Near natural: no change in extent or condition of EVCs	Near natural
no data	Estuary has not been assessed for degraded vegetation condition	No data

Data Source:

Boon, Allen, Brook, Carr, Frood, Hoye, Harty, McMahon, Mathews, Rosengren, Sinclair, White and Yugovic (2010). *Victorian Saltmarsh Study: Mangroves and Costal Saltmarsh of Victoria: distribution, condition, threats and management*. Institute for Sustainability and Innovation, Victoria University, Melbourne.

Osler, Cook, Sinclair and White (2010). *Ecological Vegetation Class Mapping – Corangamite Estuaries*, Australian Ecosystems Pty Ltd, Patterson Lakes, Victoria.

Sinclair and Sutter (2008). *Estuarine wetland vegetation mapping, Glenelg Hopkins CMA*, Technical Report Series No. 178 Arthur Rylah Institute, DSE, Heidelberg, Victoria.

Local knowledge

19.3.3 Livestock Access

To describe the threat of livestock access to estuaries, the same metric as described for river reaches and wetlands was used (refer to Section 18.1.4).

20 Invasive Flora and Fauna

Invasive animals, plants, and ecological diseases or pathogens[3] are major threats to biodiversity because of their ability to change and destroy habitats and ecosystems. They are the number one cause of native animal extinctions in Australia, the second biggest threat to river and stream areas and nationally important wetlands, and the third biggest threat to threatened ecosystems (DSE ~2009b).

The impact that invasive flora and fauna have on natural ecosystems is very serious; weeds such as blackberry and bridal creeper and pest animals such as foxes, rabbits, and common carp have the potential to destroy the biodiversity values of highly-prized ecosystems. Internationally, invasive species are now recognised as the second-greatest threat to natural ecosystems (DNRE 2002g).

Under this category, the following threats have been identified:

- For river reaches:
  - Invasive Flora (Riparian);
  - Invasive Flora (Aquatic);
  - Invasive Fauna (Terrestrial); and
  - Invasive Fauna (Aquatic).
- For wetlands:
  - Invasive Flora (Wetland);
  - Invasive Fauna (Terrestrial); and
  - Invasive Fauna (Aquatic).
- For estuaries:
  - Invasive Flora (Riparian);
  - Invasive Flora (Aquatic);
  - Invasive Fauna (Terrestrial); and
  - Invasive Fauna (Aquatic).

These threats are described in the following sections.

20.1 River Reaches

20.1.1 Invasive Flora (Riparian)

Invasive plants, or weeds, can pose a serious threat to biodiversity and to primary production. They contribute to land and water degradation, losses in productivity, and they can significantly impact native flora and fauna populations (DSE ~2009c).

To determine the threat posed by invasive flora (riparian), two measures were identified:

- the total cover of invasive flora; and
- the presence of high threat weeds.

[3] Diseases and pathogens are not considered within AVIRA as they are managed through existing DPI frameworks.

Measure 1 – Total Cover of Invasive Flora

Descriptor	Data Descriptor
>60% cover of invasive riparian flora	>60%
41-60% cover of invasive riparian flora	41-60%
11-40% cover of invasive riparian flora	11-40%
<11% cover of invasive riparian flora	<11%
Cover of invasive riparian flora is unknown	no data

The cover of invasive riparian vegetation was determined as follows:

- Tree Layer. Use the 3ISC Cover of Exotic Vegetation Indicator (Tree Layer).
- Shrub and Ground Layers. Use local knowledge together with invasive flora data collected as part of the 2ISC Streamside Zone Sub-Index.

Measure 2 – Presence of High Threat Weeds

Descriptor	Data Descriptor
High threat weeds present	Present
No high threat weeds present	Not Present
Presence of high threat weeds is unknown	no data

Determining whether particular invasive species are high threat was the responsibility of each CMA.

Rating Table

Total Cover of Invasive Flora	Presence of High Threat Weeds		
	Not Present	Present	No Data
>60%	4	5	5
41-60%	3	4	4
11-40%	2	3	3
<11%	1	2	2

The cover of invasive riparian vegetation (as collected in 2ISC) divides vegetation into three layers (tree, shrub, and ground). This division can be advantageous in determining threats to specific values.

Based on the above, three metrics were used to score Invasive Flora (Riparian) as follows:

- Invasive Flora (Riparian) – Trees;
- Invasive Flora (Riparian) – Shrub Layer; and
- Invasive Flora (Riparian) – Ground Layer.

AVIRA Metric –Invasive Flora (Riparian) – Tree Layer

This metric was only assessed for willows and hawthorn (no other high threat or other types of weeds).

Threat Score	Descriptor
5	>60% cover of willows or hawthorn
4	41-60% cover of willows or hawthorn
3	11-40% cover of willows or hawthorn
2	<11% cover of willows or hawthorn
1	<11% cover of invasive riparian flora (tree layer) with no willow or hawthorn detected
no data	Cover of invasive riparian flora (tree layer) is unknown
Data Sources: 3ISC Cover of Exotic Vegetation Indicator (Tree Layer) Local knowledge	

AVIRA Metric –Invasive Flora (Riparian) – Shrub Layer

This metric covers invasive woody vegetation less than 5m high.

Threat Score	Descriptor
5	>60% cover of invasive riparian flora (shrub layer) with high threat weeds present OR >60% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown
4	41-60% cover of invasive riparian flora (shrub layer) with high threat weeds present OR 41-60% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR >60% cover of invasive riparian flora (shrub layer) with no high threat weeds present
3	11-40% cover of invasive riparian flora (shrub layer) with high threat weeds present OR 11-40% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR 41-60% cover of invasive riparian flora (shrub layer) with no high threat weeds present
2	<11% cover of invasive riparian flora (shrub layer) with high threat weeds present OR <11% cover of invasive riparian flora (shrub layer) with presence of high threat weeds unknown OR 11-40% cover of invasive riparian flora (shrub layer) with no high threat weeds present
1	<11% cover of invasive riparian flora (shrub layer) with no high threat weeds present
no data	Cover of invasive riparian flora (shrub layer) is unknown
Data Sources: 2ISC Cover of Exotic Vegetation Indicator (Shrub Layer) Local knowledge	

AVIRA Metric –Invasive Flora (Riparian) – Ground Layer

This metric covers all invasive non-woody vegetation.

Threat Score	Descriptor
5	>60% cover of invasive riparian flora (ground layer) with high threat weeds present OR >60% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown
4	41-60% cover of invasive riparian flora (ground layer) with high threat weeds present OR 41-60% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR >60% cover of invasive riparian flora (ground layer) with no high threat weeds present
3	11-40% cover of invasive riparian flora (ground layer) with high threat weeds present OR 11-40% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR 41-60% cover of invasive riparian flora (ground layer) with no high threat weeds present
2	<11% cover of invasive riparian flora (ground layer) with high threat weeds present OR <11% cover of invasive riparian flora (ground layer) with presence of high threat weeds unknown OR 11-40% cover of invasive riparian flora (ground layer) with no high threat weeds present
1	<11% cover of invasive riparian flora (ground layer) with no high threat weeds present
no data	Cover of invasive riparian flora (ground layer) is unknown
Data Sources: 2ISC Cover of Exotic Vegetation Indicator (Ground Layer) Local knowledge	

Additional Information

Whilst the above three metrics provide the presence and severity of impact of invasive flora for a particular river reach, additional information regarding specific high threat species should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

20.1.2 Invasive Flora (Aquatic)

In addition to invasive riparian flora, the presence and extent of invasive aquatic flora (including diatoms and algae) is also significant to the health of rivers.

A listing of significant invasive flora (aquatic) is provided below (refer to DPI ~2009):

- Alligator Weed (Declared noxious weed)
- Arrowhead
- Cabomba
- Cunjevoi
- Delta Arrowhead
- Dense Waterweed
- Dwarf Arrowhead
- *Egeria densa*
- Giant Water Lily
- *Lagarosiphon major* (Declared noxious weed)
- Parrots Feather
- Reed Sweet Grass
- *Salvinia molesta* (Declared noxious weed)
- Senegal Tea Plant
- Water Hyacinth (Declared noxious weed)

Regionally significant invasive aquatic flora can be incorporated into this list by CMAs, as appropriate.

As there is no consistent mapping of these aquatic weeds, threat severity was based on a broad assessment of percentage cover.

AVIRA Metric – Invasive Flora (Aquatic)

Based on the above, Invasive Flora (Aquatic) was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>50% of the waterway perimeter has invasive aquatic flora present	>50%
4	>25-50% of the waterway perimeter has invasive aquatic flora present	25-50%
3	5-25% of the waterway perimeter has invasive aquatic flora present	5-25%
1	<5% of the waterway perimeter has invasive aquatic flora present OR No invasive aquatic flora are known to occur	<5%
no data	Presence and extent of invasive aquatic flora is unknown	No data
Data Sources: Local knowledge Waterwatch data		

20.1.3 Invasive Fauna (Terrestrial)

Invasive fauna can pose a serious threat to biodiversity and primary production. They contribute to the loss of native animals and can significantly disturb native vegetation.

To determine the threat posed by invasive fauna (terrestrial), two measures were identified:

- the presence of invasive species; and
- the type of impact.

Measure 1 – Presence of Invasive Species

Descriptor	Data Descriptor
Invasive species present	Present
No invasive species are known to occur	Not present
Presence of invasive species is unknown	No data

Measure 2 – Type of Impact

Descriptor	Data Descriptor
Invasive terrestrial species directly prey on native species and/or damage native species habitat	Prey or Damage Habitat
Invasive terrestrial species compete for food and/or habitat with native species	Compete
Invasive terrestrial species have no significant impact	Minor
Impact of invasive terrestrial species is unknown	No data

Rating Table

Type of Impact	Presence of Invasive Species	
	No Invasive Species are Known to Occur	Present
Directly prey on native species or damage habitat	1	5
Compete for food or habitat with native species	1	4
No significant impact	1	2

AVIRA Metric – Invasive Fauna (Terrestrial)

Based on the above, Invasive Fauna (Terrestrial) was scored using the following metric:

Threat Score	Descriptor
5	Invasive fauna species (terrestrial) are present and directly prey on native species or damage habitat
4	Invasive fauna species (terrestrial) are present and compete for food or habitat with native species
2	Invasive fauna species (terrestrial) are present with no significant impacts
1	No invasive species (terrestrial) are known to occur
no data	Presence and/or impact of invasive fauna species (terrestrial) is unknown
Data Sources: Victorian Fauna Database Local knowledge	

Additional Information

Whilst the above metric provides the presence and severity of impact of invasive terrestrial fauna for a particular river reach, additional information regarding specific species should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

20.1.4 Invasive Fauna (Aquatic)

The introduction of live fish outside their natural range has significantly affected many of Victoria's native fish species. Invasive fish introduced from other countries can threaten the survival of native species through competition for food and habitat, direct predation and the spread of disease (DNRE 2001c).

As for terrestrial invasive fauna, two measures were identified to determine the threat posed by invasive aquatic fauna:

- the presence of invasive species; and
- the type of impact.

Measure 1 – Presence of Invasive Species

Descriptor	Data Descriptor
Invasive species present	Present
No invasive species are known to occur	Not present
Presence of invasive species is unknown	No data

Measure 2 – Type of Impact

Descriptor	Data Descriptor
Invasive aquatic species directly prey on native species and/or damage native species habitat	Prey or Damage Habitat
Invasive aquatic species compete for food and/or habitat with native species	Compete
Invasive aquatic species have no significant impact	Minor
Impact of invasive aquatic species is unknown	No data

Rating Table

Type of Impact	Presence of Invasive Species	
	No Invasive Species are Known to Occur	Present
Directly prey on native species or damage habitat	1	5
Compete for food or habitat with native species	1	4
No significant impact	1	2

AVIRA Metric – Invasive Fauna (Aquatic)

Based on the above, Invasive Fauna (Aquatic) were scored using the following metric:

Threat Score	Descriptor
5	Invasive fauna species (aquatic) are present and directly prey on native species or damage habitat
4	Invasive fauna species (aquatic) are present and compete for food or habitat with native species
2	Invasive fauna species (aquatic) are present with no significant impacts
1	No invasive species (aquatic) are known to occur
no data	Presence and/or impact of invasive fauna species (aquatic) is unknown
Data Sources: Victorian Fauna Database Local knowledge	

Additional Information

Whilst the above metric provides the severity of impact of invasive aquatic fauna for a particular river reach, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

20.2 Wetlands

20.2.1 Invasive Flora (Wetland)

As part of the IWC, wetland vegetation quality assessments are based on:

- critical lifeforms;
- presence of weeds;
- indicators of altered processes; and
- vegetation structure and health.

The IWC measure 'presence of weeds' was used as the measure of threat of invasive flora (wetland). This measure considers the extent of impact of invasion by introduced plant species, with consideration of the ecological competitiveness of the relevant species within the respective wetland EVC (refer to Table 2). The scoring is based on assessing the proportional cover of weeds, and whether the relevant species are assessed as being of high or low threat (DSE 2006c).

Table 2 - IWC Scoring for Precense of Weeds (adapted from DSE 2006b)

Total Cover of Weeds in EVC	% of Weed Cover made up of High Threat Weeds		
	nil	<50%	≥50%
>50%	7	3	0
>25-50%	12	10	7
5-25%	18	15	12
<5%	25	22	18

AVIRA Metric –Invasive Flora (Wetland)

Based on the above, Invasive Flora (Wetland) was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>50% cover of weeds with high threat weeds present (i.e.>0%) (IWC Presence of Weeds Score: 0-3)	IWC Presence of Weeds Score
4	>25-50% cover of weeds with high threat weeds present (i.e.>0%) OR >50% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 7-10)	
3	5-25% cover of weeds with high threat weeds present (i.e.>0%) OR 25-50% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 12-15)	
2	<5% cover of weeds with ≥50% of weed cover made up of high threat weeds OR 5-25% cover of weeds with no high threat weeds present (IWC Presence of Weeds Score: 18)	
1	<5% cover of weeds with <50% of weed cover made up of high threat weeds OR No weeds are known to occur (IWC Presence of Weeds Score: 22-25)	
no data	IWC methodology to identify invasive flora has not been applied	-1
Data Sources: IWC Presence of Weeds Local knowledge		

Additional Information

Whilst the above metric provides the severity of impact of invasive flora for a particular wetland, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

20.2.2 Invasive Fauna (Terrestrial)

To describe the threat of invasive fauna (terrestrial) to wetlands, the same metric as described for river reaches was used (refer to Section 19.1.3).

20.2.3 Invasive Fauna (Aquatic)

To describe the threat of invasive fauna (aquatic) to wetlands, the same metric as described for river reaches was used (refer to Section 19.1.4).

20.3 Estuaries

20.3.1 Invasive Flora (Riparian)

To describe the threat of invasive flora (riparian) to estuaries, the same three metrics as described for river reaches were used (refer to Section 19.1.1):

- Invasive Flora (Riparian) – Trees;
- Invasive Flora (Riparian) – Shrub Layer; and
- Invasive Flora (Riparian) – Ground Layer.

20.3.2 Invasive Flora (Aquatic)

To describe the threat of invasive flora (aquatic) to estuaries, the same metric as described for river reaches was used (refer to Section 19.1.2).

20.3.3 Invasive Fauna (Terrestrial)

To describe the threat of invasive fauna (terrestrial) to estuaries, the same metric as described for river reaches was used (refer to Section 19.1.3).

20.3.4 Invasive Fauna (Aquatic)

To describe the threat of invasive fauna (aquatic) to estuaries, a similar metric as described for river reaches was used (refer to Section 19.1.4). However, as the relative ecological importance of predation, habitat modification or competition is not likely to be known or consistent between species in an estuarine context, the 'type of impact' measure has been excluded.

Measure 1 – Presence of Invasive Species

Descriptor	Data Descriptor
Invasive species present	Present
No invasive species are known to occur	Not Present
Presence of invasive species is unknown	No data

Measure 2 – Type of Impact

Descriptor	Data Descriptor
Invasive aquatic species directly prey on native species, damage native species habitat and/or compete for food and/or habitat with native species	Major
Invasive aquatic species have no significant impact	Minor
Impact of invasive aquatic species is unknown	No data

Rating Table

Type of Impact	Presence of Invasive Species	
	No Invasive Species are Known to Occur	Invasive Species are Present
Directly prey on native species, damage habitat and/or compete for food or habitat with native species	1	5
No significant impact	1	2

AVIRA Metric –Invasive Fauna (Aquatic)

Based on the above, Invasive Fauna (Aquatic) was scored using the following metric:

Threat Score	Descriptor
5	Invasive fauna species (aquatic) are present and directly prey on native species, damage habitat or compete for food or habitat with native species
2	Invasive fauna species (aquatic) are present with no significant impacts
1	No invasive species are known to occur
no data	Presence and/or impact of invasive fauna species (aquatic) is unknown
Data Sources: Victorian Fauna Database Local knowledge	

Additional Information

Whilst the above metric provides the severity of impact of invasive aquatic fauna for a particular estuary, additional information regarding specific species present should be included for transparency and management purposes. This can be achieved by including the species name in the rationale column of the data file (see Appendix D).

21 Reduced Connectivity

Connectivity is the ability of ecosystems to 'connect' and form networks. For rivers, wetlands and estuaries there are three key connectivity types: lateral; longitudinal; and vertical. These connectivity types cover the movement of water, materials, food and organisms from place to place.

Under the category 'Reduced Connectivity', the following threats have been identified:

- For river reaches:
  - Barriers to Fish Migration
  - Reduced Riparian Connectivity; and
  - Reduced Floodplain Connectivity.
- For wetlands:
  - Reduced Wetland Connectivity
- For estuaries:
  - Barriers to Estuarine Biota; and
  - Reduced Floodplain and Wetland Connectivity.

These threats are described in the following sections.

21.1 River Reaches

21.1.1 Background

Rivers form a network of linked habitat through the catchment, such as linkages from forested headwaters to lowland plains and local networks through agricultural land.

In addition, riparian lands often contain a high diversity of living organisms and play an essential role as corridors for the movement of plants and animals (LWRRDC 1996).

To assess the threat posed to river values from reduced connectivity, three measures were identified:

- Barriers to Fish Migration;
- Reduced Riparian Connectivity; and
- Reduced Floodplain Connectivity.

21.1.2 Barriers to Fish Migration

Most Victorian river systems have been changed in some way, either to control water, improve drainage or reduce erosion and flooding. Structures have been built for water storage (dams, reservoirs and weirs); for crossings (bridges and culverts); and for erosion control. There are now thousands of these structures in Victorian rivers and streams which act as barriers to fish movement; impacting the migration and recolonisation of aquatic species (DNRE 2001c).

A barrier near the mouth of a river can exclude fish from the entire river system. Barriers located further up the stream may prevent fish from accessing areas necessary for spawning (DNRE 2001c).

The State Fishway Program (McGuckin and Bennett 1999) used the following key criteria to establish priorities for fish passage across Victoria:

- native fish species likely to benefit (high conservation status or migratory species will be highest priority);
- length of river and area of habitat made accessible to fish;

- quality of habitat made accessible to fish;
- proximity to the sea or River Murray (the number and diversity of native fish that would benefit is highest at the lower end of catchments);
- complementary restoration programs being undertaken within the basin;
- an assessment of adverse impacts such as spread of noxious/predatory species; and
- a feasibility analysis that accounts for issues such as total cost of works, drown-out weir frequency, etc.

For AVIRA, the proximity of a barrier to the sea or River Murray was used as the key measure of threat to the migration of native fish.

The remaining criteria are either considered elsewhere in AVIRA (e.g.threatened species, habitat quality) or should be included as part of action plan development (e.g.complementary programs, adverse impacts, feasibility).

AVIRA Metric – Barriers to Fish Migration

Based on the above, Barriers to Fish Migration were scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Artificial barrier exists in the estuary OR Artificial barrier exists in the floodplain reach	Estuary or Floodplain Reach
4	Artificial barrier exists in the valley reach	Valley Reach
3	Artificial barrier exists in the mountain reach	Mountain Reach
0	No artificial barrier exists	No Barrier
Data Sources: Statewide Fish Barrier database Regional fish barrier databases (including location of fishways) 3ISC – location of barriers Local knowledge		

21.1.3 Reduced Riparian Connectivity

To determine the threat posed to river values from reduced riparian connectivity, two measures were identified:

- Reduced Longitudinal Continuity; and
- Reduced Vegetation Width.

AVIRA Metric – Reduced Longitudinal Continuity

The 3ISC has two indicators that can be used as measures to assess threats to longitudinal continuity of riparian areas:

- fragmentation of woody vegetation; and
- vegetation overhang.

Measure 1 – Fragmentation of Woody Vegetation

Descriptor	Data Descriptor
Gaps in woody vegetation cover 80-100% of riparian area (3ISC score = 1)	3ISC Fragmentation Score
Gaps in woody vegetation cover 60-79 of riparian area (3ISC score = 2)	
Gaps in woody vegetation cover 40-59% of riparian area (3ISC score = 3)	
Gaps in woody vegetation cover 20-39% of riparian area (3ISC score = 4)	
Gaps in woody vegetation cover 0-19% of riparian area (3ISC score = 5)	

Measure 2 – Vegetation Overhang

Descriptor	Data Descriptor
0 – 19% of streambank length has overhanging vegetation, Score = 1 or 2 (Very Poor)	3ISC Overhang Score
20 – 39% of streambank length has overhanging vegetation, Score = 3 (Poor)	
40 – 59% of streambank length has overhanging vegetation, Score = 4 (Moderate)	
60 – 79% of streambank length has overhanging vegetation, Score = 5 (Good)	
80 – 100% of streambank length has overhanging vegetation, Score = 6 (Excellent)	

Rating Table

Length of Streambank with Overhanging Vegetation	Gaps in Woody Vegetation Cover					
	0-19%	20-39%	40-59%	60-79	80-100%	no data
0 – 19%	1	2	3	4	5	5
20 – 39%	1	1	2	3	4	4
40 – 59%	1	1	1	2	3	3
60 – 79%	1	1	1	1	2	2
80 – 100%	1	1	1	1	1	1
no data	1	2	3	4	5	no data

Based on the above, Reduced Longitudinal Continuity was scored using the following metric:

Threat Score	Descriptor
5	0-39% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps
4	0-39% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps
3	0-39% of streambank has overhanging vegetation with 40-59% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps
2	0-39% of streambank has overhanging vegetation with 20-39% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 40-59% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 60-79% of vegetated area being gaps OR 80-94% of streambank has overhanging vegetation with 80-100% of vegetated area being gaps
1	0-39% of streambank has overhanging vegetation with 0-19% of vegetated area being gaps OR 40-64% of streambank has overhanging vegetation with 0-39% of vegetated area being gaps OR 65-79% of streambank has overhanging vegetation with 0-59% of vegetated area being gaps OR 80-94% of streambank has overhanging vegetation with 0-79% of vegetated area being gaps OR 95-100% of streambank has overhanging vegetation
Data Source: 3ISC Fragmentation of Woody Vegetation 3ISC Vegetation Overhang Local knowledge	

AVIRA Metric – Reduced Vegetation Width

Good riparian widths act as habitat corridors, providing a full range of plant communities needed for a range of species and to link effectively with adjacent terrestrial ecosystems. The 3ISC assesses the width of vegetation by measuring both the riparian width (i.e.river dependent vegetation) and adjacent vegetation width.

Based on the above, Reduced Vegetation Width was scored using the following metric:

Threat Score	Descriptor		Data Descriptor
	Small Streams (bankfull width ≤ 15m wide)	Large Streams (bankfull width ≥ 15m wide)	
5	< 5m	< 0.25 x baseflow width	1
4	5 - 10m	(0.25 x baseflow width) - (< 0.5 x baseflow width)	2
3	> 10 - 30m	(0.5 x baseflow width) - (< 1.5 x baseflow width)	3
2	> 30 - 40m	(1.5 x baseflow width)- (< 3 x baseflow width)	4
1	> 40m	> 3 x baseflow width	5
Data Source: 3ISC Width of Vegetation Indicator			

21.1.4 Reduced Floodplain Connectivity

Reduced linkages between rivers and floodplains are an outcome of:

- water regulation and extraction which reduce flooding;
- actions taken to protect property from flooding, mostly by building levees; and
- laser-levelling on private land which infills floodways (DNRE 2002a).

As the issue of water regulation and extraction is covered under the threat category 'Altered Water Regimes', only the location and function of levees and other infrastructure has been considered further under this threat.

AVIRA Metric – Reduced Floodplain Connectivity

Based on the above, Reduced Floodplain Connectivity was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	Levees and/or other infrastructure exist that completely disconnect* the waterway from the floodplain	Completely Disconnected
3	Levees and/or other infrastructure exist that partially disconnect the waterway from the floodplain	Partially Disconnected
0	Floodplain is fully connected** to the waterway OR No floodplain naturally exists	Fully Connected
Data Source: Regional Floodplain Strategies		

* Completely Disconnected Floodplain - Flood events ≥10% Annual Exceedence Probability (AEP) cannot enter the floodplain

**Fully Connected Floodplain - Floodwaters from all AEP events can naturally enter the floodplain.

21.2 Wetlands

21.2.1 Background

Wetland connectivity is most likely to occur where there are a series of habitat areas arranged like 'stepping stones'.

DEWHA and DAFF (2008) define connectivity as 'the location and spatial distribution of natural areas in the landscape to provide species and populations with access to resources (food, breeding sites and shelter), increase habitat availability and facilitate population processes (dispersal, migration, expansion and contraction) and enable ecological processes (evolution, water, fire and nutrients)'.

21.2.2 Reduced Wetland Connectivity

At this stage there is insufficient information available to determine optimum proximities between wetlands, or what type or area of wetland is required to provide adequate connectivity. DELWP is currently undertaking a project to model wetland connectivity across the landscape. Part of this project is to develop guidelines for how to use the model results to inform wetland management and prioritisation.

Therefore, the metric for Reduced Wetland Connectivity has been left blank until this work is completed.

21.3 Estuaries

21.3.1 Background

To assess the threat posed to estuary values from reduced connectivity, two measures were identified:

- Barriers to Estuarine Biota; and
- Reduced Floodplain and Wetland Connectivity.

21.3.2 Barriers to Estuarine Biota

Artificial barriers within estuaries can impact a number of estuarine fish species, including:

- estuarine dependent (freshwater derived);
- estuarine residents;
- estuarine dependent (marine derived); and
- estuarine opportunists (marine derived).

To describe the threat to estuarine values from barriers, the same metric as 'Reduced Estuary Extent' (refer to Section 16.3.2) was used with some minor changes to descriptors.

AVIRA Metric – Barriers to Estuarine Biota

Based on the above, Barriers to Estuarine Biota was scored using the following metric:

Threat Score	Descriptor	Data Descriptor
5	>50% of the estuary length is affected by an artificial barrier that completely blocks the movement of biota (in a typical year)	Very Significant
4	1-50% of the estuary length is affected by an artificial barrier that completely blocks the movement of biota (in a typical year) OR >50% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year)	Significant
3	>25-50% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year)	Moderate
2	1-25% of the estuary length is affected by an artificial barrier that interferes (intermittently or selectively) with the movement of biota (in a typical year)	Minor
0	No artificial barrier occurs within the estuary	No Barrier
Data Sources: IEC Physical Form Sub Index Statewide Fish Barrier database Regional fish barrier databases Local knowledge		

21.3.3 Reduced Floodplain and Wetland Connectivity

Lateral connectivity is about linkages across the estuarine shoreline, including floodplain and wetland systems and the natural movement of materials and biota between those habitats and the central water body.

The key measures for this threat are:

- the presence of artificial structures (e.g.seawalls, levee banks, jetties, bridges, platforms); and
- degree of connectivity to adjoining floodplains or wetlands.

Measure 1 – Presence of Artificial Structures

Descriptor	Data Descriptor
>15% of the estuary perimeter has artificial structures	Major
1-15% of the estuary perimeter has artificial structures	Minor
Estuary has no artificial structures	None

Measure 2 – Degree of Connectivity

Descriptor	Data Descriptor
Wetlands are no longer connected to the estuary	Completely Disconnected
Wetlands are connected to the estuary but less than natural	Partially Disconnected
Wetlands fully connected to the estuary OR No estuarine wetlands exist naturally	Fully Connected
Degree of estuary-wetland connectivity is unknown	No data

AVIRA Metric – Reduced Floodplain and Wetland Connectivity

Based on the above, Reduced Floodplain and Wetland Connectivity were scored using the following metric:

Threat Score	Descriptor
5	>15% of the estuary perimeter has artificial structures OR Wetlands are no longer connected to the estuary
3	1-15% of the estuary perimeter has artificial structures OR Wetlands are connected to the estuary but less than natural
0	Estuary has no artificial structures AND Wetlands fully connected to the estuary OR No estuarine wetlands exist naturally
no data	Degree of estuarine-wetland connectivity is unknown
Data Source: Local knowledge	

Part E Summary of Values and Threats

The following sections provide a summary of waterway values and threats for AVIRA.

22 Summary of AVIRA Values

22.1 Environmental Values

AVIRA ENVIRONMENTAL VALUES		
River Reaches	**Wetlands**	**Estuaries**

FORMALLY RECOGNISED SIGNIFICANCE
• National Significance
  o Living Murray Icon Sites
  o National Heritage Sites
• State Significance
  o Heritage Rivers
  o Icon Rivers
  o Essentially Natural Catchments
  o Victorian Parks and Reserves
  o Victorian Heritage Sites
	FORMALLY RECOGNISED SIGNIFICANCE
	• International Significance
	  o Ramsar Sites
	  o East Asian-Australasian Flyway Sites
	• National Significance
	  o Nationally Important Wetlands
	  o Living Murray Icon Sites
	  o National Heritage Sites
	• State Significance
	  o Heritage Rivers
	  o Essentially Natural Catchments
	  o Victorian Parks and Reserves
	  o Victorian Heritage Sites
		FORMALLY RECOGNISED SIGNIFICANCE
		• International Significance
		  o Ramsar Sites
		  o East Asian-Australasian Flyway Sites
		• National Significance
		  o Nationally Important Wetlands
		  o National Heritage Sites
		• State Significance
		  o Heritage Rivers
		  o Icon Rivers
		  o Essentially Natural Catchments
		  o Victorian Parks and Reserves
		  o Victorian Heritage Sites

REPRESENTATIVENESS • Representative Rivers	REPRESENTATIVENESS	REPRESENTATIVENESS
RARE OR THREATENED SPECIES & COMMUNITIES • Significant Invertebrates – Aquatic • Significant Invertebrates – Terrestrial • Significant Fish – Migratory • Significant Fish – Non-migratory • Significant Birds – Riparian • Significant Birds – Waterway • Significant Amphibians • Significant Reptiles – Aquatic • Significant Reptiles – Riparian • Significant Mammals • Significant Flora – Aquatic • Significant Flora – Terrestrial • Significant Riparian EVCs	RARE OR THREATENED SPECIES & COMMUNITIES • Significant Invertebrates • Significant Fish • Significant Birds • Significant Amphibians • Significant Reptiles – Aquatic • Significant Reptiles – Riparian • Significant Mammals • Significant Flora • Significant Wetland EVCs	RARE OR THREATENED SPECIES & COMMUNITIES • Significant Fish – Resident • Significant Fish – Dependent • Significant Birds • Significant Reptiles • Significant Flora • Significant Estuarine EVCs

Environmental Values (cont.)

AVIRA ENVIRONMENTAL VALUES		
River Reaches	**Wetlands**	**Estuaries**
NATURALNESS • Aquatic Invertebrate Community Condition • Native Fish • Riparian Vegetation Condition	NATURALNESS • Wetland Vegetation Condition	NATURALNESS
LANDSCAPE FEATURES • Drought Refuges • Important Bird Habitats • Biosphere Reserves	LANDSCAPE FEATURES • Drought Refuges • Important Bird Habitats (Important Bird Areas, Migratory Shorebird Sites, Colonial Nesting Bird Sites) • Biosphere Reserves	LANDSCAPE FEATURES • Drought Refuges • Important Bird Habitats • Biosphere Reserves

22.2 Social Values

AVIRA SOCIAL VALUES		
River Reaches	**Wetlands**	**Estuaries**
ACTIVITY • Recreational Fishing • Non-Motor Boating • Motor Boating • Camping • Swimming • Beside Water Activities o Walking, Hiking, Cycling o Sightseeing o Picnics/Barbecues • Game Hunting	ACTIVITY • Recreational Fishing • Non-Motor Boating • Motor Boating • Camping • Swimming • Beside Water Activities o Walking, Hiking, Cycling o Sightseeing o Picnics/Barbecues • Game Hunting	ACTIVITY • Recreational Fishing • Non-Motor Boating • Motor Boating • Camping • Swimming • Beside Water Activities o Walking, Hiking, Cycling o Sightseeing o Picnics/Barbecues • Game Hunting
PLACE • Heritage o Pre-European (Indigenous) Heritage o Post-European Heritage • Landscape	PLACE • Heritage o Pre-European (Indigenous) Heritage o Post-European Heritage • Landscape	PLACE • Heritage o Pre-European (Indigenous) Heritage o Post-European Heritage • Landscape
PEOPLE • Community Groups • Use of Flagship Species	PEOPLE • Community Groups • Use of Flagship Species	PEOPLE • Community Groups • Use of Flagship Species

22.3 Economic Values

AVIRA ECONOMIC VALUES		
River Reaches	**Wetlands**	**Estuaries**
WATER	WATER	WATER
• Urban/Rural Township Water Sources	• Urban/Rural Township Water Sources	• Urban/Rural Township Water Sources
• Rural Water Sources for Production	• Rural Water Sources for Production	• Rural Water Sources for Production
• Water Storages	• Water Storages	• Wastewater Discharges
• Water Carriers	• Water Carriers	
• Wastewater Discharges	• Wastewater Discharges	
POWER GENERATION	POWER GENERATION	
• Hydro-Electricity	• Hydro-Electricity	
OTHER RESOURCES	OTHER RESOURCES	OTHER RESOURCES
• Commercial Fishing	• Commercial Fishing	• Commercial Fishing
• Extractive Industries	• Extractive Industries	• Extractive Industries
• Timber Harvesting and Firewood Collection	• Timber Harvesting and Firewood Collection	• Timber Harvesting and Firewood Collection

23 Summary of AVIRA Threats

AVIRA THREATS		
River Reaches	**Wetlands**	**Estuaries**
ALTERED WATER REGIMES • Altered Flow Regimes o Increase in Low Flow Magnitude o Reduction in High Flow Magnitude o Increase in Proportion of Zero Flow o Change in Monthly Streamflow Variability o Altered Streamflow Seasonality	ALTERED WATER REGIMES • Changed Water Regime	ALTERED WATER REGIMES • Altered Flow Regimes o Increase in Low Flow Magnitude o Reduction in High Flow Magnitude o Increase in Proportion of Zero Flow o Change in Monthly Streamflow Variability o Altered Streamflow Seasonality • Altered Marine Exchange o Intermittently Open Estuaries o Permanently Open Estuaries
ALTERED PHYSICAL FORM • Bank Instability • Bed Instability (Degradation)	ALTERED PHYSICAL FORM • Reduced Wetland Area • Altered Wetland Form	ALTERED PHYSICAL FORM • Bank Instability • Reduced Estuary Extent
POOR WATER QUALITY • Degraded Water Quality o EC, turbidity, pH, P o SIGNAL o Algal blooms, fish deaths • Thermal Water Pollution • Disturbance of Acid Sulfate Soils	POOR WATER QUALITY • Changed Water Properties o Salinity o Nutrients • Disturbance of Acid Sulfate Soils	POOR WATER QUALITY • Degraded Water Quality o DO, turbidity, pH, Chlorophyll a o Excessive instream macrophyte growth o Algal blooms, fish deaths • Disturbance of Acid Sulfate Soils

Summary of Threats (cont.)

AVIRA THREATS		
River Reaches	**Wetlands**	**Estuaries**

DEGRADED HABITATS
• Degraded Riparian Vegetation
  o Large Trees
• Loss of Instream Habitat
  o Large Wood
  o Sedimentation
• Livestock Access
	DEGRADED HABITATS
	• Soil Disturbance
	• Degraded buffer vegetation
	• Livestock Access
		DEGRADED HABITATS
		• Degraded Estuarine Vegetation
		• Livestock Access

INVASIVE FLORA AND FAUNA
• Invasive Flora (Riparian)
  o Trees
  o Shrub Layer
  o Ground Layer
• Invasive Flora (Aquatic)
• Invasive Fauna (Terrestrial)
• Invasive Fauna (Aquatic)
	INVASIVE FLORA AND FAUNA
	• Invasive Flora (Wetland)
	• Invasive Fauna (Terrestrial)
	• Invasive Fauna (Aquatic)
		INVASIVE FLORA AND FAUNA
		• Invasive Flora (Riparian)
		  o Trees
		  o Shrub Layer
		  o Ground Layer
		• Invasive Flora (Aquatic)
		• Invasive Fauna (Terrestrial)
		• Invasive Fauna (Aquatic)

REDUCED CONNECTIVITY
• Barriers to Fish Migration
• Reduced Riparian Connectivity
  o Longitudinal Continuity
  o Vegetation width
• Reduced Floodplain Connectivity
	REDUCED CONNECTIVITY	REDUCED CONNECTIVITY
		• Barriers to Estuarine Biota
		• Reduced Floodplain and Wetland Connectivity

Part F Summary of the Risk Assessment Process

This appendix provides a summary of the risk assessment process used within AVIRA. The process is described in full in Peters G, Doeg T and Herron S, 2009, *Aquatic Value Identification and Risk Assessment (AVIRA) – Risk Assessment Process*, Report Prepared for the Department of Sustainability and Environment.

24 Risk Assessment Process for AVIRA

24.1 Risk Management Process

The Victorian River Health Strategy (DNRE 2002) and the Victorian Waterway Management Strategy (2013) stated that RRHSs and RWSs will set priorities for protection and restoration using a risk-based approach.

Establishing a risk-based approach within AVIRA will provide guidance that enables CMAs, Melbourne Water and DSE to achieve:

- a more confident and rigorous basis for decision-making and planning;
- better identification of opportunities and threats;
- pro-active rather than re-active management;
- more effective allocation and use of resources; and
- improved stakeholder confidence and trust.

Risk management is the term applied to the culture, processes and structures that are directed towards realizing potential opportunities whilst managing adverse effects (SA/SNZ 2004 p4).

The risk management process is defined by AS/NZS 4360:2004: Risk Management, and is shown in **Figure 5**.

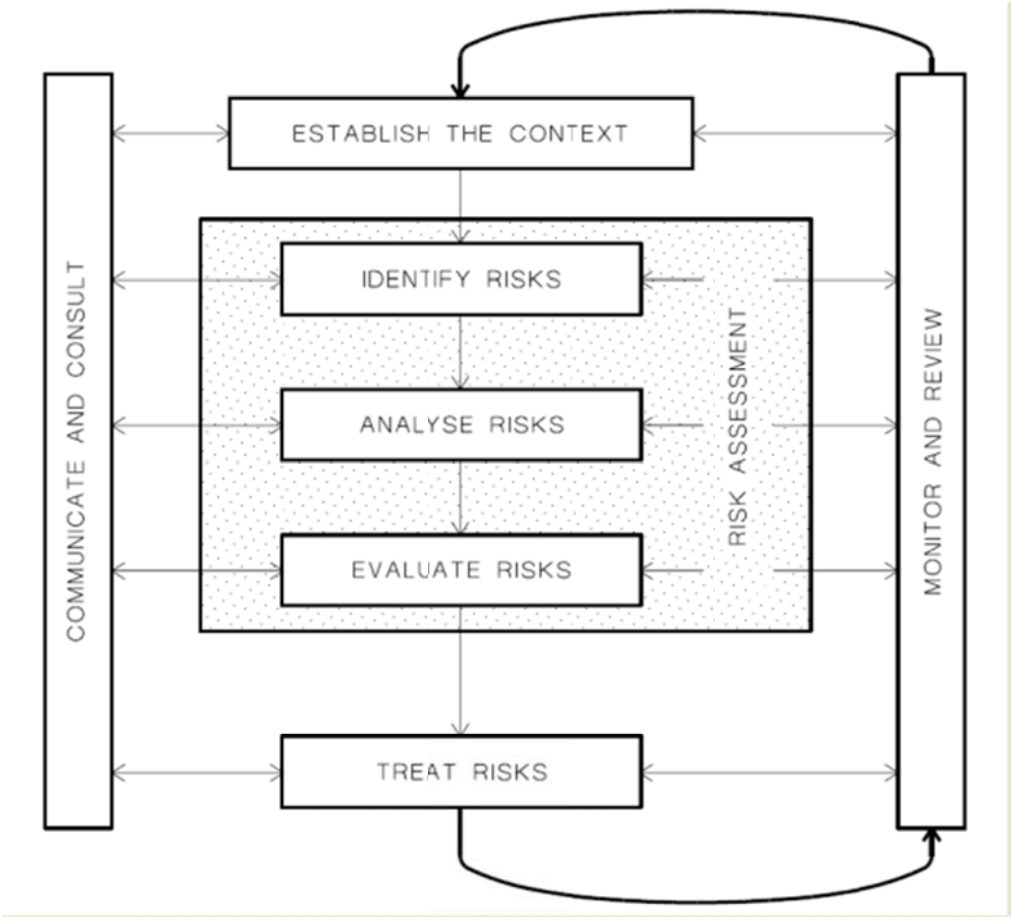

Figure 5 - Risk Management Process from AS/NZS 4360:2004: Risk Management

The risk assessment process for AVIRA is shown in **Figure 6**.

Figure 6 - Risk Assessment Process for AVIRA

24.2 Establishing the Context

24.2.1 Objectives

Risk is the chance of something happening that will impact on the objectives. Therefore to ensure that all significant risks are captured, it is necessary to identify the objectives. The AVIRA risk assessment process is broadly aligned to the objectives of the Victorian Waterway Management Strategy, 2013.

24.2.2 Management Responses

To achieve the objectives broad management responses need to be identified. Broad management responses have been identified for the AVIRA risk assessment process, and are outlined in Section 23.5.

24.2.3 Identifying Risks

To identify the risk, we need to identify the values, threats and causes of these threats. The grouping of values identified for AVIRA which were included in the risk assessment process were:

Environmental

- rare or threatened species/communities
- naturalness
- special features

Social

- activity
- place
- people

Economic

- water
- power generation
- other resources

The threats groupings identified for AVIRA and used in the risk assessment process were:

- Altered Water Regimes;
- Altered Physical Form;
- Poor Water Quality;
- Degraded Habitats;
- Exotic Flora and Fauna; and
- Reduced Connectivity.

Under each grouping individual values and threats have been identified.

24.3 Analysing Risks

To identify risk, the following variables must be defined:

- the impact of the risk if it occurred (the consequence); and
- the probability or frequency of the risk occurring (the likelihood).

A consequence is an outcome or impact of an event. For AVIRA, it is proposed that consequence be evaluated as the severity of the impact that a threat has on a value. Therefore, to measure consequence, we need to determine:

- the value score (e.g.migratory fish);
- the threat score (e.g.the type of fish barrier); and
- the association between the value and the threat (e.g.strong evidence of an association between fish barriers and migratory fish).

An association can be seen as a measure of how much influence a particular threat (e.g.fish barriers) can have on a particular value (e.g.native fish). Each individual threat-value combination has a particular association score. The association rating table for AVIRA and example of possible associations are shown in

Table 3 and

Table 4**.**

Table 3 - Association Rating Table for AVIRA

Association Ratings	Clarifier
High	Threat always or often impacts the value
Medium	Threat may impact the value
Low	Threat does not impact the value, but it is remotely possible.
None	Threat does not impact the value

Table 4 - Example of Possible Associations

		Value Category - Naturalness	
Threat Category	**Threat**	**Aquatic macroinvertebrates**	**Native Fish**
Reduced Connectivity	Barriers	Low	High*
	Altered Longitudinal Continuity	Medium	Medium
Altered Water Regimes	Changed Variability	Low	Medium
	Reduced High Flow	Low	Medium

To further refine the association ratings, a level of confidence should be applied to the source of the information. The confidence ratings are shown in Table 5.

Table 5 - Confidence Ratings for Associations in AVIRA

Confidence Ratings	Clarifier
High	Repeated scientific evidence supports association rating
Medium	Single studies or observations suggests association rating
Low	Expert/professional opinion based on logical/plausible connection rather than direct evidence

Three consequence ratings were developed based on level of association (high, medium or low). If no association existed, there is no risk. These are shown in **Figure 7**, **Figure 8** and **Figure 9**.

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NC	VL	L	M	H	VH	VH
	5	NC	VL	L	M	H	VH	VH
	4	NC	NC	VL	L	M	H	H
	3	NC	NC	NC	VL	L	M	M
	2	NC	NC	NC	NC	VL	L	L
	1	NC	NC	NC	NC	NC	VL	VL
	0	NC	NC	NC	NC	NC	NC	NC

Figure 7 - Consequence Rating Table for High Value-Threat Associations

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NC	NC	VL	L	M	H	H
	5	NC	NC	VL	L	M	H	H
	4	NC	NC	NC	VL	L	M	M
	3	NC	NC	NC	NC	VL	L	L
	2	NC	NC	NC	NC	NC	VL	VL
	1	NC	NC	NC	NC	NC	NC	NC
	0	NC	NC	NC	NC	NC	NC	NC

Figure 8 - Consequence Rating Table for Medium Value-Threat Associations

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NC	NC	NC	VL	L	M	M
	5	NC	NC	NC	VL	L	M	M
	4	NC	NC	NC	NC	VL	L	L
	3	NC	NC	NC	NC	NC	VL	VL
	2	NC	NC	NC	NC	NC	NC	NC
	1	NC	NC	NC	NC	NC	NC	NC
	0	NC	NC	NC	NC	NC	NC	NC

Figure 9 - Consequence Rating Table for Low Value-Threat Assocations

Likelihood is a general description of probability or frequency where: probability is a measure of the chance of occurrence; and frequency is a measure of the number of occurrences per unit of time. Likelihood can be measured or estimated in terms of general descriptors (such as rare, unlikely, likely, almost certain), frequencies or (mathematical) probabilities. The likelihood rating table for AVIRA is shown in

Table 6.

Table 6 - Likelihood Rating Table for AVIRA

Descriptor	Description	Existing Threat Score
Certain	Existing Threats Threat already occurring AND is not expected to increase or decrease in the next six years	0, 1, 2, 3, 4 or 5
Probable	Modified Threats Threat already occurring AND there is clear pressure to increase or decrease the extent or the intensity of the cause of the threat in the next six years	2, 3, 4 or 5
	New Threats Threat currently not present or negligible BUT there is clear pressure to increase the extent or the intensity of the cause of the threat in the next six years	0,1

24.4 Risk Level

The level of risk is determined by combining consequence and likelihood using suitable scales and methods. The level of risk for existing threats (i.e.those that have already occurred and are unlikely to increase or decrease in the foreseeable future) is determined by consequence alone. Therefore, the risk level tables for existing threats are the same as the consequence tables shown in **Figure 7**, **Figure 8** and **Figure 9**, as shown in **Figure 10**.

Determining risk levels for potential threats, requires the modification or 'gaming' of existing threats based on existing threat trajectory and an understanding of probable future threatening processes. The approach for assessing risk levels for potential threats involves an assessment process that occurs outside of the AVIRA software application.

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NR	VL	L	M	H	VH	VH
	5	NR	VL	L	M	H	VH	VH
	4	NR	NR	VL	L	M	H	H
	3	NR	NR	NR	VL	L	M	M
	2	NR	NR	NR	NR	VL	L	L
	1	NR	NR	NR	NR	NR	VL	VL
	0	NR	NR	NR	NR	NR	NR	NR

Figure 10 - Risk Level (High Association)

24.5 Management Response

For AVIRA, available management responses for identified risks include:

- changing the likelihood;
- changing the consequence; or

- retaining the risk.

For existing threats, a set of generic management responses have been recommended, namely:

- Fill data gap (either threat , value or both);
- Reduce threat level (the priority would be to manage or alter the cause of the threat where possible);
- Investigate whether the threat is the cause of the low value score and act accordingly (e.g.no action, reduce threat);
- Protect (prevent an increase in the threat level); and
- No priority action.

These generic responses were applied to the risk tables, to form a set of management response tables for existing threats shown in **Figure 11**, **Figure 12** and **Figure 13**. For potential threats, prevention is the key primary response.

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NR No Priority Action	VL No Priority Action	L Fill Data Gap	M Fill Data Gap	H Fill Data Gap	**VH Fill Data Gap**	**VH Fill Data Gap**
	5	NR No Priority Action	VL No Priority Action	L Investigate	M Investigate	H Reduce Threat	**VH Reduce Threat**	**VH Fill Data Gap**
	4	NR No Priority Action	NR No Priority Action	VL Investigate	L Investigate	M Reduce Threat	H Reduce Threat	H Fill Data Gap
	3	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Investigate	L Reduce Threat	M Reduce Threat	M Fill Data Gap
	2	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Protect	L Protect	L Fill Data Gap
	1	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Protect	VL No Priority Action
	0	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action

Figure 11 - Risk Level and Management Response for Existing Threats (High Association)

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NR No Priority Action	NR No Priority Action	VL Fill Data Gap	L Fill Data Gap	M Fill Data Gap	H Fill Data Gap	H Fill Data Gap
	5	NR No Priority Action	NR No Priority Action	VL Investigate	L Investigate	M Reduce Threat	H Reduce Threat	H Fill Data Gap
	4	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Investigate	L Reduce Threat	M Reduce Threat	M Fill Data Gap
	3	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Reduce Threat	L Reduce Threat	L Fill Data Gap
	2	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Protect	VL Fill Data Gap
	1	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action
	0	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action

Figure 12 - Risk Level and Management Response for Existing Threats (Moderate Association)

		Value Score						
		0	1	2	3	4	5	No Data
Threat Score	No Data	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Fill Data Gap	L Fill Data Gap	M Fill Data Gap	M Fill Data Gap
	5	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Investigate	L Reduce Threat	M Reduce Threat	M Fill Data Gap
	4	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Reduce Threat	L Reduce Threat	L Fill Data Gap
	3	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	VL Reduce Threat	VL Fill Data Gap
	2	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action
	1	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action
	0	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action	NR No Priority Action

Figure 13 - Risk Level and Management Response for Existing Threats (Low Association)

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Appendix A - Workshop Participants

Workshop 1 - Environmental Values of River Reaches (7th July 2008)

Jane Doolan (DSE, SWE&ID)
Sarina Loo (DSE, SWE&ID)
Paul Wilson (DSE, SWE&ID)
Ian Rutherfurd (DSE, SWE&ID)
Kirsty Hopkins (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Adrian Moorrees (DSE, BES)
Chris Schweizer (Australian Government)
Nick Bond (Monash University, eWater)
Sam Lake (Monash University)
Rhys Coleman (Melbourne Water)
Wayne Tennant (Goulburn Broken CMA)
Greg Peters (Riverness)
Shelley Heron (KBR)
Tim Doeg (Consultant)
Leon Metzeling (EPA Victoria)
Stephen Saddlier (DSE, ARI)
Pat Feehan (Goulburn Broken CMA)
Phil Slessar (North Central CMA)
Patrick Lea (University of Melbourne, eWater)

Workshop 2 - Threats to River Reaches (8th July 2008)

Jane Doolan (DSE, SWE&ID)
Sarina Loo (DSE, SWE&ID)
Paul Wilson (DSE, SWE&ID)
Ian Rutherfurd (DSE, SWE&ID)
Kirsty Hopkins (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Chris Schweizer (Australian Government)
Nick Bond (Monash University, eWater)
Rhys Coleman (Melbourne Water)
Wayne Tennant (Goulburn Broken CMA)
Greg Peters (Riverness)
Shelley Heron (KBR)
Tim Doeg (Consultant)
Leon Metzeling (EPA Victoria)
Stephen Saddlier (DSE, ARI)
Pat Feehan (Goulburn Broken CMA)
Phil Slessar (North Central CMA)
Patrick Lea (University of Melbourne, eWater)

Workshop 3 - Risk Assessment Process (1st August 2008)

Sarina Loo (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Belinda Wong (DSE, Organisational Risk)
Nick Bond (Monash University, eWater)
Greg Peters (Riverness)
Shelley Heron (KBR)
Tim Doeg (Consultant)
Anne-Maree Westbury (EPA Victoria)
Patrick Lea (University of Melbourne, eWater)

Workshop 4 - Environmental Values and Threats for Wetlands (4th September 2008)

Ian Rutherfurd (DSE, SWE&ID)
Sarina Loo (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Andrea Joyce (DSE, North West)
Phil Papas (DSE, ARI)
Michael Smith (DSE, ARI)
Yvette Baker (DSE, BES)
Greg Peters (Riverness)

Shelley Heron (KBR)
Michelle Dickson (West Gippsland CMA)
Donna Smithyman (Corangamite CMA)
Simon Casanelia (Goulburn Broken CMA)
Will Steele (Melbourne Water)
Emer Campbell (North Central CMA)
Rhonda Butcher (Water's Edge)
Paul Boon (Victoria University)

Workshop 5 - Social Values (30th September 2008)

Ian Rutherfurd (DSE, SWE&ID)
Sarina Loo (DSE, SWE&ID)
Michelle Dickson (West Gippsland CMA)
Victoria Penko (DSE, SWE&ID)
Greg Bain (Melbourne Water)
John Cary (Victoria University)
Jane Ryan (DSE, SWE&ID)
Casey Damen (Goulburn Broken CMA)
Greg Peters (Riverness)

Workshop 6 - Economic Values (1st October 2008)

Ian Rutherfurd (DSE, SWE&ID)
Sarina Loo (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Claire Edwards (DSE, EEU)
Ingrid Burford (DSE, EEU)
Deb Brown (DSE, WES)
Helen Campbell (Melbourne Water)
Greg Peters (Riverness)

Workshop 7 - Environmental Values and Threats for Estuaries (13th November 2008)

Sarina Loo (DSE, SWE&ID)
Janet Holmes (DSE, BES)
Paul Wilson (DSE, SWE&ID)
Jeremy Hindell (DSE, ARI)
Adam Pope (Deakin University)
David Tiller (Karoo Consulting)
Simone Wilkie (Corangamite CMA)
Michelle Dickson (West Gippsland CMA)
Anne Casey (Melbourne Water)
Chris Barry (Gippsland Coastal Board)
Nina Bate (EPA Victoria)
Greg Peters (Riverness)

Appendix B - List of Estuaries in AVIRA

Estuary systems included in AVIRA. Note that for those estuaries that are not part of the IEC program many of the AVIRA threat metrics will not be populated.

CMA	AVIRA ID	System Name	IEC
Glenelg Hopkins	36~201	Hopkins River	Yes
Glenelg Hopkins	36~238	Merri River	Yes
Glenelg Hopkins	37~201	Wattle Hill Creek	No
Glenelg Hopkins	37~203	Surrey River	No
Glenelg Hopkins	37~206	Fitzroy River	Yes
Glenelg Hopkins	37~211	Lake Yambuk (Eumeralla Rv)	Yes
Glenelg Hopkins	37~216	Moyne River	No
Glenelg Hopkins	38~201	Glenelg River	Yes
Corangamite	32~215	Limeburners Lagoon (Hovell)	No
Corangamite	33~201	Barwon River	No
Corangamite	35~201	Curdies Inlet	Yes
Corangamite	35~202	Sherbrook River	No
Corangamite	35~203	Johanna River	No
Corangamite	35~211	Campbell Creek	Yes
Corangamite	36~212	Gellibrand River	Yes
Corangamite	35~227	Aire River	Yes
Corangamite	35~230	Barham River	Yes
Corangamite	35~233	Erskine River	Yes
Corangamite	35~234	Anglesea River	Yes
Corangamite	35~235	Spring Creek	Yes
Corangamite	36~236	Thompson Creek	Yes
Corangamite	35~242	Painkalac Creek	Yes
Corangamite	35~244	St George River	No
Corangamite	35~246	Wye River	Yes
Corangamite	35~247	Kennett River	Yes

CMA	AVIRA ID	System Name	IEC
West Gippsland	25~219	Avon River	No
West Gippsland	26~201	LaTrobe River	No
West Gippsland	27~203	Bourne Creek	Yes
West Gippsland	27~204	Wreck Creek	Yes
West Gippsland	27~205	Powlett River	Yes
West Gippsland	27~206	Shallow Inlet	No
West Gippsland	27~207	Old Hat Creek	No
West Gippsland	27~208	Stockyard Creek	No
West Gippsland	27~210	Anderson Inlet	Yes
West Gippsland	27~211	Darby River	No
West Gippsland	27~213	Sealers Creek	No
West Gippsland	27~214	Miranda Creek	Yes
West Gippsland	27~218	Jack Smith Lake	Yes
West Gippsland	27~220	Bennison Creek	No
West Gippsland	27~221	Franklin River	No
West Gippsland	27~223	Tidal River	Yes
West Gippsland	27~225	Agnes River	No
West Gippsland	27~227	Nine Mile Creek	No
West Gippsland	27~228	Albert River	No
West Gippsland	27~233	Tarra River	Yes
West Gippsland	27~236	Bruthen Creek	No
West Gippsland	27~239	Merriman Creek	No
East Gippsland	21~201	Yeerung River	Yes
East Gippsland	21~202	Sydenham Inlet	Yes
East Gippsland	21~203	Mueller River	Yes
East Gippsland	21~208	Shipwreck Creek	Yes
East Gippsland	21~212	Tamboon Inlet	Yes
East Gippsland	21~224	Thurra River	Yes
East Gippsland	21~226	Wingan Inlet	Yes
East Gippsland	21~230	Mallacoota Inlet	Yes

CMA	AVIRA ID	System Name	IEC
East Gippsland	22~203	Snowy River	Yes
East Gippsland	23~204	Tambo River	No
East Gippsland	23~205	Mississippi Creek	No
East Gippsland	23~206	Bunga Creek	Yes
East Gippsland	23~221	Lake Tyers	Yes
East Gippsland	24~201	Tom Creek	No
East Gippsland	24~203	Newlands Arm	No
East Gippsland	24~204	Mitchell/Nicholson	Yes

Appendix C - AVIRA User Manual – Version 2, November 2012

Contents

AVIRA User Manual

1. Log in to AVIRA

AVIRA is a desktop application accessible from a Citrix environment using a web browser. It is developed as a plug-in to the Open Source GIS product, MapWindow.

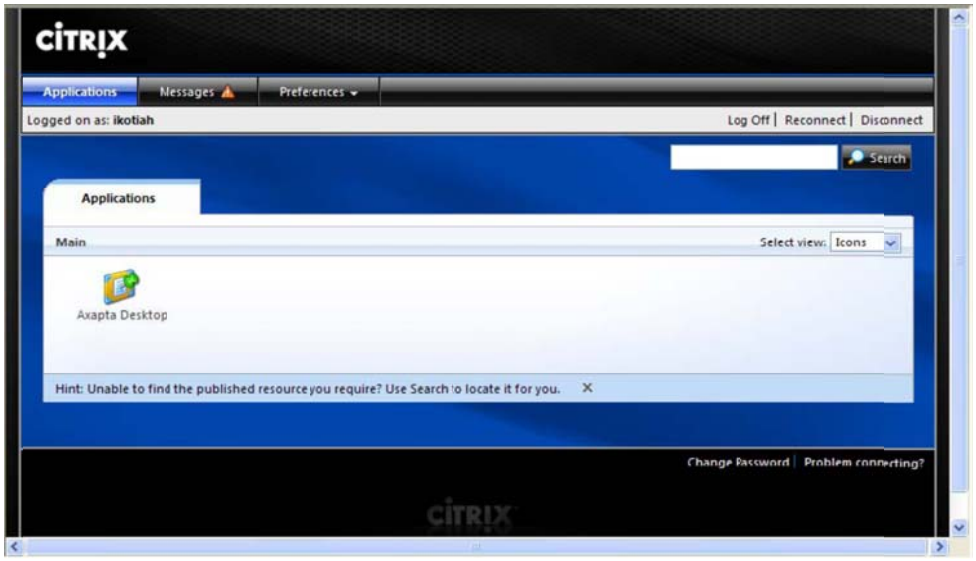
You need to connect to the Citrix environment from a web browser using the following URL:

https://citrix.dosae.integr8it.com.au/Citrix/XenApp/auth/login.aspx

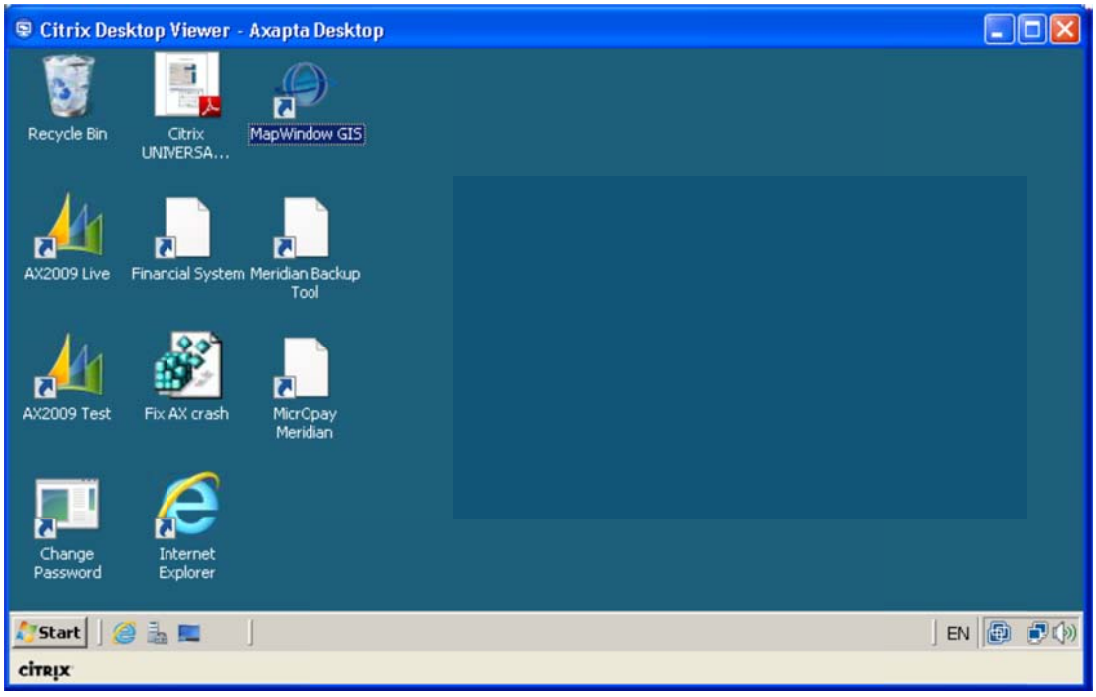
Access to the application requires authentication on two levels: to the Citrix server and to the application itself. Users authenticate in the Citrix environment. This gives access to the Axapta Desktop.

Step 1: Log in to Citrix

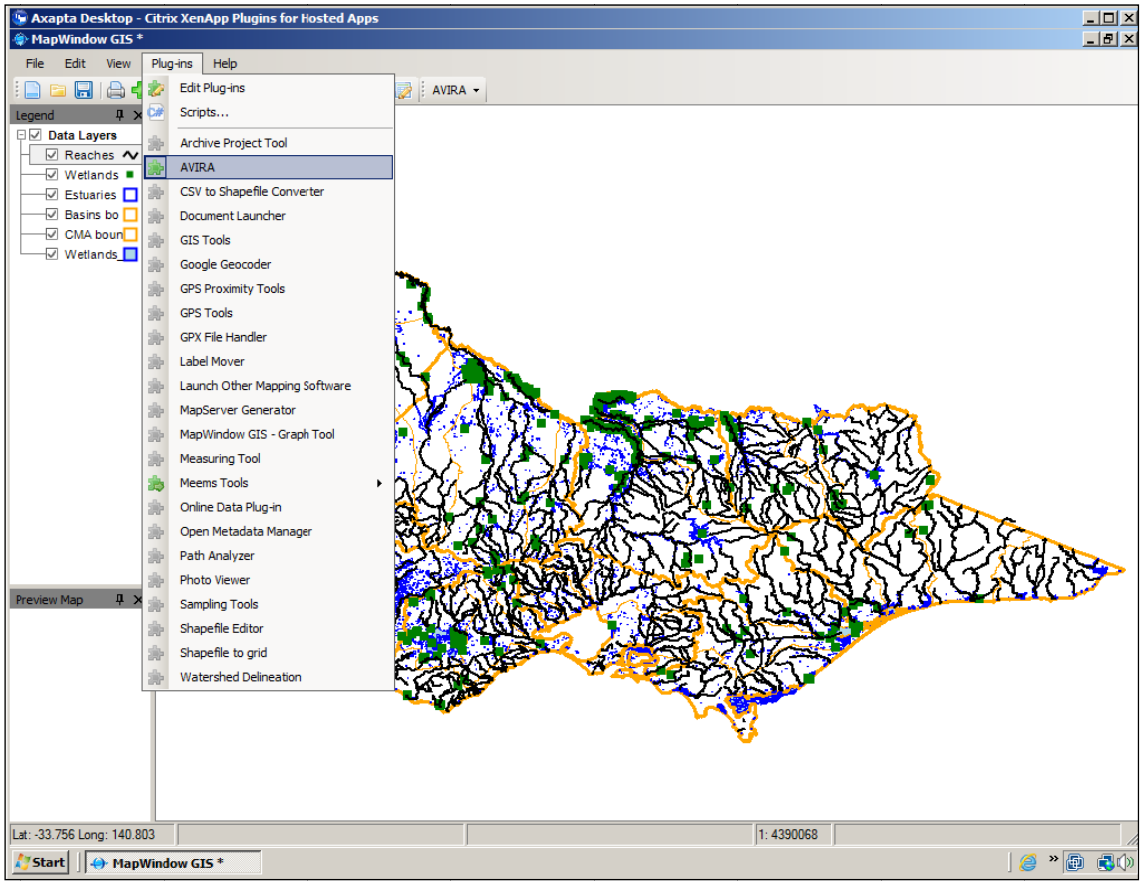
Step 2: Click on Axapta Desktop



Step 3: Double click on MapWindow

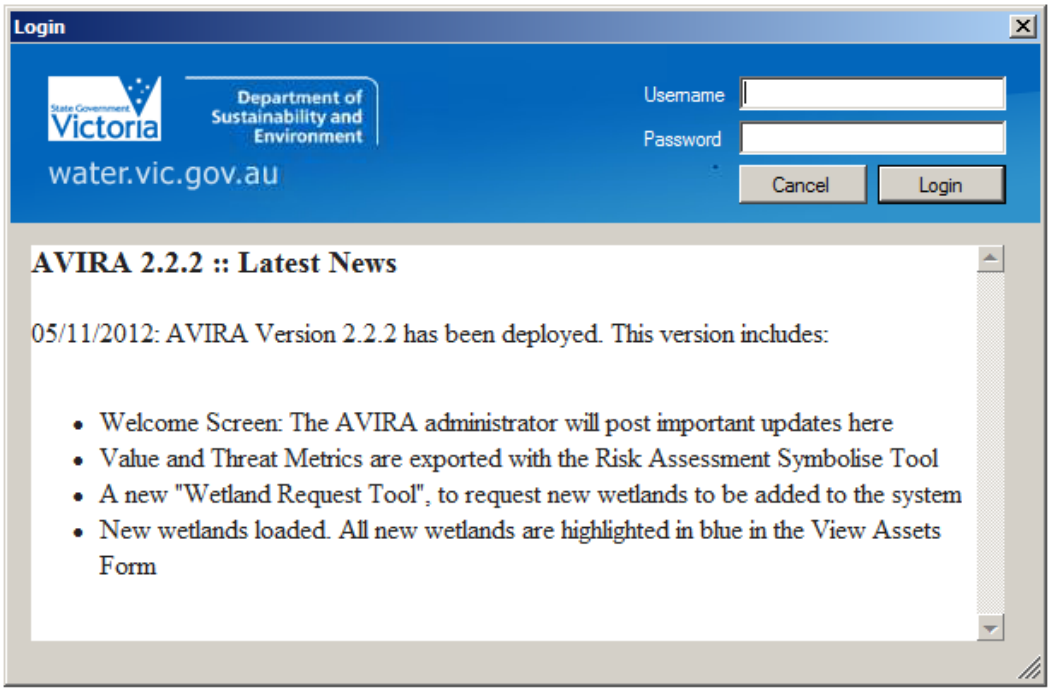


Step 4: Activate the AVIRA plugin (Plug-ins drop-down menu). User will be prompted to download the plug-in the first time the site is accessed.

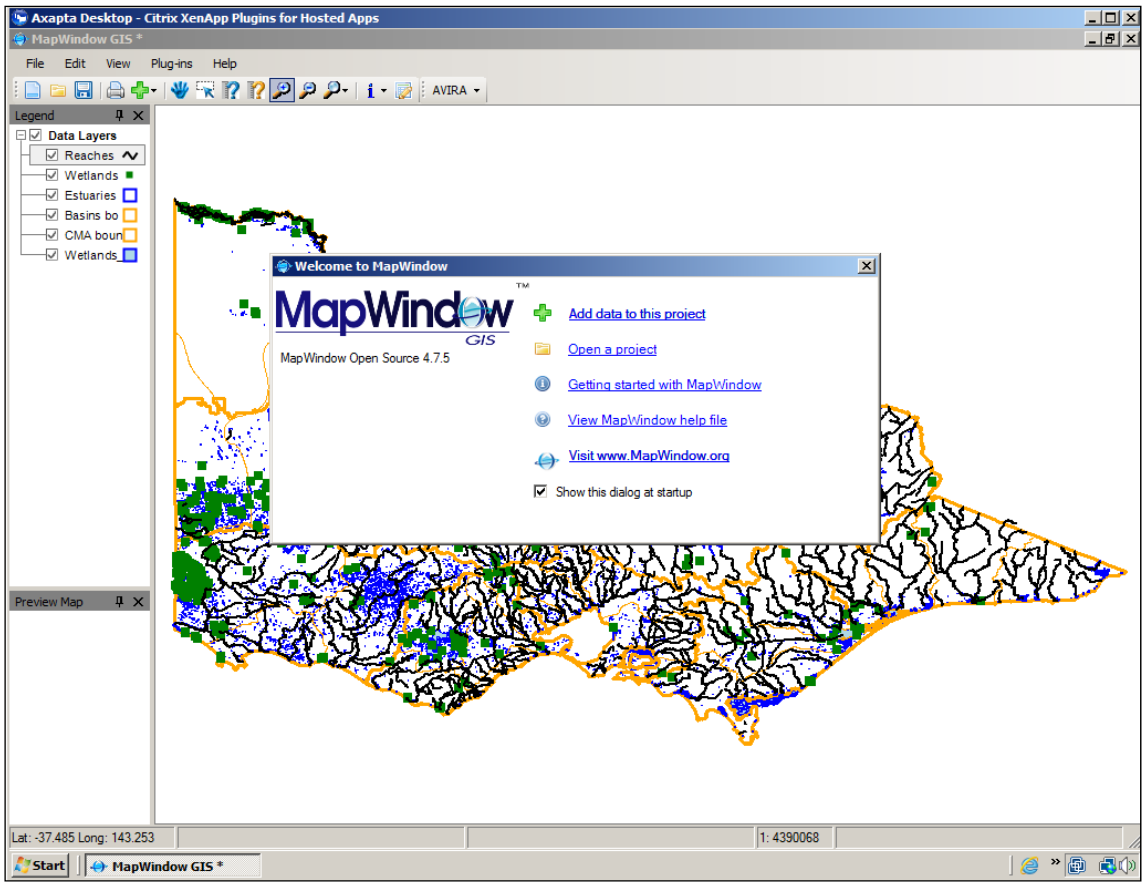


Step 5: Log in to AVIRA

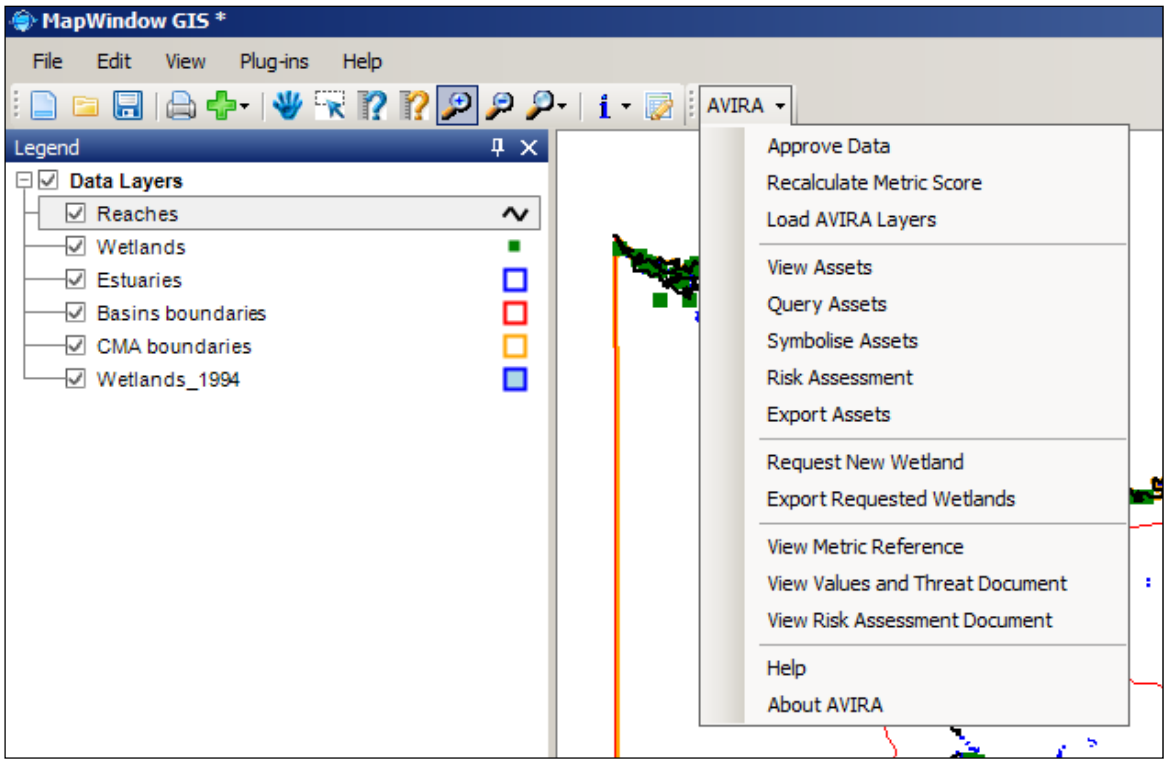
The log in screen includes a “Welcome Screen” where updates are posted.



Step 6: You will be prompted to ‘Add Data’ / ‘Open a Project’ etc. – simply close this window.



The **AVIRA** menu should be immediately available.



Map Window User Manual

A MapWindow User Manual can be accessed using the following link:

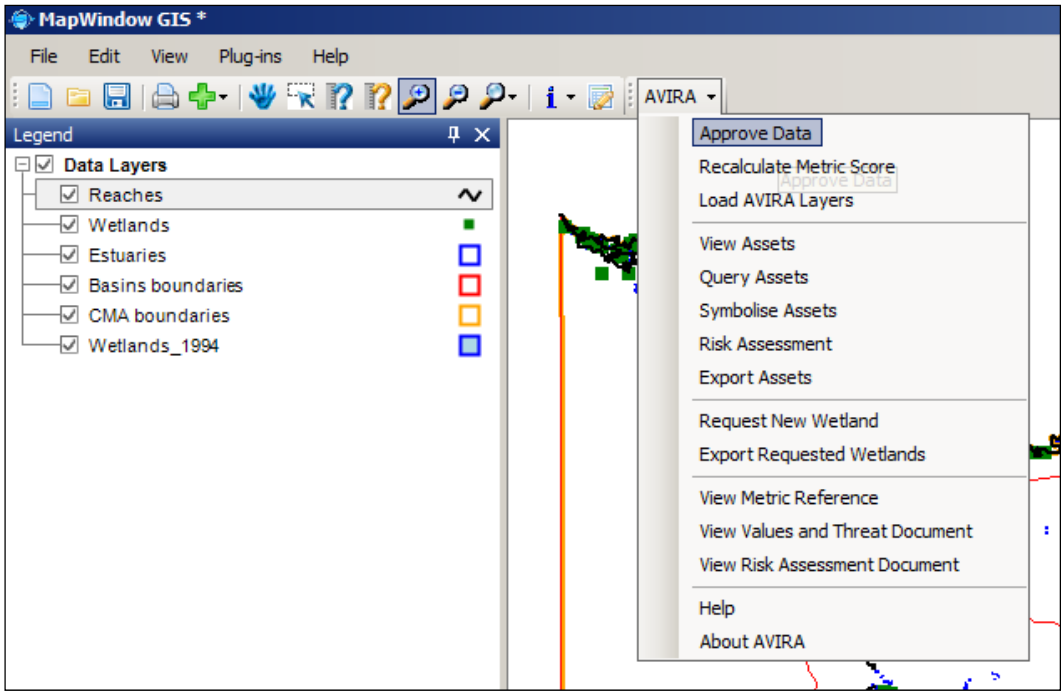
http://www.mapwindow.org/apps/wiki/doku.php?id=mapwindow_4_users_manual

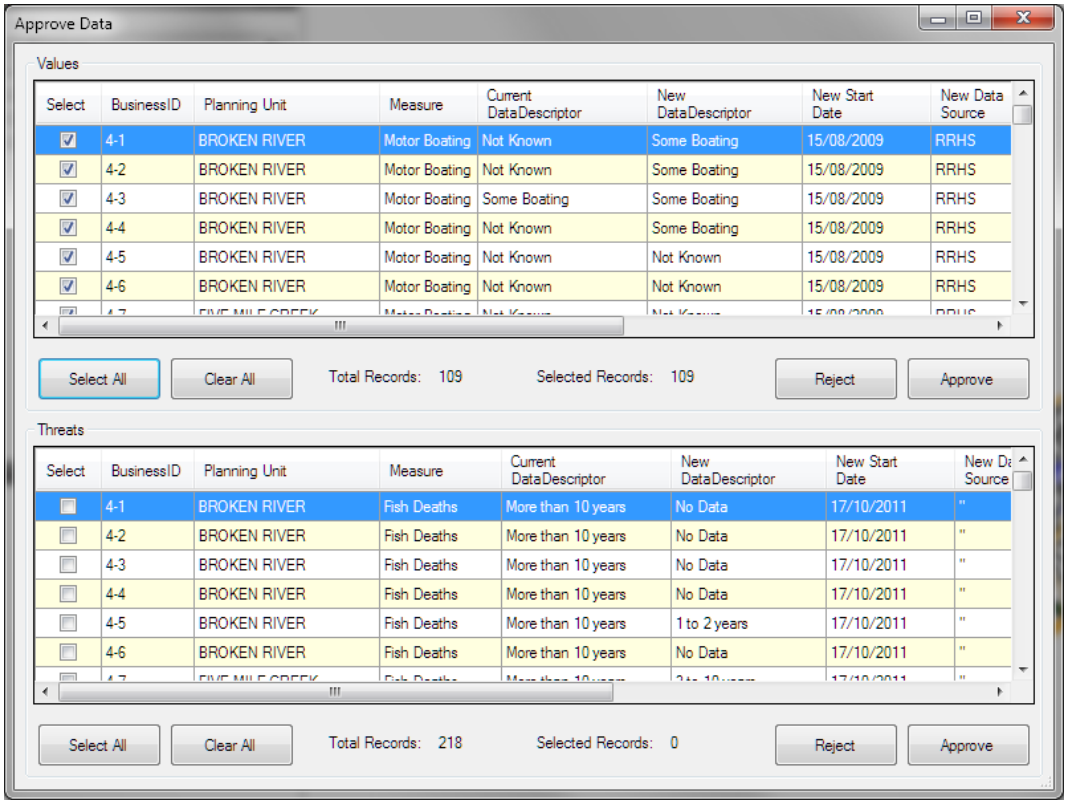
The manual is very helpful if you are not familiar with MapWindow. Particularly useful sections are the *Main User Interface*, *Working with the Legend* and *Creating Print Layouts*. The print layout can be used to create a Map Layout through the File>Print option. This invokes a Print layout from which you can arrange the map and other elements (e.g. north arrow) and either print the layout or export to PNG, BMP, GIF or TIF for insertion into a report. Exporting is possible through the Select>Convert to Bitmap menu option in the Print Layout form.

2. Approve Data: DSE Administrator only

Purpose: Enables DSE administrator to approve or reject all imported measure values.

The **Approve Data** form is only availabe to the **DSE user with administrator permission**. It will allow the administrator to approve or reject all imported measure values. After logging in, the Approve Data form will be automatically opened on startup. The Approve Data Form can also be accessed from **AVIRA > Approve Data.**





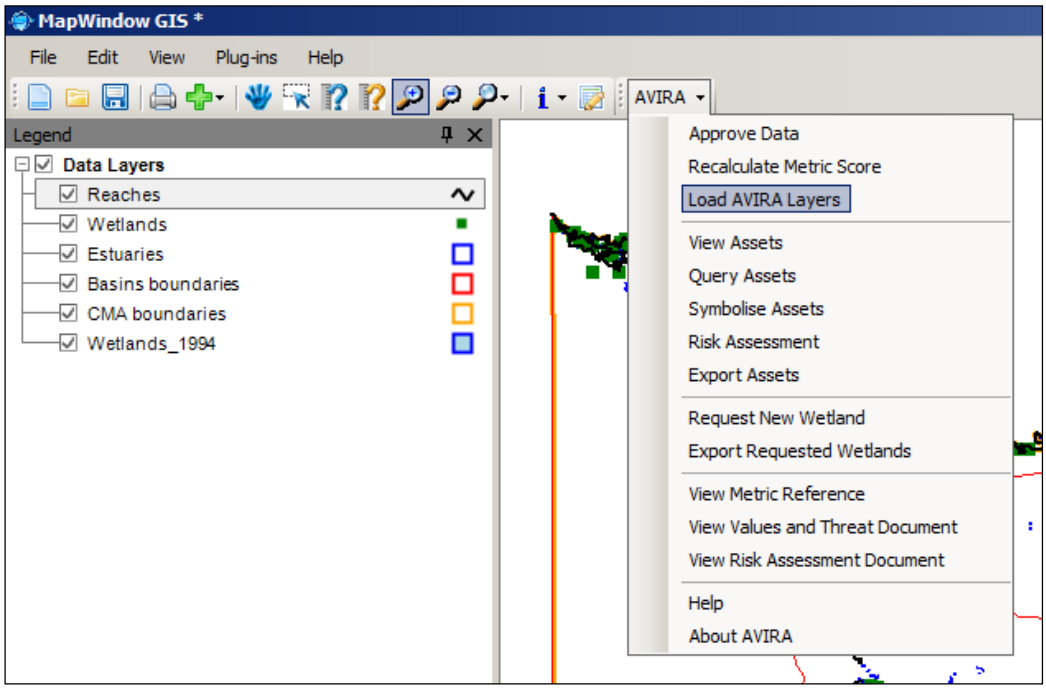
When a general user imports data, only those measures that do not have a value already inserted in the table for a given asset will be added, others will be inserted in the Temporary Import table for Approval (only availabe to the **DSE user with administrator permission**). The approver will compare 'current' (original) and new data and assess if original data is to be overriden, using the information contained in the rationale.

- **Reject** – Reject checked measure value.
- **Approve** – Approve checked measure value.

3. Load AVIRA Layers

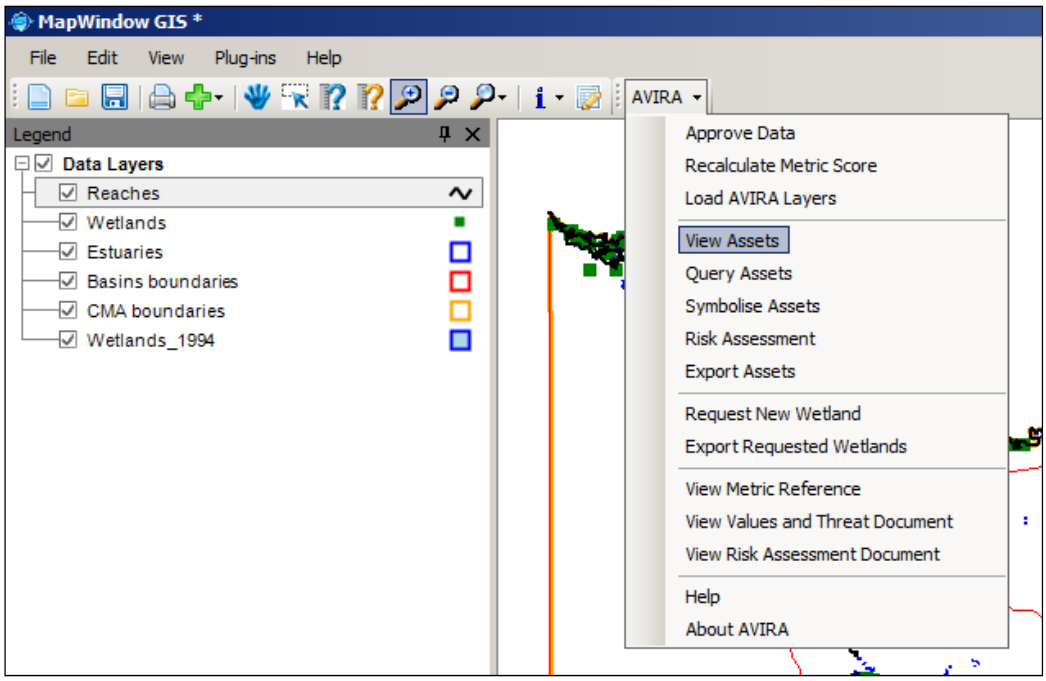
Purpose: Use the load layers command to add the default startup layers into the map view, if for some reason they do not appear.

The Load AVIRA Layers command is accessed from AVIRA > Load AVIRA Layers.



4. View Assets

To open the **Assets** form, click **AVIRA > View Assets**.



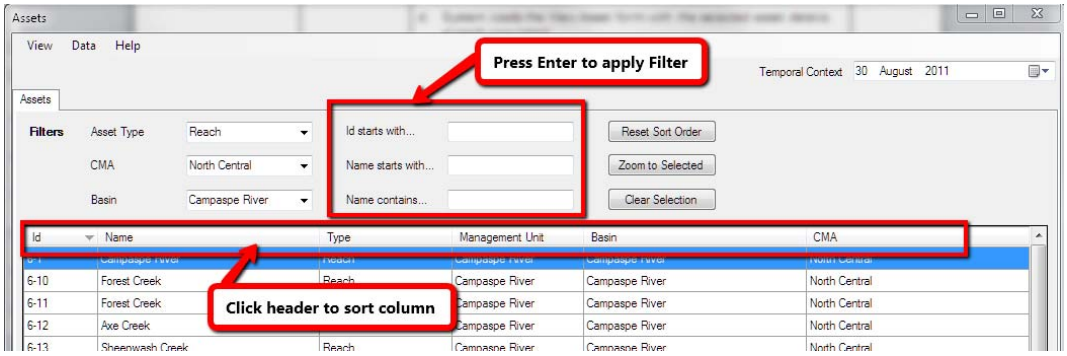
From the **Assets** Form, the user can:

- 4.1 Select Assets
- Access a Detailed View for Individual **Assets**
- 4.3 Import Measure Data (for Values and Threats)

4.1 Select Assets

Purpose: The **Assets View** displays general information for any assets selected in the mapping view.

The **Assets** tab is the default view, it will display general information for any assets selected in the mapping view (selected using the 'Select' Tool in MapWindow). If no assets are selected in the mapping view, then no assets will be shown. Click the Show All Assets button to show all available assets.



- **Filters -** You can use the filters to query and limit the number of listed assets – this will speed up processing significantly and is highly recommended (i.e. work on a subset of assets rather than the whole list, e.g. a single basin).
- The drop down filters (Asset Type, CMA and Basin) will be automatically applied when changed. For the textbox filters (Id starts with, Name begins with, and Name contains) user will need to **press Enter** to apply the filter. Please note, the text filters are case sensitive (e.g. to filter for all lakes use 'Lakes' as the filter).
- **Sort** - Click on the table header to sort the column alphabetically.
- **Reset Sort Order –** Reset default sort order using the ID column (the default sort order is alphabetical, i.e. 1-1 is followed by 1-2 not 1-10).
- **Zoom to Listed** – Zoom to all assets listed in the table. This will change the extent of the area shown in the map window. E.g. select the Barwon River Basin and the mapped area in the map window will show just this basin, with the assets highlighted.
- **Show All Assets** – Remove all filters, and show all available assets in the table.

4.2 Detailed View for Individual Asset

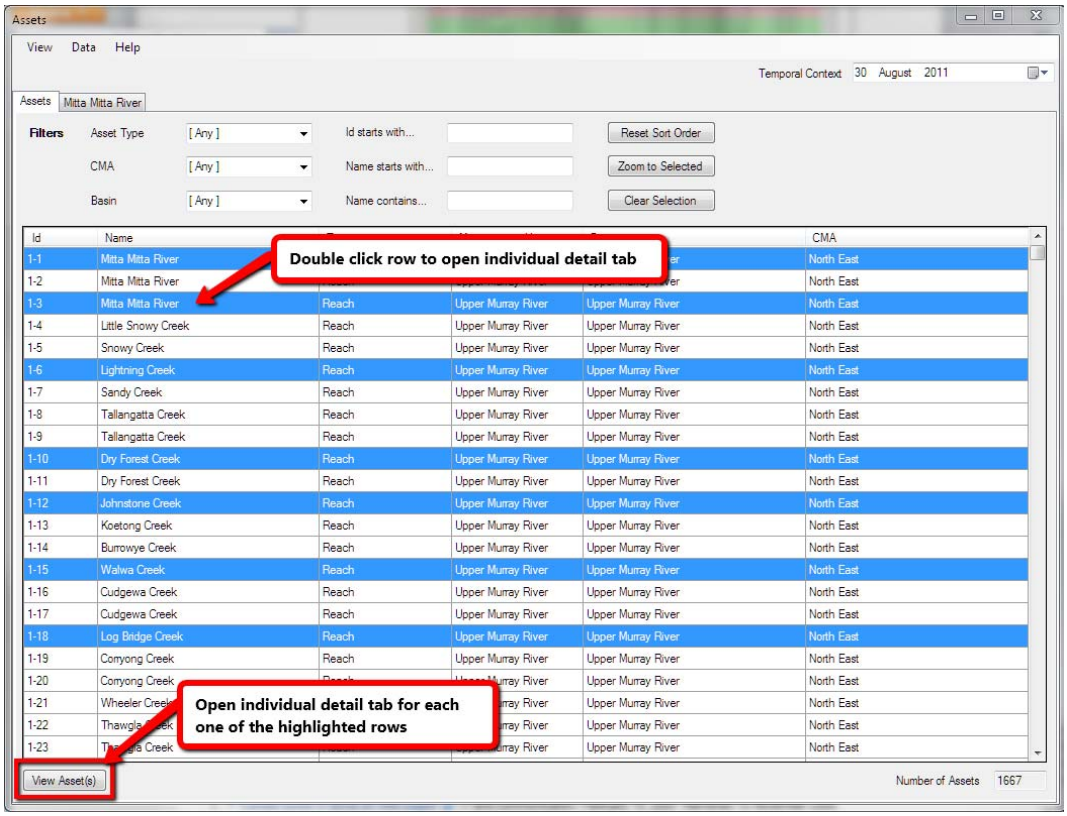
Purpose: The **Detailed View** allows the user to view metrics, risk assessments and base data for individual assets.

From the **Assets** tab, user can access the **detailed view** for individual assets via two ways:

Double click on the table row to open up the detailed view for a single asset, or

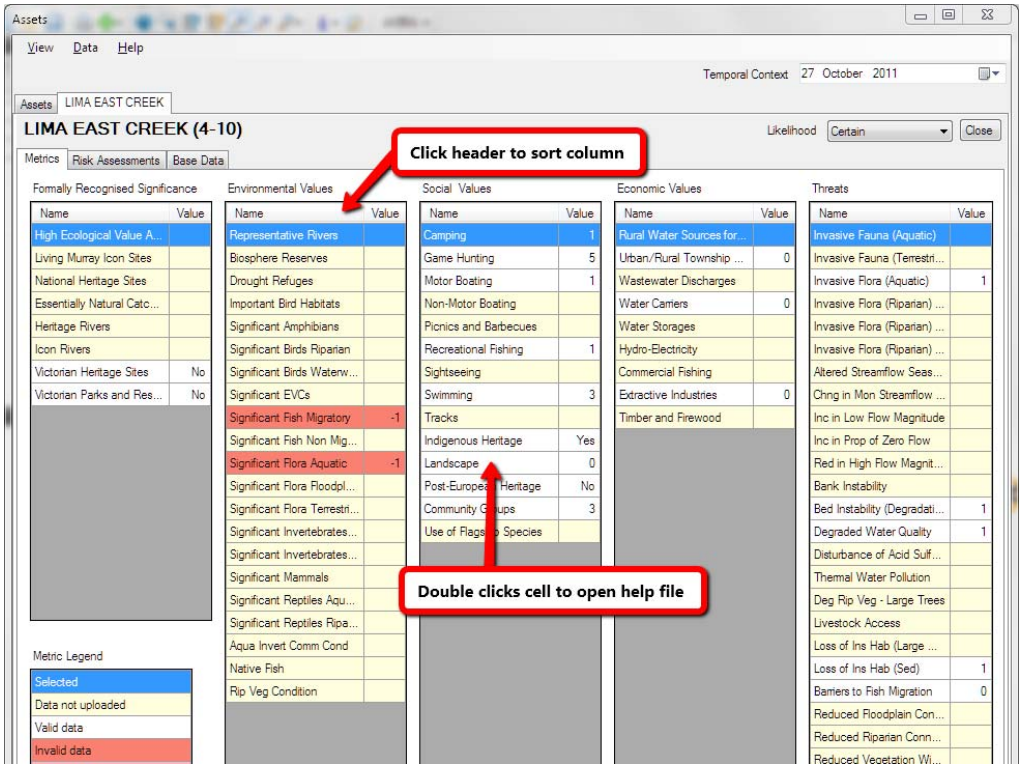
Highlight multiple assets by holding the down the Shift Key and then click the **View Asset(s)** button (bottom left-hand corner).

See diagram below.

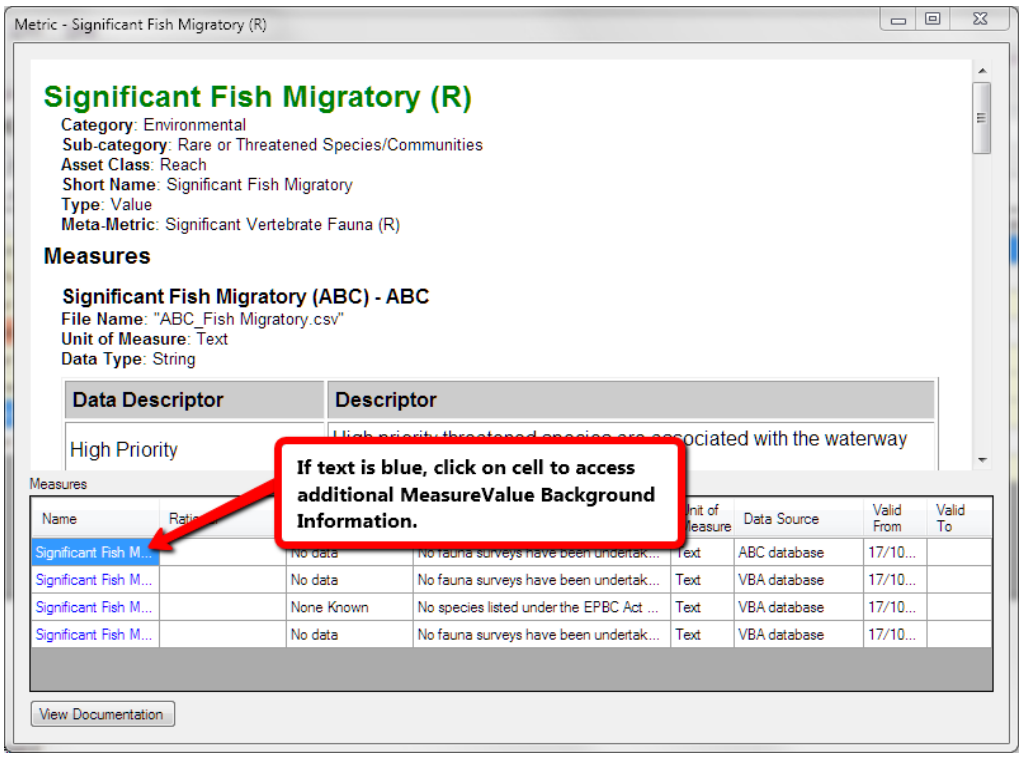


The **detailed view** for individual asset have three tabs:

Metrics – Display metric value grouped by category (see below)



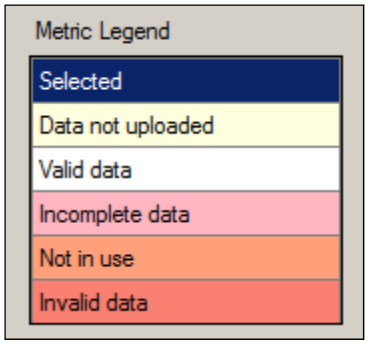
- **Sort** - Click on the table header to sort the column alphabetically, click on the score column to sort according to score value.
- **Display Full Name –** Hover your mouse cursor over a **Value Name** or **Threat Name** cell to display its full name
- **Help File -** You can double click on each of the metric **Name** cells to open up the metric help file. This displays the metric and measure information.



If the text in the Name cell is blue (see previous figure) addditional background information is available by clicking on the cell (additional information may be available for the following metrics: Significant Flora, Fauna, EVCs and Water Quality).

More detail on the metric and measure information can be viewed by clicking on the **View Documentation** button. This will launch the AVIRA Threats and Values Report and take you to the relevant section.

Metric Legend



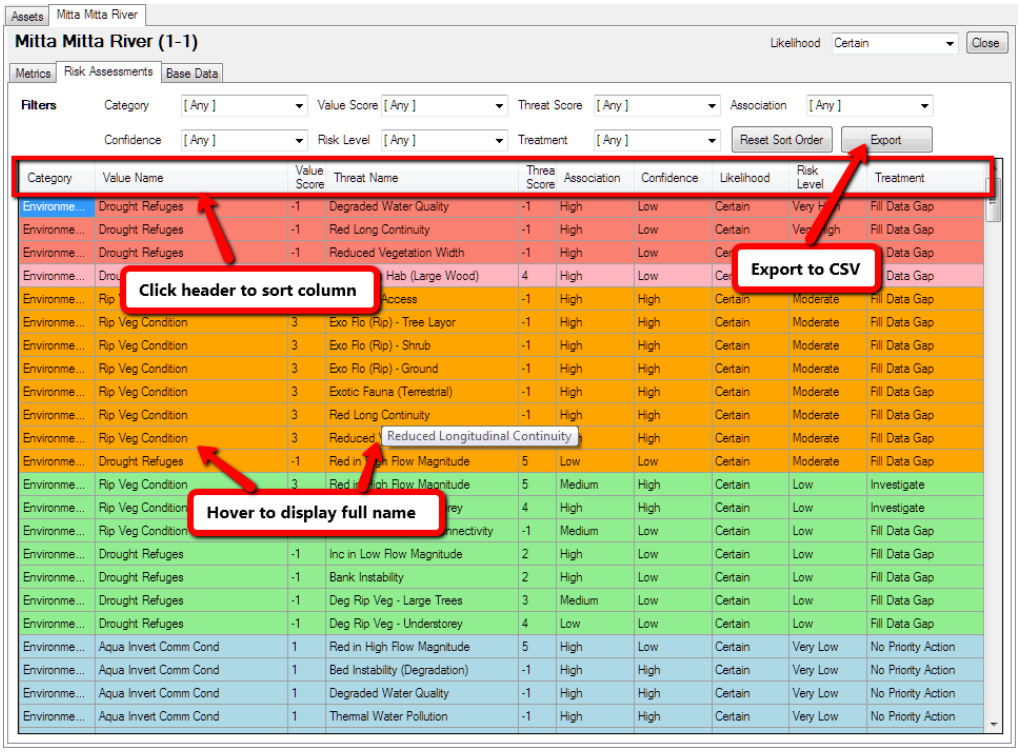
The metric tab has a legend that is colour-coded as follows

- Blue: metric has been selected
- Yellow: data has not been uploaded for this metric
- White: valid data has been uploaded for this metric
- Pink: data has been uploaded for some but not all measures for this metric
- Orange: This metric is not currently in use (to be developed)
- Red: data uploaded for this asset is invalid (double click on metric to access further information – see notes on page 16)

In addition, the value/threat scores for *No Data*, *Incomplete data*, *Not in use* and *Invalid Data* are as follows:

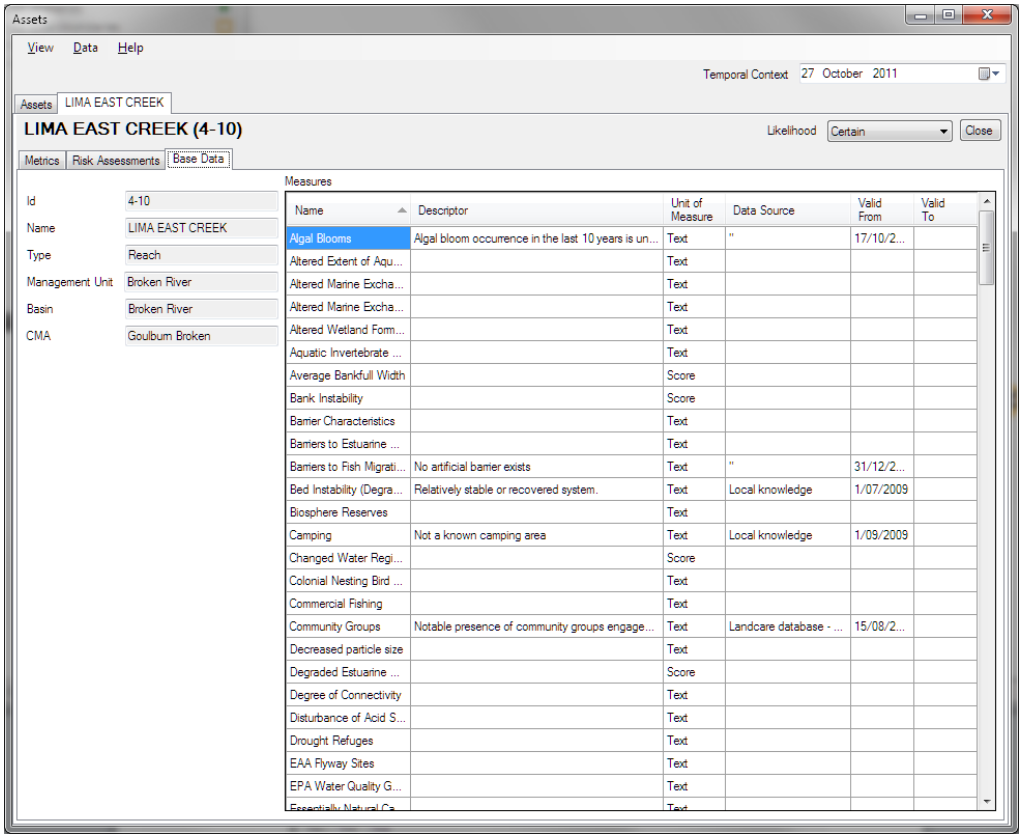
- -1 = No data
- -2 = Incomplete data
- -3 = Metric not in use
- -4 = Invalid Data

Risk Assessments – Display risk assessments in a colour coded table



- **Filters -** You can use the filters to query and limit the number risk assessments displayed. The drop-down filters will be automatically applied on change.
- **Sort** - Click on the table header to sort the column alphabetically.
- **Display Full Name –** Hover your mouse cursor over a **Value Name** or **Threat Name** cell to display its full name
- **Reset Sort Order –** Reset default display order (set by Category, then Risk Level, then Value Name).
- **Export –** Export all listed risk assessments as a CSV file. The output file is saved to the V Drive (**V:**). If multiple files are exported with the same date (i.e. on the same day) for a single asset they will be labelled sequentially.

Base Data – Display measure value



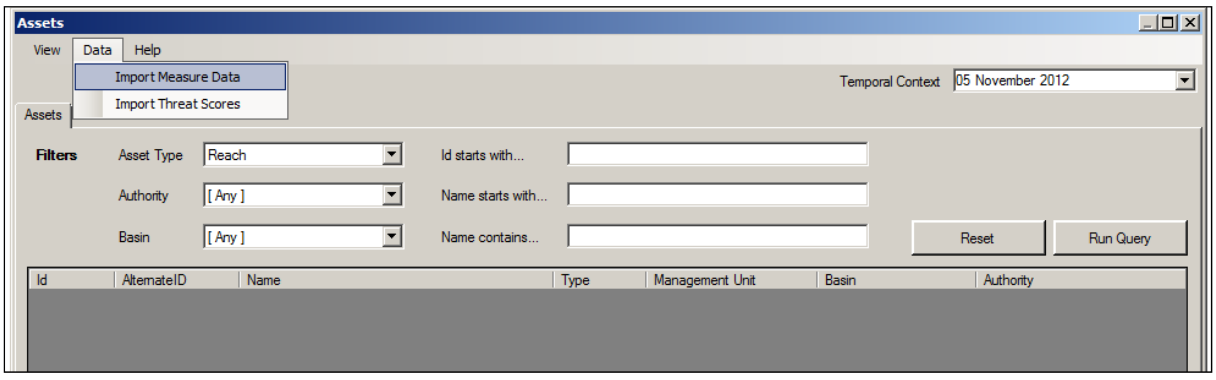
- **Sort** - Click on the table header to sort the column alphabetically.

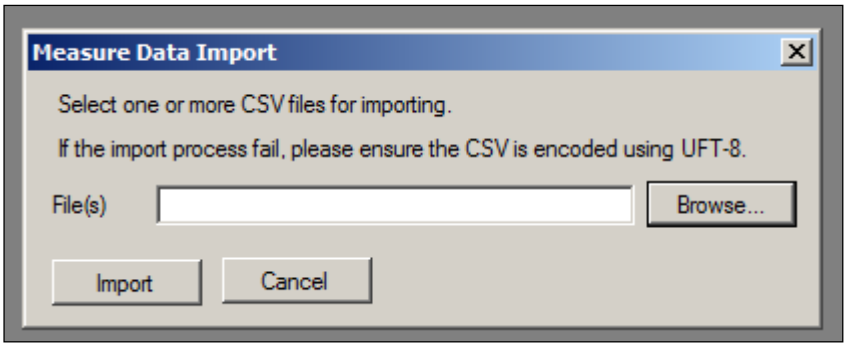
4.3 Import Measure Data

Purpose: Use the **Measure Data Import** tool to import data for both **threats** and **values**.

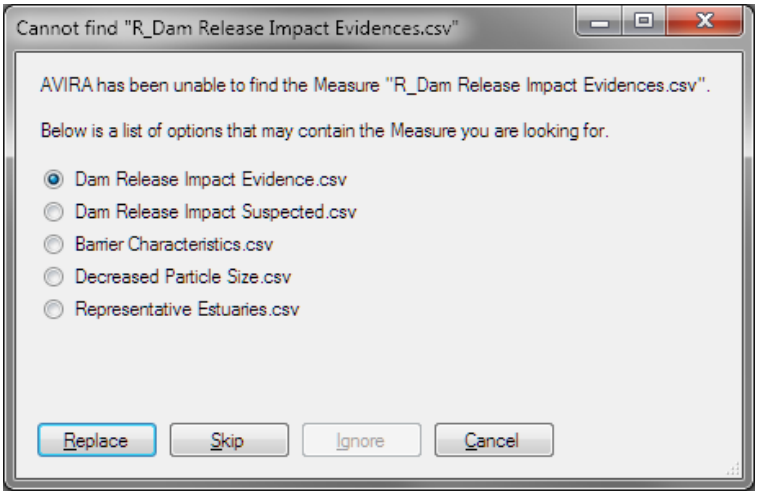
Note: Users can only import data from their own authority. Only DSE users with Administrator permission can import data from any authorities.

To open the **Import Measure Data** dialog box, click **Data > Import Measure Data** from the main toolbar on the **Assets** form (see below)

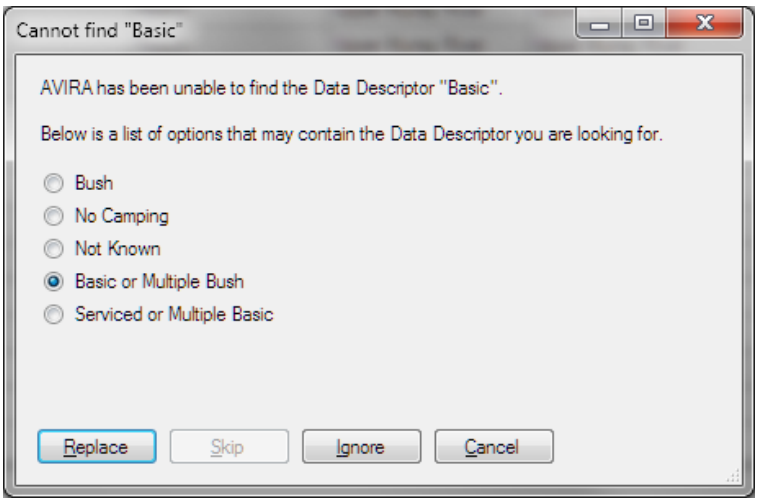


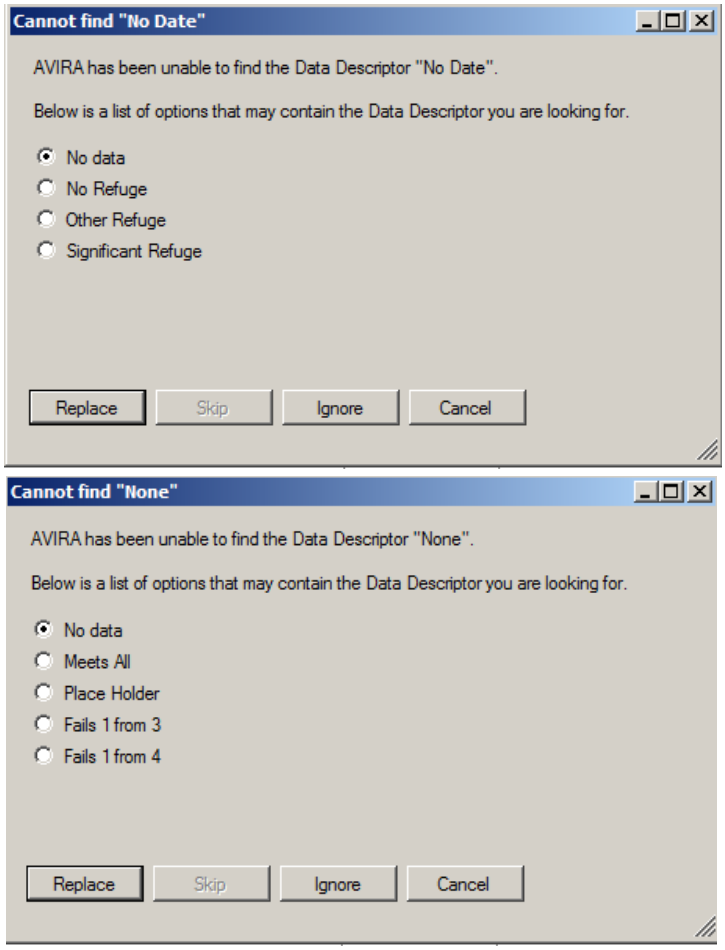


- **Browse -** You can select one **or more** CSV file to import. If you import files in a batch you may wish to set the process and leave it to run overnight.
- **Import -** Click the Import button to process the selected CSV files.
- **File naming error**: If there is a mismatch between the name of the CSV file and the software, user will be prompted to pick the best match.

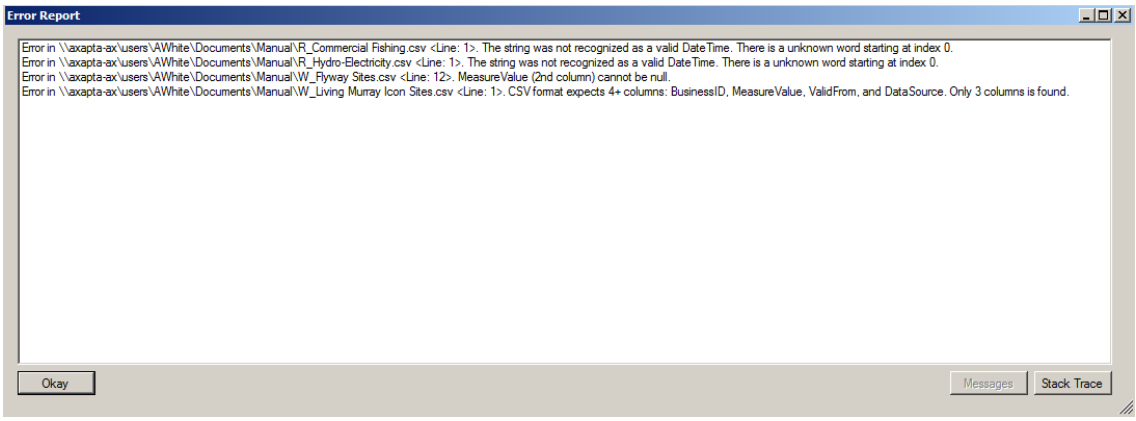


- Data descriptior errors: If there is a mismatch between the data descriptors in the CSV file and the software, user will be prompted to pick the best match.

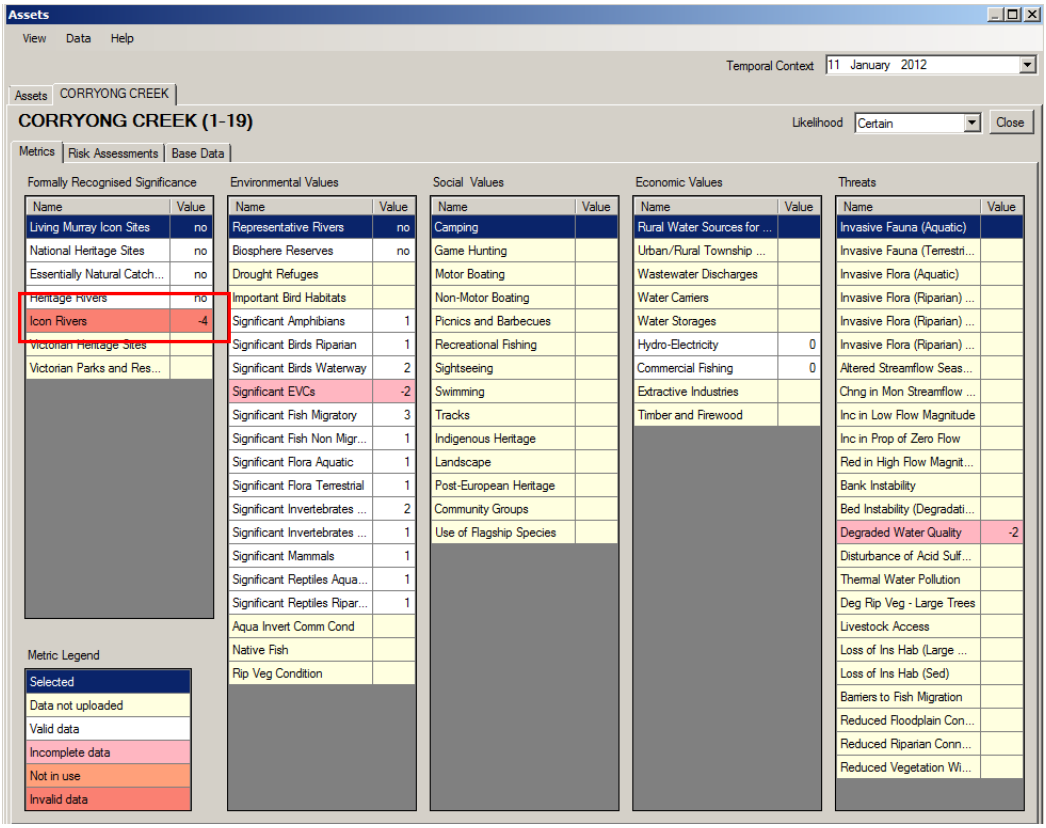




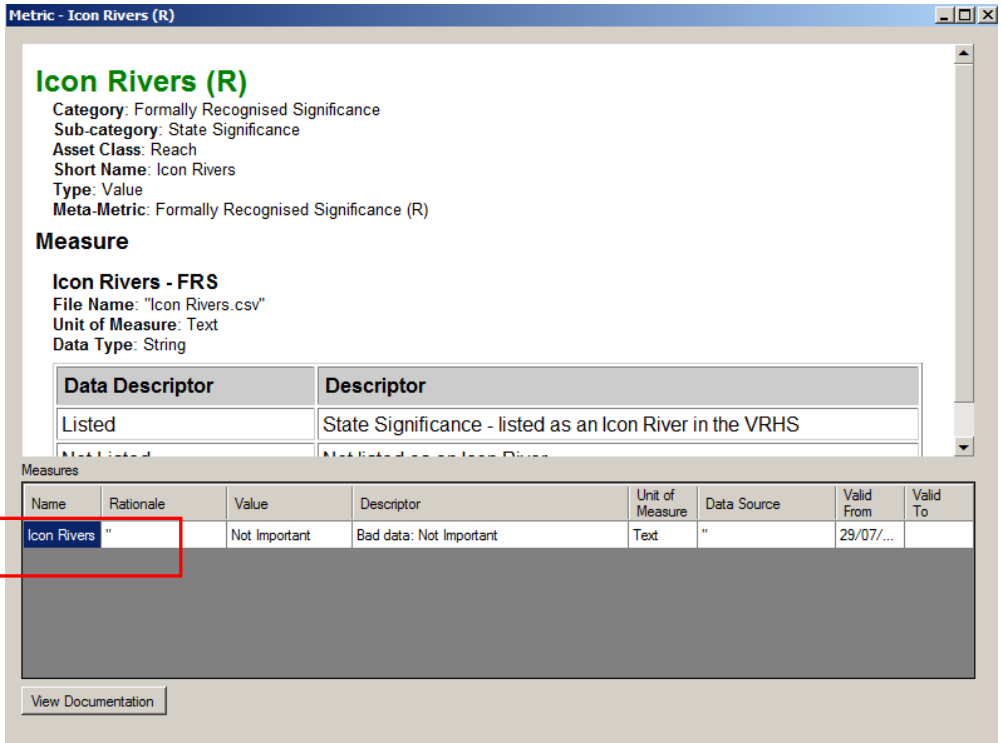
- **Formatting error**: If CSV file contains formatting errors they will appear in the Error Report and the file will not load. The file should be fixed (using the error report as a guide – see below for example) and the complete data file uploaded again.



- **Other errors**: There are some errors that may not be recognised by AVIRA (e.g. when an incorrect data descriptor is used but is not picked up by the software). These files will upload and errors will only be detected when viewing assets; these will appear as invalid data (see red box below).



- You can double click on the individual metric to access further detail about these errors (see red box below). The file should be fixed and the complete data file uploaded again. The file will remain in a temporary staging area until the administrator as approved it. The administrator does not get a notification that approvals are pending, except when the software is first launched (usually at the start of the day). If you wish to have the data approved straight away email the administrator to let them know you are waiting on approvals.

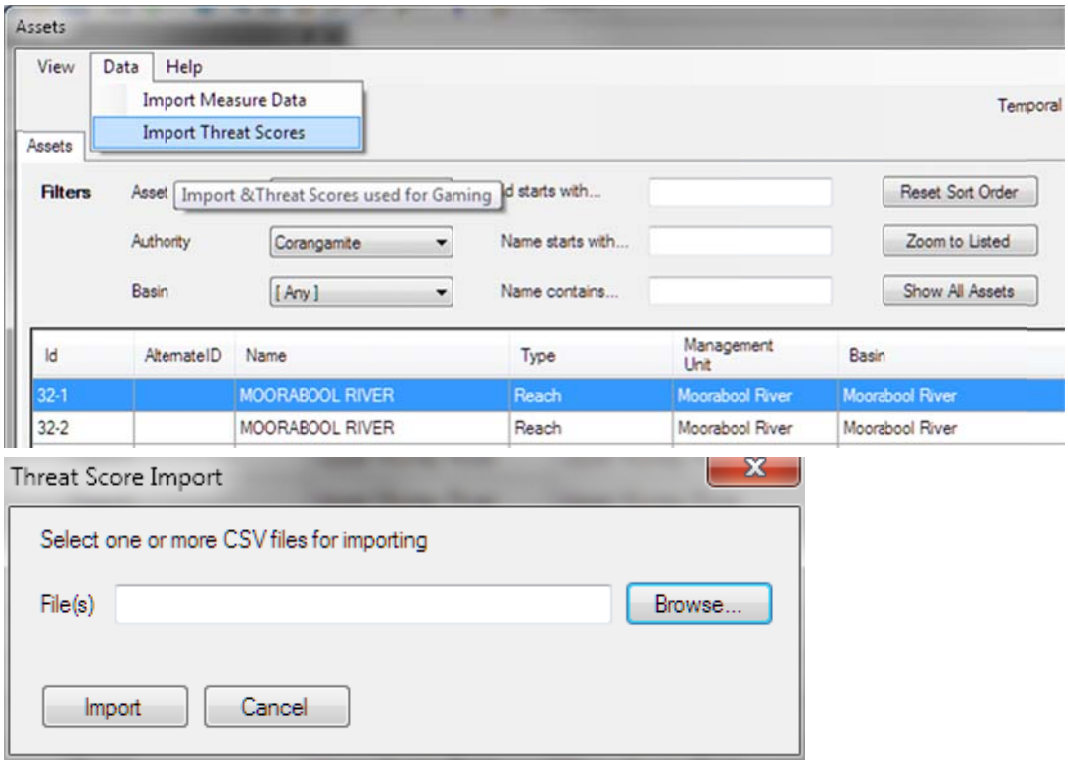


4.4 Import Threat Scores

Note: The **Threat Score Import** tool is **not currently functional**.

Purpose: Allows import of threat scores to reflect **Possible** scenarios, as opposed to Certain (i.e. current) scenarios, using the Likelihood drop-down (the 'gaming' function).

To open the **Import Threat Scores** dialog box, click **Data > Import Threat Scores**, from the main toolbar on the **Assets** form.



4.5 Spatial Layer View

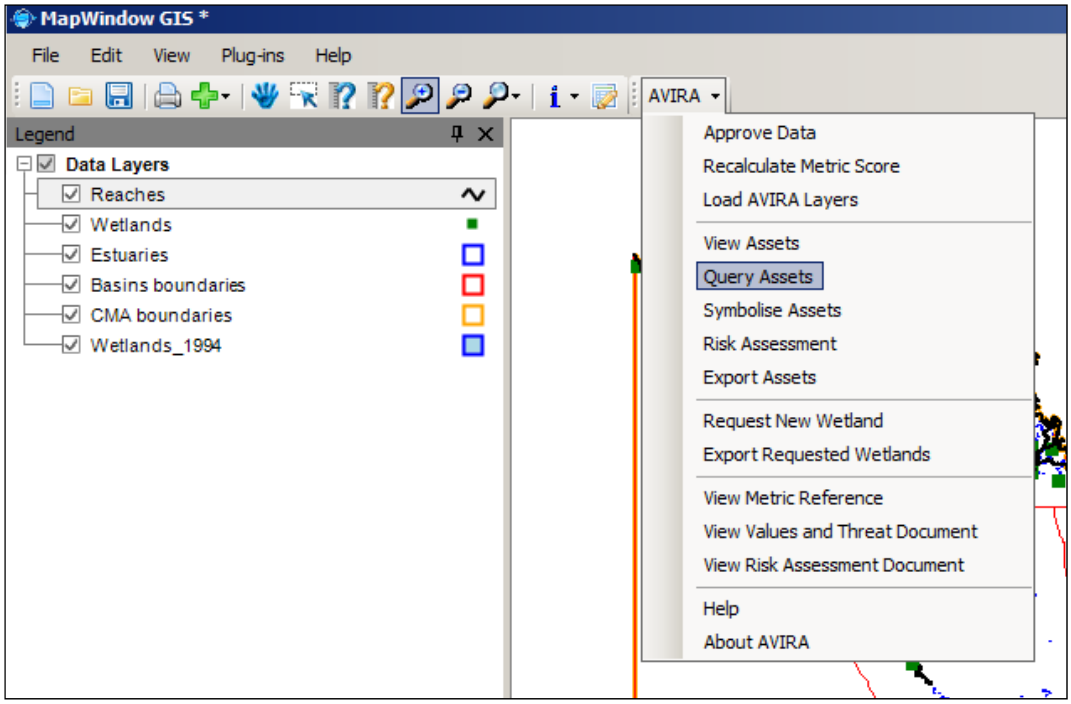
Note: This tool is **not functional** and has been replaced by the **Risk Assessment Mapping Tool** (see Section 7).

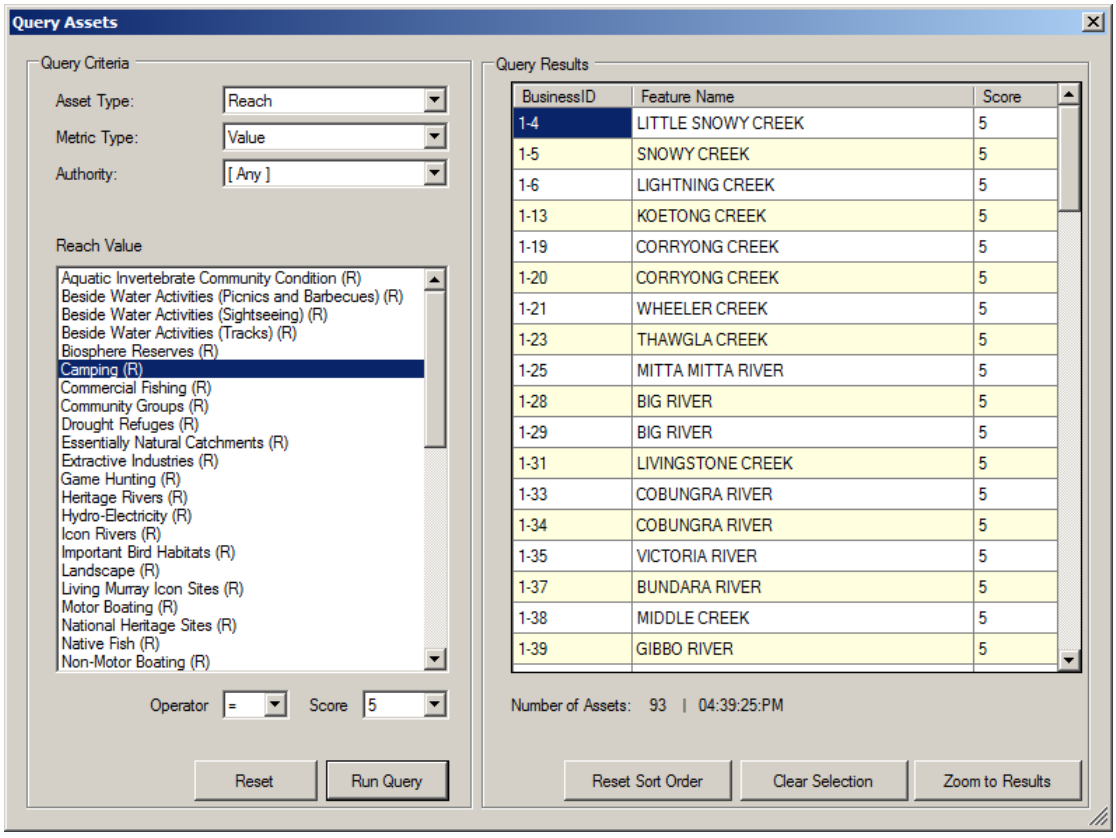
To open the **Spatial Layer View** from, click **View > Spatial Layer View**, from the main toolbar on the **Assets** form.

5. Query Assets

Purpose: Use **Query Asset** to search asset based on its metric score.

To open the Query Assets form, click AVIRA > Query Assets.



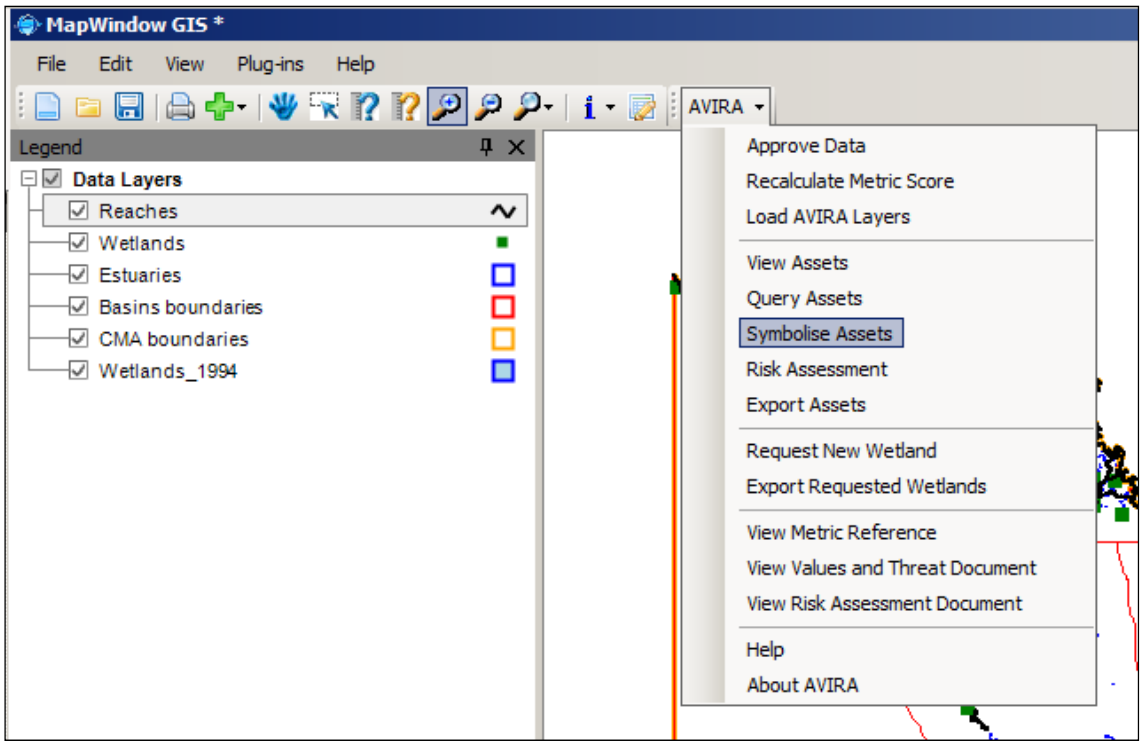


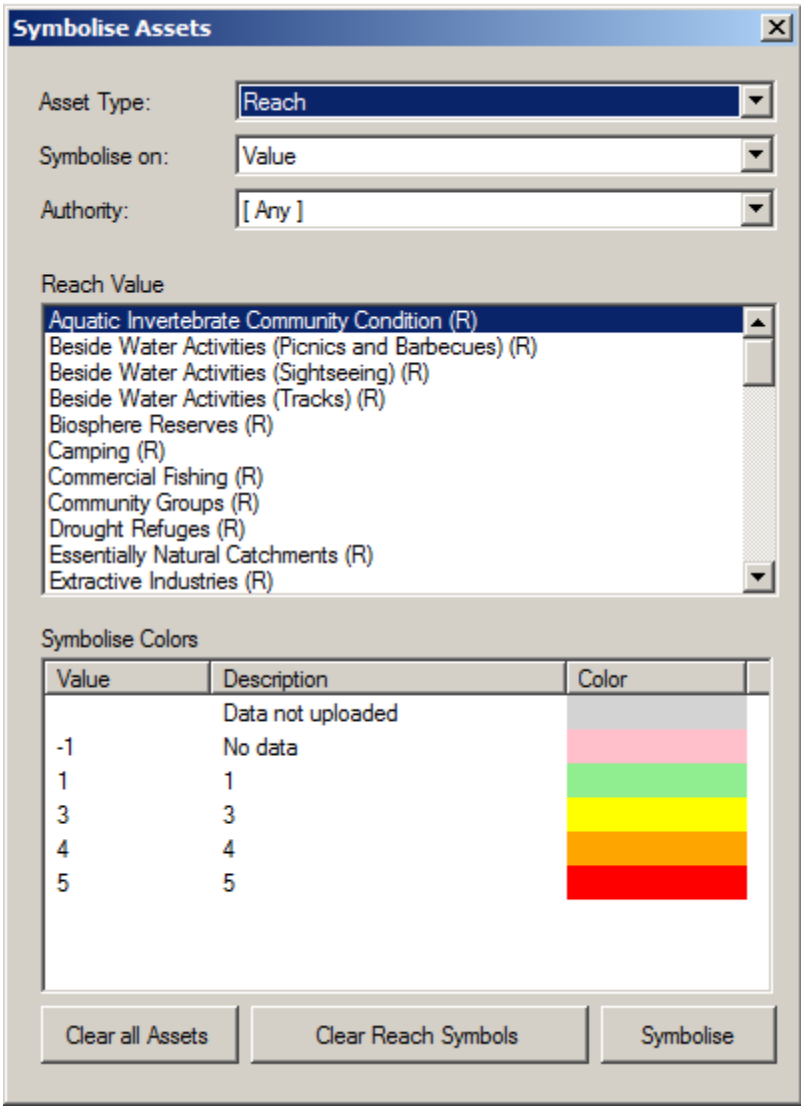
- **Query Criteria –** Use the controls in the **Query Criteria** Panel to build the desired query. The value in the **Score** drop-down will be automatically repopulated with valid values according to the selected metric value.
- **Run Query** – Click to execute the defined query. Results will be shown in the **Query Results** Panel, and selected in the mapping view.
- **Reset** – Click to reset the controls in the **Query Criteria** Panel.
- **Sort** – Click on the table header to sort the column alphabetically.
- **Reset Sort Order –** Reset default display order.
- **Clear Selection –** Clear selected features on the map view.
- **Zoom to Results –** Zoom to the extent of the selected features on the map view.
- **Export results** – If you would like to export the query results, close the query tool and open the **Export Assets** tool, select **Map Selections** choose files types to export (shape file, values and/or threats) and then export.

6. Symbolise Assets

Purpose: Use the **Symbolise Assets** form to symbolise asset based on metric scores.

To open the Symbolise Assets form, click AVIRA > Symbolise Assets.



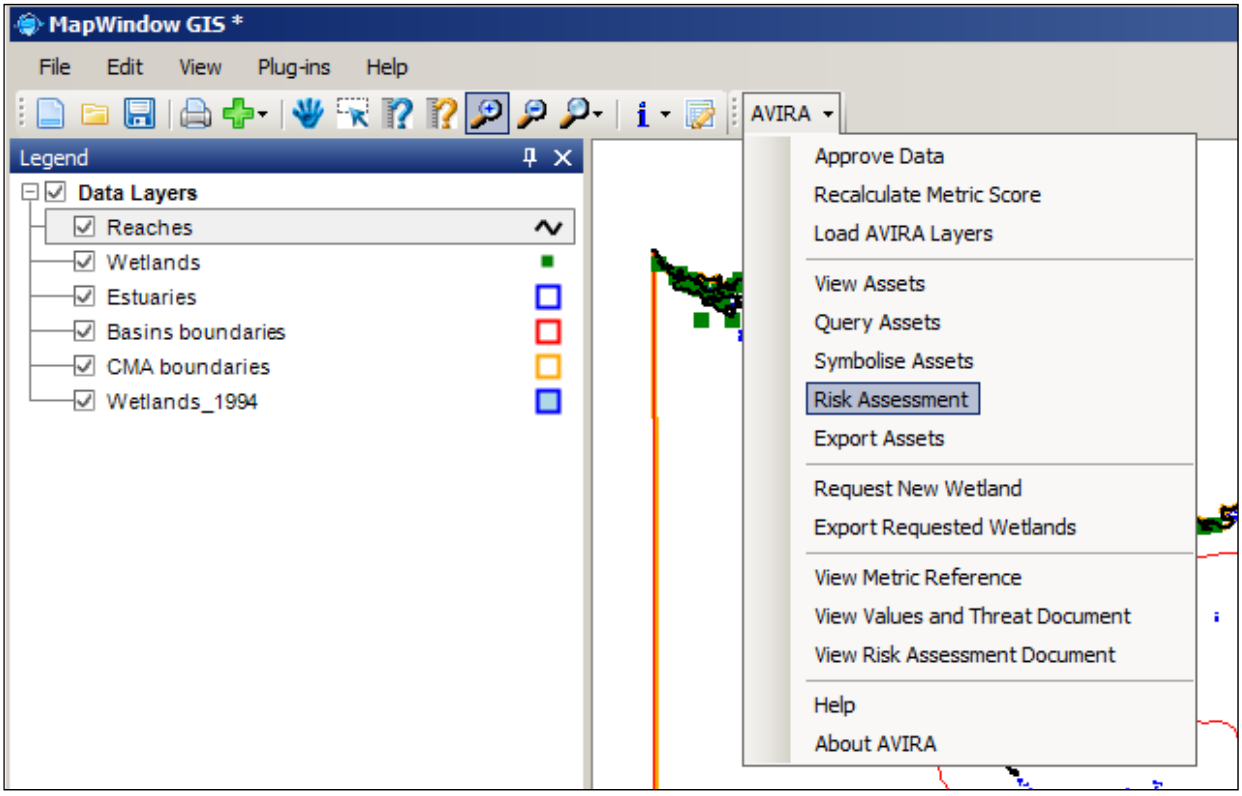


- **Clear All Assets** – Removes all symbolised layers from the map view, and deletes the **Symobolise** folder and its contents. **Clear all Assets should be used whenever a new query is executed**. If you would like to keep the symbolised layers then you can save them in another folder (i.e. remove them from the Symbolise folder).
- **Clear Asset Symbols** – Similar to Clear All Assets except that it only removes the symbolise files for that asset type (not all asset types). For the currently selected **Asset Type**, this will remove any associated symbolised layers from the map view, and delete from the **Symobolise** Directory**.**
- **Symbolise –** Click to symbolise according to selected value or threat. The system will **export** a copy of the asset shapefile and **append** the metric score to it. This shapefile is then symbolised and added to the map view. The source of the shapefiles is saved to the Symobolise Directory, and will be found at **V: \Symbolise**.

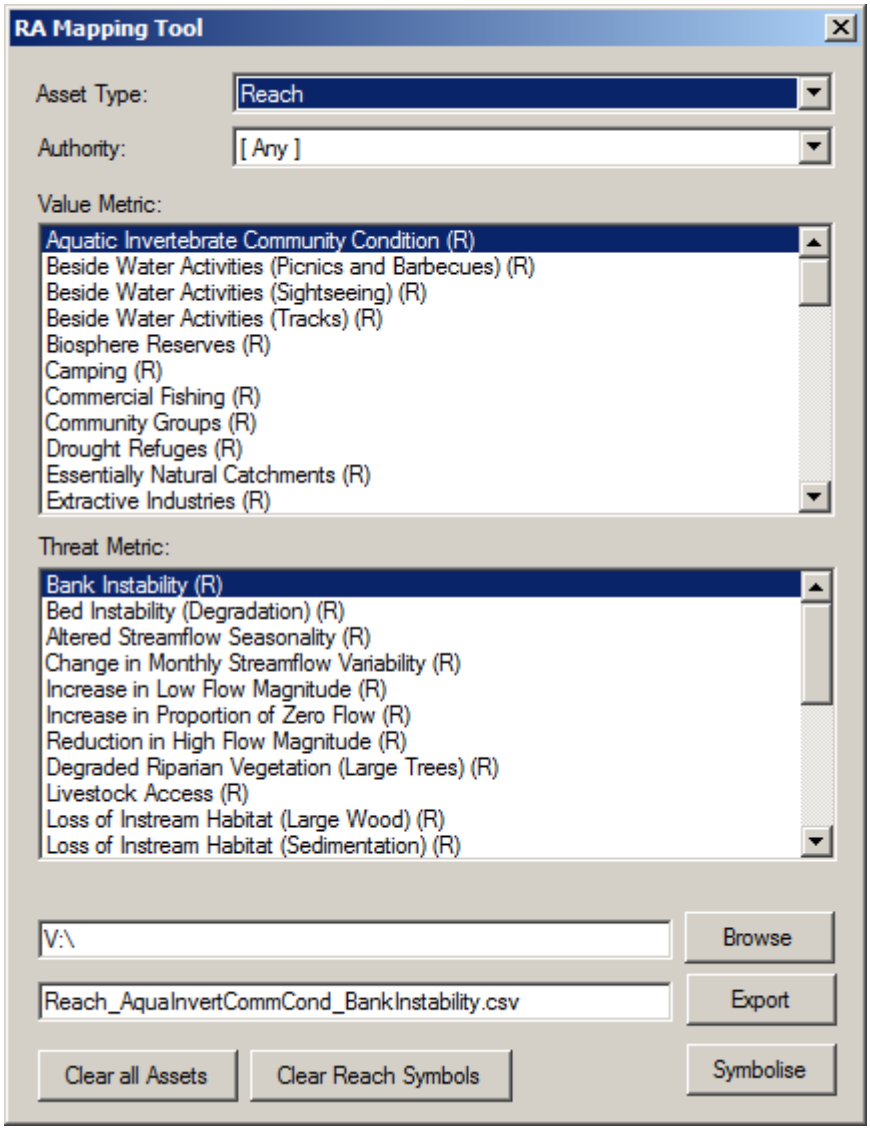
7. Risk Assessment Mapping Tool

Purpose: Use the **Risk Assessment Mapping Tool** to symbolise, map and export risk assessment results.

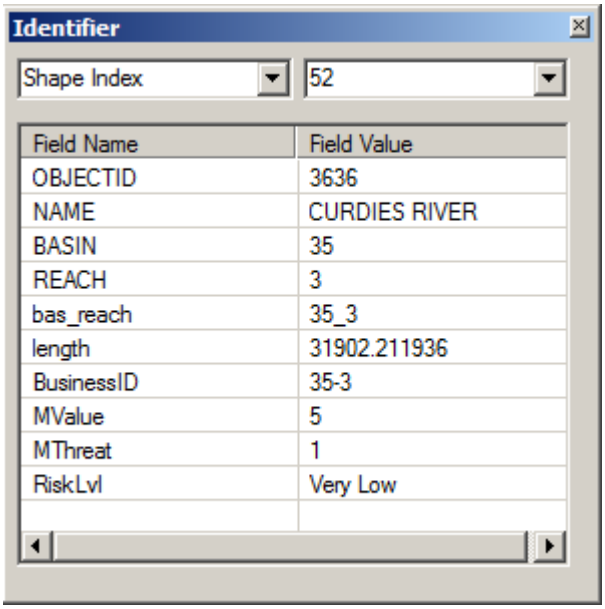
To open the Risk Assessment Mapping Tool, click **AVIRA > Risk Assessment**



- Threat-value combination – Use the controls in the **RA Mapping Tool** panel to choose the asset type and the desired threat-value combination (see below).
- **Symbolise** – Click symbolise to view risk assessment results on the mapping interface.
- To export the risk assessment results click **Export**. An export directory can be selected by clicking on **Browse**; otherwise files will be automatically exported to the **V:** directory. Risk assessment results can then be imported to another GIS program.



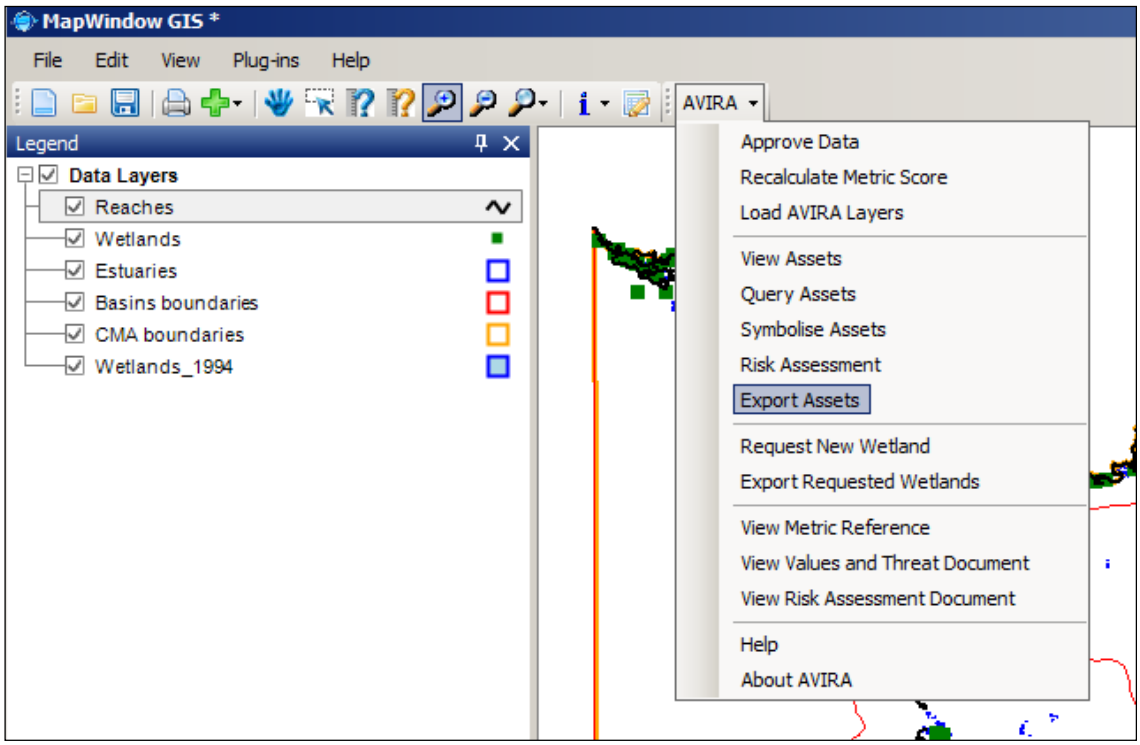
- **Clear All Assets** – Removes all symbolised layers from the map view, and deletes the **Symobolise** folder and its contents. **Clear all Assets should be used whenever a new RA is executed**. If you would like to keep the symbolised layers then you can save them in another folder (i.e. remove them from the Symbolise folder).
- **Clear Asset Symbols** – Similar to Clear All Assets except that it only removes the symbolise files for that asset type (not all asset types). For the currently selected **Asset Type**, this will remove any associated symbolised layers from the map view, and delete from the **Symobolise** Directory**.**
- The risk assessment results can be queried in the mapping interface using the **Identifier** (this is accessed using the drop down menu of the Identifier tool). This will indicate the risk level and the threat and value scores that were used to calculate the risk level (see below).

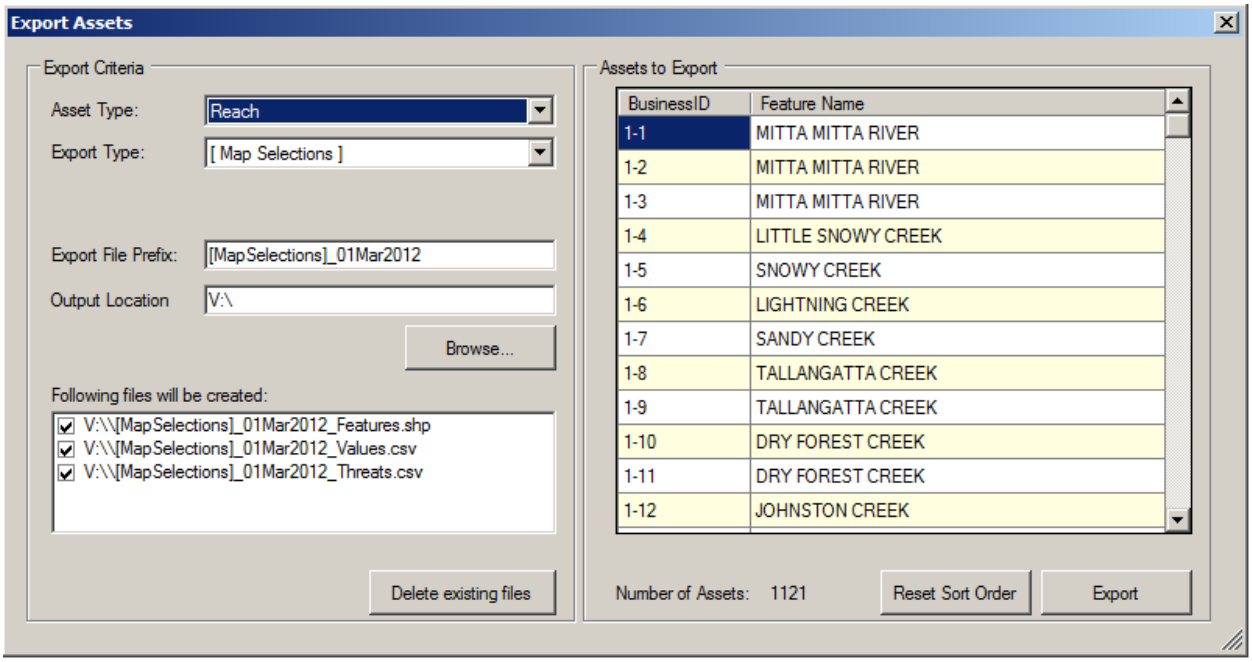
- 

8. Export Assets

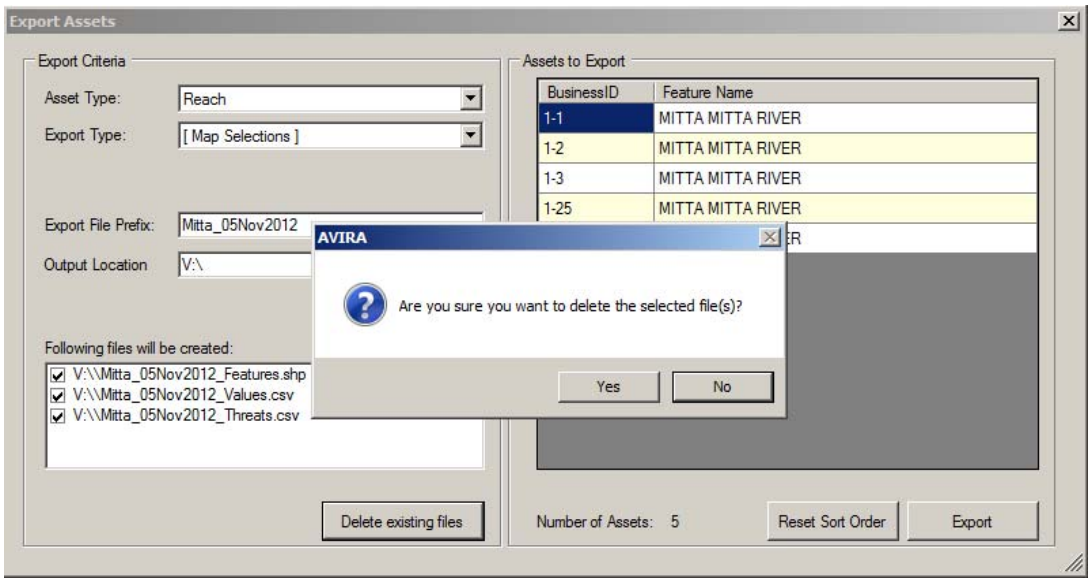
Purpose: Use the **Export Assets** form to export asset shapefiles, and the associated threats and values, in csv format.

To open the Export Assets form, click AVIRA > Export Assets.

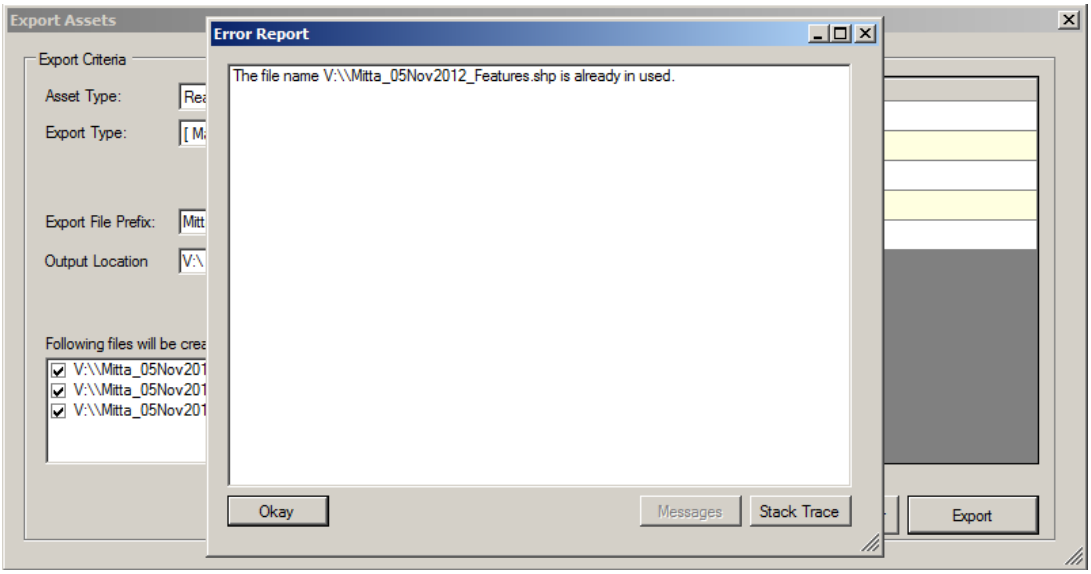




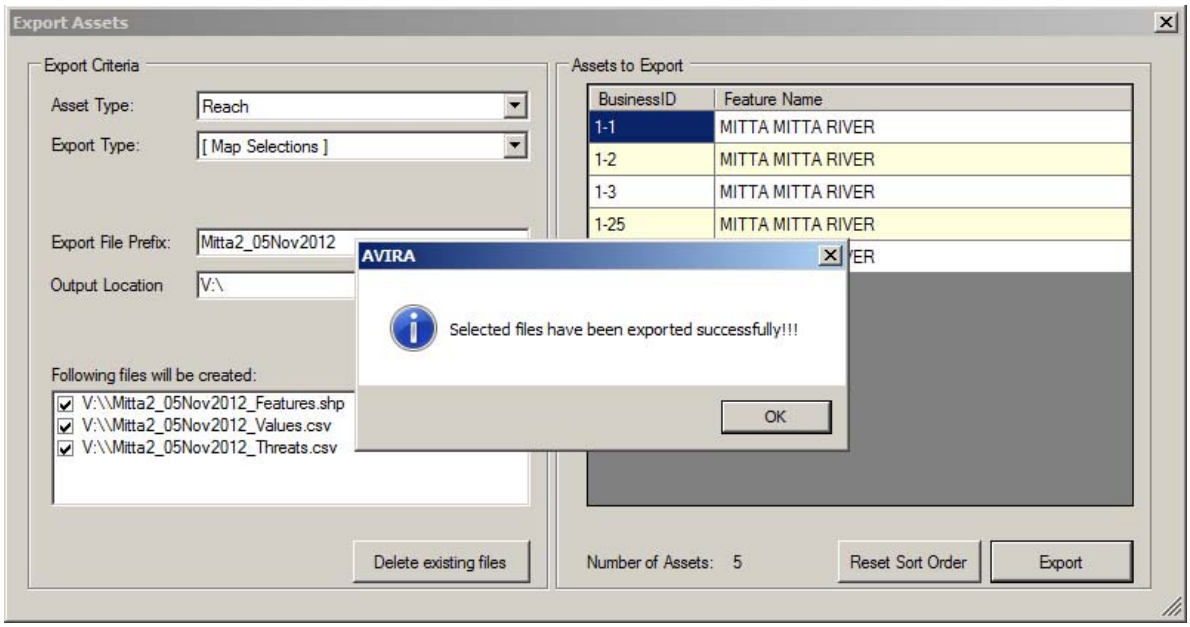
- **Asset Type –** Select which asset you would like to export.
- **Export Type -** All Assets or **Map Selections** (you would have selected the assets before opening the Export Assets Form).
- **Export to folder** – Use the **Browse** button to select an output folder. The default directory is **V:**
- **Delete existing files** – Delete the listed files if you don't need them anymore. You will be prompted to confirm the delete.



- If you export a file with the same name and error will alert you, you will need to manually change the name of the file to export successfully (see below).



- **Reset Sort Order –** Reset default display order.
- **Export** – Export the requested output based on the export criteria. You will be alerted at the end of the export process.

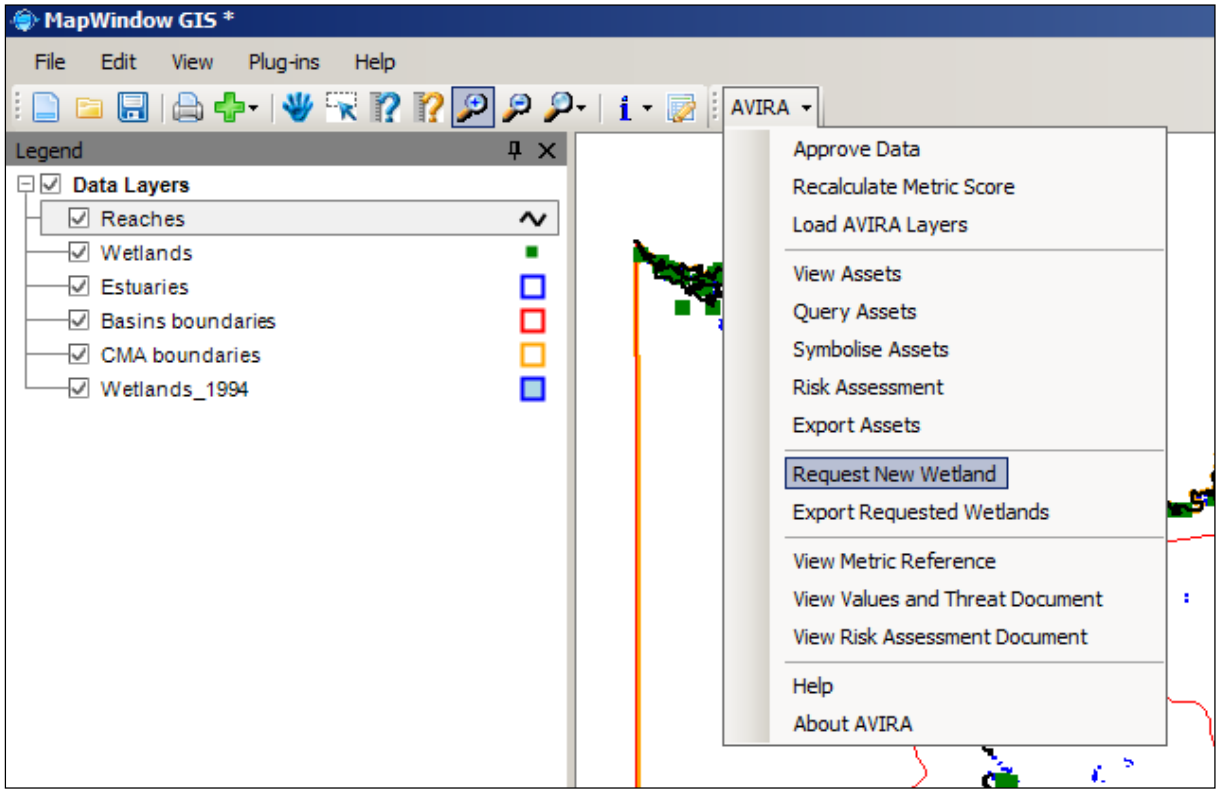


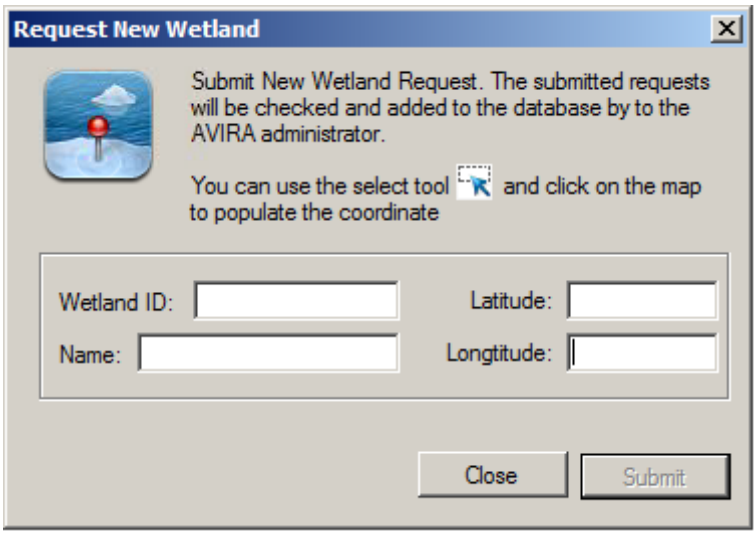
Note:	Export is a time consuming process. On a Dell Precision T1500 machine with 2.96GB RAM, it takes around 1 second for each asset to be exported into shapefile, and quarter of a second into CSV.

9. Upload New Wetland

Purpose: To add new wetlands to AVIRA, using the **Request a Wetland** tool.

To open the Request a Wetland form, click AVIRA > Request New Wetland.





- Enter the Wetland ID from the **Wetland 2012** spatial layer.
- Enter the name of the wetland (could be your local name for the wetland, does not need to be included in the Wetland 2012 spatial layer).
- Use the cursor to locate a point roughly in the centre of the wetland, click to populate the Latitude and Longitude, and then submit the information.
- The AVIRA administrator will check the entry and add it to the database.

Appendix D - AVIRA Data File Creation

AVIRA requires information from DELWP and CMAs on a standard set of values and threats for river, estuary and wetland assets. There are three types of values (environmental, social and economic) to reflect Victoria's triple bottom line approach to managing waterway health.

Each individual value and threat in AVIRA has one or more **measures** that are used to provide data for the value or threat. Each individual value and threat also has a **metric** that assigns a descriptive AND numerical score to the value or threat. Most metrics have been developed using one measure, although some metrics combine multiple measures to arrive at a final description and numerical score.

Scores for values and threats range from 5 (very high) to 1 (very low). A score of zero is sometimes used and signifies 'no value' or 'not applicable/suitable'. There is also a category for 'No Data' which is applied in cases where we don't know if a particular threat or value is associated with a particular waterway. The values and threats in AVIRA are also grouped into categories to indicate similar types of values or threats.

DATA COLLECTION REQUIREMENTS

The waterways included in AVIRA that require information on values and threats are as follows:

- river reaches assessed by the Index of Stream Condition
- estuary reaches assessed by the Index of Estuary Condition and other important estuaries
- wetlands assessed by the Index of Wetland Condition and other wetlands uploaded by CMAs
- major water storages

Major water storages were assessed as a wetland asset. Where there is an on-river weir it was considered a part of the river reach for the purposes of assigning values and threats.

CREATING DATA FILES

As with other software, AVIRA is built with coded scripts. This means it anticipates data in a particular order and data uploads will fail if the data is not in the correct order. It is important that the file format, file name and data format follow the rules outlined below.

FILE FORMAT

Data files need to be created for each **measure** in AVIRA. For metrics that that have multiple measures, individual files for each measure need to be created, once uploaded to AVIRA the software will automatically compute the metric score.

The files need to be saved as comma separated value files (.csv). This file type uses commas to determine where each column starts. That means **commas cannot be used** in the data files *within* the cells. Please note that **every measure in AVIRA requires a separate .csv file**. You can find this file type when you click 'Save As' and then look through the options contained in the drop-down 'Save As Type' until you find 'CSV (comma delimited) (*.csv)'.

You can set up individual .csv files for each measure in Excel from the start of your data collection process, or collect information in workbooks saved as .xls files until all the data entry is complete. The .xls files are a useful format for keeping all your information together when you are collating the data, but when the data is finalised, separate .csv files for each measure are required.

When saving as .csv files you will get the following message:

"the selected file format does not support work books that contain multiple sheets"

To save all the sheets as .csv files, you need to save them individually using a different name for each. Name the file using the exact term as supplied in the tables below. You can save each tab individually as a .csv file and still retain your whole workbook as a .xls file. When the data file is complete and you are ready to save it as a .csv file the **header row must be removed**.

FILE NAMES

The file name must be the *exact* name of the **measure** as supplied in the tables below.

Please note that the data files names for each asset have a prefix, as follows:

- River data has the 'R_' prefix
- Wetland data has the 'W_' prefix
- Estuary data has the 'E_' prefix

DATA FORMAT

Each .csv file should contain a minimum of four columns and maximum of six columns. The first four columns will contain compulsory information about the data:

1) Asset Identification, 2) Data Descriptor, 3) Start Date and 4) Data Source

When the data file is complete and you are ready to save it as a .csv file you need to remove the header row or the file will fail to load. Each row in the file represents an individual asset.

Column 1: Asset Identification (compulsory)

- Rivers: the unique basin and reach number as per the Index of Stream Condition spatial layer e.g. 25~1
- Wetlands: 5-digit wetland identification numbers as per the Wetland_Current spatial layer e.g. 18651
- Estuaries: the unique basin and estuary number as per the estuary spatial layer e.g. 36~201

Note for rivers and estuaries that the separator between the basin and reach is a tilde (~) and not a dash.

Column 2: Data Descriptor (Compulsory)
= the description of the value or threat that AVIRA uses to assign the score.

This will be a string of words (see text in blue in table below) or a number. Where it is a string of words the data descriptor column needs to contain the *exact* term as it appears in the measure tables throughout the AVIRA Threats and Values report.

High Value Waterway	Descriptor	Data Descriptor
Yes	State Significance - key feature of a park or reserve listed within Park Groups A1 or A2 *	Park A1 or A2
No	Not a key feature of a park or reserve listed within Park Groups A1 or A2	Not Park A1 or A2

Column 3: Date (Compulsory)

= the start date from when the data becomes valid.

- Format: dd/mm/yyyy. It must not be in US date format.
- Do not use dates that are in the future, the file will not upload.
- If the day is unknown, assume the first day of the month (e.g. 01/11/2004).
- If the month is unknown, assume the first day of the year (e.g. 01/01/2004).
- If you are overwriting data make sure the new data file has a date later than the data to be overwritten (AVIRA will always use the data with the most recent date).
- If the threat or value score is 'No Value' or 'Not Applicable' (or there is 'No Data') then the date on which the data file was created can be used. This indicates that at this point in time this is true for a *particular metric at a particular asset.*

Column 4: Data Source (Compulsory)

= the source the data has been obtained from.

Data sources for each metric are listed in the report on values and threats. Some metrics require 'local knowledge'. Suggested sources include: reports, input from Parks Victoria and Local Councils, spatial layers, GIS analysis, workshops, surveys, targeted discussions with locals who have personal observations or expertise, and/or literature reviews. Once the data is collected/collated a line describing where it has come from (e.g. for the metric 'Non-motor boating' the data source may be 'Canoeing Victoria') should be included. It is vital that **commas are not used** in the description.

As stated above, there may be some measures for which CMAs do not have the information described in the data source; if this is the case other information can be used. The expectation was that existing data/information/resources be used to make the AVIRA data files, not that new studies will be undertaken.

Optional information (2 columns)

The fifth and sixth columns are optional and provide additional information that may be useful:

5) Rationale and 6) References.

Column 5: Rationale (Optional except where data is being overwritten)

A sentence is required in this cell whenever statewide data is changed using more up-to-date or more appropriate local information. This column should contain a sentence outlining why the data has been changed. Again, it is vital that you **commas are not used** in the sentence.

In addition, there are some metrics where extra information should be added to the rationale column, e.g. when specific species are present, as follows:

- Significant flora or fauna species or significant EVCs
- Use of Flagship species (enter the name of the flagship species present)
- Invasive Flora Shrub layer (record the name of the high threat species present)
- Invasive Flora Ground layer (record the name of the high threat species present)
- Invasive Fauna Terrestrial (record the name of the invasive fauna species present)
- Invasive Fauna Aquatic (record the name of the invasive fauna species present)

Any other information that you would like to have access to while viewing data in AVIRA can also be included in the rationale column.

Column 6: References (Optional)
= a reference source for the data.

More detailed information on the source for the data can be provided here. For example: a website, the author of a report and/or the page number the data is from, personal communication from *X*, an expert workshop held. Note that this information is **not viewable in AVIRA** only in your data file.

AVIRA Import Data File Names

Values Measure	Asset Types	Import File Name
Formally recognised significance		
Ramsar Sites	W	W_Ramsar.csv
Ramsar Sites	E	E_Ramsar.csv
EAA Flyway Sites	W	W_Flyway sites.csv
EAA Flyway Sites	E	E_Flyway sites.csv
Nationally Important Wetlands	W	W_DIWA.csv
Nationally Important Wetlands	E	E_DIWA.csv
Living Murray Icon Sites	R	R_Living Murray Icon Sites.csv
Living Murray Icon Sites	W	W_Living Murray Icon Sites.csv
National Heritage Sites	R	R_National Heritage Sites.csv
National Heritage Sites	W	W_National Heritage Sites.csv
National Heritage Sites	E	E_National Heritage Sites.csv
Heritage Rivers	R	R_Heritage Rivers.csv
Heritage Rivers	E	E_Heritage Rivers.csv
Heritage Rivers	W	W_Heritage Rivers.csv
Icon Rivers	R	R_Icon Rivers.csv
Icon Rivers	E	E_Icon Rivers.csv
Essentially Natural Catchments	R	R_Essentially Natural Catchments.csv
Essentially Natural Catchments	W	W_Essentially Natural Catchments.csv
Essentially Natural Catchments	E	E_Essentially Natural Catchments.csv
Victorian Parks and Reserves	R	R_Victorian Parks and Reserves.csv
Victorian Parks and Reserves	W	W_Victorian Parks and Reserves.csv
Victorian Parks and Reserves	E	E_Victorian Parks and Reserves.csv
Victorian Heritage Sites	R	R_Victorian Heritage Sites.csv
Victorian Heritage Sites	W	W_Victorian Heritage Sites.csv
Victorian Heritage Sites	E	E_Victorian Heritage Sites.csv
Representativeness		
Representative Rivers	R	R_Representative Rivers.csv

Values Measure	Asset Types	Import File Name
Rare or threatened species and communities		
Significant Fish Migratory (ABC)	R	R_ABC_Fish Migratory.csv
Significant Fish Migratory (IUCN)	R	R_IUCN_Fish Migratory.csv
Significant Fish Migratory (EPBC)	R	R_EPBC_Fish Migratory.csv
Significant Fish Migratory (ALTVFV)	R	R_ALTVFV_Fish Migratory.csv
Significant Fish Non Migratory (ABC)	R	R_ABC_Fish Non Migratory.csv
Significant Fish Non Migratory (IUCN)	R	R_IUCN_Fish Non Migratory.csv
Significant Fish Non Migratory (EPBC)	R	R_EPBC_Fish Non Migratory.csv
Significant Fish Non Migratory (ALTVFV)	R	R_ALTVFV_Fish Non Migratory.csv
Significant Birds Riparian (ABC)	R	R_ABC_Birds Riparian.csv
Significant Birds Riparian (IUCN)	R	R_IUCN_Birds Riparian.csv
Significant Birds Riparian (EPBC)	R	R_EPBC_Birds Riparian.csv
Significant Birds Riparian (ALTVFV)	R	R_ALTVFV_Birds Riparian.csv
Significant Birds Waterway (ABC)	R	R_ABC_Birds Waterway.csv
Significant Birds Waterway (IUCN)	R	R_IUCN_Birds Waterway.csv
Significant Birds Waterway (EPBC)	R	R_EPBC_Birds Waterway.csv
Significant Birds Waterway (ALTVFV)	R	R_ALTVFV_Birds Waterway.csv
Significant Amphibians (ABC)	R	R_ABC_Amphibians.csv
Significant Amphibians (IUCN)	R	R_IUCN_Amphibians.csv
Significant Amphibians (EPBC)	R	R_EPBC_Amphibians.csv
Significant Amphibians (ALTVFV)	R	R_ALTVFV_Amphibians.csv
Significant Invertebrates Aquatic (ABC)	R	R_ABC_Invertebrates Aquatic.csv
Significant Invertebrates Aquatic (IUCN)	R	R_IUCN_Invertebrates Aquatic.csv
Significant Invertebrates Aquatic (EPBC)	R	R_EPBC_Invertebrates Aquatic.csv
Significant Invertebrates Aquatic (ALTIFV)	R	R_ALTIFV_Invertebrates Aquatic.csv
Significant Invertebrates Riparian (ABC)	R	R_ABC_Invertebrates Riparian.csv
Significant Invertebrates Riparian (IUCN)	R	R_IUCN_Invertebrates Riparian.csv
Significant Invertebrates Riparian (EPBC)	R	R_EPBC_Invertebrates Riparian.csv
Significant Invertebrates Riparian (ALTIFV)	R	R_ALTIFV_Invertebrates Riparian.csv

Values Measure	Asset Types	Import File Name
Significant Reptiles Aquatic (ABC)	R	R_ABC_Reptiles Aquatic.csv
Significant Reptiles Aquatic (IUCN)	R	R_IUCN_Reptiles Aquatic.csv
Significant Reptiles Aquatic (EPBC)	R	R_EPBC_Reptiles Aquatic.csv
Significant Reptiles Aquatic (ALTVFV)	R	R_ALTVFV_Reptiles Aquatic.csv
Significant Reptiles Riparian (ABC)	R	R_ABC_Reptiles Riparian.csv
Significant Reptiles Riparian (IUCN)	R	R_IUCN_Reptiles Riparian.csv
Significant Reptiles Riparian (EPBC)	R	R_EPBC_Reptiles Riparian.csv
Significant Reptiles Riparian (ALTVFV)	R	R_ALTVFV_Reptiles Riparian.csv
Significant Mammals (ABC)	R	R_ABC_Mammals.csv
Significant Mammals (IUCN)	R	R_IUCN_Mammals.csv
Significant Mammals (EPBC)	R	R_EPBC_Mammals.csv
Significant Mammals (ALTVFV)	R	R_ALTVFV_Mammals.csv
Significant Fish (ABC)	W	W_ABC_Fish.csv
Significant Fish (IUCN)	W	W_IUCN_Fish.csv
Significant Fish (EPBC)	W	W_EPBC_Fish.csv
Significant Fish (ALTVFV)	W	W_ALTVFV_Fish.csv
Significant Birds (ABC)	W	W_ABC_Birds.csv
Significant Birds (IUCN)	W	W_IUCN_Birds.csv
Significant Birds (EPBC)	W	W_EPBC_Birds.csv
Significant Birds (ALTVFV)	W	W_ALTVFV_Birds.csv
Significant Amphibians (ABC)	W	W_ABC_Amphibians.csv
Significant Amphibians (IUCN)	W	W_IUCN_Amphibians.csv
Significant Amphibians (EPBC)	W	W_EPBC_Amphibians.csv
Significant Amphibians (ALTVFV)	W	W_ALTVFV_Amphibians.csv
Significant Invertebrates (ABC)	W	W_ABC_Invertebrates.csv
Significant Invertebrates (IUCN)	W	W_IUCN_Invertebrates.csv
Significant Invertebrates (EPBC)	W	W_EPBC_Invertebrates.csv
Significant Invertebrates (ALTIFV)	W	W_ALTIFV_Invertebrates.csv
Significant Reptiles Aquatic (ABC)	W	W_ABC_Reptiles Aquatic.csv

Values Measure	Asset Types	Import File Name
Significant Reptiles Aquatic (IUCN)	W	W_IUCN_Reptiles Aquatic.csv
Significant Reptiles Aquatic (EPBC)	W	W_EPBC_Reptiles Aquatic.csv
Significant Reptiles Aquatic (ALTVFV)	W	W_ALTVFV_Reptiles Aquatic.csv
Significant Reptiles Riparian (ABC)	W	W_ABC_Reptiles Riparian.csv
Significant Reptiles Riparian (IUCN)	W	W_IUCN_Reptiles Riparian.csv
Significant Reptiles Riparian (EPBC)	W	W_EPBC_Reptiles Riparian.csv
Significant Reptiles Riparian (ALTVFV)	W	W_ALTVFV_Reptiles Riparian.csv
Significant Mammals (ABC)	W	W_ABC_Mammals.csv
Significant Mammals (IUCN)	W	W_IUCN_Mammals.csv
Significant Mammals (EPBC)	W	W_EPBC_Mammals.csv
Significant Mammals (ALTVFV)	W	W_ALTVFV_Mammals.csv
Significant Fish Resident (ABC)	E	E_ABC_Fish Resident.csv
Significant Fish Resident (IUCN)	E	E_IUCN_Fish Resident.csv
Significant Fish Resident (EPBC)	E	E_EPBC_Fish Resident.csv
Significant Fish Resident (ALTVFV)	E	E_ALTVFV_Fish Resident.csv
Significant Fish Dependent (ABC)	E	E_ABC_Fish Dependent.csv
Significant Fish Dependent (IUCN)	E	E_IUCN_Fish Dependent.csv
Significant Fish Dependent (EPBC)	E	E_EPBC_Fish Dependent.csv
Significant Fish Dependent (ALTVFV)	E	E_ALTVFV_Fish Dependent.csv
Significant Birds (ABC)	E	E_ABC_Birds.csv
Significant Birds (IUCN)	E	E_IUCN_Birds.csv
Significant Birds (EPBC)	E	E_EPBC_Birds.csv
Significant Birds (ALTVFV)	E	E_ALTVFV_Birds.csv
Significant Reptiles (ABC)	E	E_ABC_Reptiles.csv
Significant Reptiles (IUCN)	E	E_IUCN_Reptiles.csv
Significant Reptiles (EPBC)	E	E_EPBC_Reptiles.csv
Significant Reptiles (ALTVFV)	E	E_ALTVFV_Reptiles.csv
Significant Flora Aquatic (ABC)	R	R_ABC_Flora Aquatic.csv
Significant Flora Aquatic (IUCN)	R	R_IUCN_Flora Aquatic.csv

Values Measure	Asset Types	Import File Name
Significant Flora Aquatic (EPBC)	R	R_EPBC_Flora Aquatic.csv
Significant Flora Aquatic (ALRTPV)	R	R_ALRTPV_Flora Aquatic.csv
Significant Flora Terrestrial (ABC)	R	R_ABC_Flora Terrestrial.csv
Significant Flora Terrestrial (IUCN)	R	R_IUCN_Flora Terrestrial.csv
Significant Flora Terrestrial (EPBC)	R	R_EPBC_Flora Terrestrial.csv
Significant Flora Terrestrial (ALRTPV)	R	R_ALRTPV_Flora Terrestrial.csv
Significant Flora Wetland (ABC)	W	W_ABC_Flora.csv
Significant Flora Wetland (IUCN)	W	W_IUCN_Flora.csv
Significant Flora Wetland (EPBC)	W	W_EPBC_Flora.csv
Significant Flora Wetland (ALRTPV)	W	W_ALRTPV_Flora.csv
Significant Flora Aquatic (ABC)	E	E_ABC_Flora Aquatic.csv
Significant Flora Aquatic (IUCN)	E	E_IUCN_Flora Aquatic.csv
Significant Flora Aquatic (EPBC)	E	E_EPBC_Flora Aquatic.csv
Significant Flora Aquatic (ALRTPV)	E	E_ALRTPV_Flora Aquatic.csv
Significant Flora Terrestrial (ABC)	E	E_ABC_Flora Terrestrial.csv
Significant Flora Terrestrial (IUCN)	E	E_IUCN_Flora Terrestrial.csv
Significant Flora Terrestrial (EPBC)	E	E_EPBC_Flora Terrestrial.csv
Significant Flora Terrestrial (ALRTPV)	E	E_ALRTPV_Flora Terrestrial.csv
EVC Conservation Status	R	R_EVC_Conservation Status.csv
Riparian vegetation condition	R	R_EVC_Vegetation Condition.csv
EVC Conservation Status	W	W_EVC_Conservation Status.csv
Wetland vegetation condition	W	W_EVC_Vegetation Condition.csv
EVC Conservation Status	E	E_EVC_Conservation Status.csv
Naturalness		
Aquatic Invertebrate Community Condition	R	R_Aquatic Invert Comm Condition.csv
Native Fish	R	R_Native Fish.csv
Riparian Vegetation Condition	R	R_Riparian Vegetation Condition.csv
Wetland Vegetation Condition	W	W_Wetland Vegetation Condition.csv

Values Measure	Asset Types	Import File Name
Landscape features		
Drought Refuges	R	R_Drought Refuges.csv
Drought Refuges	W	W_Drought Refuges.csv
Drought Refuges	E	E_Drought Refuges.csv
Important Bird Areas	R	R_Important Bird Areas.csv
Important Bird Areas	W	W_Important Bird Areas.csv
Important Bird Areas	E	E_Important Bird Areas.csv
Migratory Shorebird Sites	R	R_Migratory Shorebird Sites.csv
Migratory Shorebird Sites	W	W_Migratory Shorebird Sites.csv
Migratory Shorebird Sites	E	E_Migratory Shorebird Sites.csv
Colonial Nesting Bird Sites	R	R_Colonial Nesting Bird Sites.csv
Colonial Nesting Bird Sites	W	W_Colonial Nesting Bird Sites.csv
Colonial Nesting Bird Sites	E	E_Colonial Nesting Bird Sites.csv
Biosphere Reserves	R	R_Biosphere Reserves.csv
Biosphere Reserves	W	W_Biosphere Reserves.csv
Biosphere Reserves	E	E_Biosphere Reserves.csv
Activity		
Recreational Fishing	R	R_Recreational Fishing.csv
Recreational Fishing	W	W_Recreational Fishing.csv
Recreational Fishing	E	E_Recreational Fishing.csv
Non-Motor Boating	R	R_Non-Motor Boating.csv
Non-Motor Boating	W	W_Non-Motor Boating.csv
Non-Motor Boating	E	E_Non-Motor Boating.csv
Motor Boating	R	R_Motor Boating.csv
Motor Boating	W	W_Motor Boating.csv
Motor Boating	E	E_Motor Boating.csv
Camping	R	R_Camping.csv
Camping	W	W_Camping.csv
Camping	E	E_Camping.csv

Values Measure	Asset Types	Import File Name
Swimming	R	R_Swimming.csv
Swimming	W	W_Swimming.csv
Swimming	E	E_Swimming.csv
Tracks	R	R_Tracks.csv
Tracks	W	W_Tracks.csv
Tracks	E	E_Tracks.csv
Sightseeing	R	R_Sightseeing.csv
Sightseeing	W	W_Sightseeing.csv
Sightseeing	E	E_Sightseeing.csv
Picnics and Barbecues	R	R_Picnics and Barbecues.csv
Picnics and Barbecues	W	W_Picnics and Barbecues.csv
Picnics and Barbecues	E	E_Picnics and Barbecues.csv
Game Hunting	R	R_Game Hunting.csv
Game Hunting	W	W_Game Hunting.csv
Game Hunting	E	E_Game Hunting.csv
Place		
Indigenous Heritage	R	R_Pre-European Heritage.csv
Indigenous Heritage	W	W_Pre-European Heritage.csv
Indigenous Heritage	E	E_Pre-European Heritage.csv
Post-European Heritage	R	R_Post-European Heritage.csv
Post-European Heritage	W	W_Post-European Heritage.csv
Post-European Heritage	E	E_Post-European Heritage.csv
Landscape	R	R_Landscape.csv
Landscape	W	W_Landscape.csv
Landscape	E	E_Landscape.csv
People		
Community Groups	R	R_Community Groups.csv
Community Groups	W	W_Community Groups.csv
Community Groups	E	E_Community Groups.csv

Values Measure	Asset Types	Import File Name
Use of Flagship Species	R	R_Flagship Species.csv
Use of Flagship Species	W	W_Flagship Species.csv
Use of Flagship Species	E	E_Flagship Species.csv
Water		
Township Water Sources	R	R_Township Water Source.csv
Township Water Sources	W	W_Township Water Source.csv
Township Water Sources	E	E_Township Water Source.csv
Rural Water Sources for Production	R	R_Production Water Source.csv
Rural Water Sources for Production	W	W_Production Water Source.csv
Rural Water Sources for Production	E	E_Production Water Source.csv
Water Storages	R	R_Water Storages.csv
Water Storages	W	W_Water Storages.csv
Water Carriers	R	R_Water Carriers.csv
Water Carriers	W	W_Water Carriers.csv
Wastewater Discharges	R	R_Wasterwater Discharges.csv
Wastewater Discharges	W	W_Wasterwater Discharges.csv
Wastewater Discharges	E	E_Wasterwater Discharges.csv
Power generation		
Hydro-Electricity Capacity	R	R_Hydro-Electricity.csv
Hydro-Electricity Capacity	W	W_Hydro-Electricity.csv
Other resources		
Commercial Fishing	R	R_Commercial Fishing.csv
Commercial Fishing	W	W_Commercial Fishing.csv
Commercial Fishing	E	E_Commercial Fishing.csv
Extractive Industries	R	R_Extractive Industries.csv
Extractive Industries	W	W_Extractive Industries.csv
Extractive Industries	E	E_Extractive Industries.csv
Timber and Firewood	R	R_Timber and Firewood.csv
Timber and Firewood	W	W_Timber and Firewood.csv
Timber and Firewood	E	E_Timber and Firewood.csv

AVIRA Import Data File Names - Threats

Threats Measure	Asset Types	Import File Name
Altered water regimes		
Low Flow Index Score	R	R_Increased Low Flow.csv
High Flow Index Score	R	R_Decreased High Flow.csv
Zero Flow Index Score	R	R_Increased Zero Flow.csv
Variability Index Score	R	R_Changed Variability.csv
Seasonality Index Score	R	R_Changed Seasonality.csv
Changed Water Regime	W	W_Changed Water Regime.csv
Low Flow Index Score	E	E_Increased Low Flow.csv
High Flow Index Score	E	E_Decreased High Flow.csv
Zero Flow Index Score	E	E_Increased Zero Flow.csv
Variability Index Score	E	E_Changed Variability.csv
Seasonality Index Score	E	E_Changed Seasonality.csv
Altered Marine Exchange (Intermittently Open Estuaries)	E	E_Altered Marine Exchange_Intermittent.csv
Altered Marine Exchange (Permanently Open Estuaries)	E	E_Altered Marine Exchange_Permanent.csv
Altered physical form		
Bank Instability	R	R_Bank Instability.csv
Bed Instability (Degradation)	R	R_Bed Instability.csv
Reduced Wetland Area (IWC Physical Form Sub-Index)	W	W_Reduced Area.csv
Altered Wetland Form (IWC Physical Form Sub-Index)	W	W_Altered Form.csv
Bank Instability	E	E_Bank Instability.csv
Barrier Characteristics	E	E_Barrier Characteristics.csv
Barrier Proximity	E	E_Barrier Proximity.csv
Poor water quality		
SIGNAL Objectives	R	R_Signal.csv
VWQMN Sites	R	R_VWQMN Sites.csv

Threats Measure	Asset Types	Import File Name
Waterwatch Data	R	R_Waterwatch.csv
Algal Blooms	R	R_Algal Blooms.csv
Fish Deaths	R	R_Fish Deaths.csv
Excessive Instream Macrophyte Growth	R	R_Excessive Instream Macrophytes.csv
IWC Water Properties Score	W	W_Degraded Water Quality.csv
EPA Water Quality Guideline Values for Estuaries	E	E_EPA guideline values.csv
Algal Blooms	E	E_Algal Blooms.csv
Fish Deaths	E	E_Fish Deaths.csv
Excessive Instream Macrophyte Growth	E	E_Excessive Instream Macrophytes.csv
Thermal Impact from Dam Releases (Evidence Based)	R	R_Dam Release Impact Evidence.csv
Thermal Impact from Industrial Coolant	R	R_Industrial Coolant Impact.csv
Thermal Impact from Dam Releases (Suspected)	R	R_Dam Release Impact Suspected.csv
Disturbance of Acid Sulfate Soils	R	R_Acid Sulfate Soils.csv
Disturbance of Acid Sulfate Soils	W	W_Acid Sulfate Soils.csv
Disturbance of Acid Sulfate Soils	E	E_Acid Sulfate Soils.csv
Degraded habitats		
Large Trees	R	R_Large Trees.csv
Loss of Instream Habitat (Large Wood)	R	R_Large Wood.csv
Loss of Instream Habitat (Sedimentation)	R	R_Sedimentation.csv
Livestock Access	R	R_Livestock Access.csv
Livestock Access	W	W_Livestock Access.csv
Livestock Access	E	E_Livestock Acess.csv
Soil Disturbance	W	W_Soil Disturbance.csv
Degraded buffer vegetation	W	W_Degraded Buffer.csv
Invasive flora and fauna		
Total Cover of Invasive Flora (Tree)	R	R_Invasive Flora Cover Tree.csv
Presence of High Threat Weeds (Tree)	R	R_Invasive Flora High Threat Tree.csv

Threats Measure	Asset Types	Import File Name
Total Cover of Invasive Flora (Shrub)	R	R_Invasive Flora Cover Shrub.csv
Presence of High Threat Weeds (Shrub)	R	R_Invasive Flora High Threat Shrub.csv
Total Cover of Invasive Flora (Ground)	R	R_Invasive Flora Cover Ground.csv
Presence of High Threat Weeds (Ground)	R	R_Invasive Flora High Threat Ground.csv
Invasive Flora (Aquatic)	R	R_Invasive Aquatic Flora.csv
Presence of Invasive Fauna (Terrestrial)	R	R_Invasive Terrestrial Fauna Presence.csv
Type of Impact (Terrestrial)	R	R_Invasive Terrestrial Fauna Impact.csv
Presence of Invasive Fauna (Aquatic)	R	R_Invasive Aquatic Fauna Presence.csv
Type of Impact (Aquatic)	R	R_Invasive Aquatic Fauna Impact.csv
IWC Presence of Weeds Score	W	W_Invasive Flora.csv
Presence of Invasive Fauna (Terrestrial)	W	W_Invasive Terrestrial Fauna Presence.csv
Type of Impact (Terrestrial)	W	W_Invasive Terrestrial Fauna Impact.csv
Presence of Invasive Fauna (Aquatic)	W	W_Invasive Aquatic Fauna Presence.csv
Type of Impact (Aquatic)	W	W_Invasive Aquatic Fauna Impact.csv
Total Cover of Invasive Flora (Tree)	E	E_Invasive Flora Cover Tree.csv
Presence of High Threat Weeds (Tree)	E	E_Invasive Flora High Threat Tree.csv
Total Cover of Invasive Flora (Shrub)	E	E_Invasive Flora Cover Shrub.csv
Presence of High Threat Weeds (Shrub)	E	E_Invasive Flora High Threat Shrub.csv
Total Cover of Invasive Flora (Ground)	E	E_Invasive Flora Cover Ground.csv
Presence of High Threat Weeds (Ground)	E	E_Invasive Flora High Threat Ground.csv
Invasive Flora (Aquatic)	E	E_Invasive Aquatic Flora.csv
Presence of Invasive Fauna (Terrestrial)	E	E_Invasive Terrestrial Fauna Presence.csv
Type of Impact (Terrestrial)	E	E_Invasive Terrestrial Fauna Impact.csv

Threats Measure	Asset Types	Import File Name
Presence of Invasive Fauna (Aquatic)	E	E_Invasive Aquatic Fauna Presence.csv
Type of Impact (Aquatic)	E	E_Invasive Aquatic Fauna Impact.csv
Reduced connectivity		
Barriers to fish migration	R	R_Fish Barriers.csv
Fragmentation of Woody Vegetation	R	R_Fragmentation Woody Vegetation.csv
Vegetation Overhang	R	R_Vegetation Overhang.csv
Reduced vegetation width	R	R_Vegetation Width.csv
Reduced Floodplain Connectivity	R	R_Reduced Floodplain Connectivity.csv
Barriers to Estuarine Biota	E	E_Barriers to Biota.csv
Presence of Artificial Structures	E	E_Artificial Structures.csv
Degree of Connectivity	E	E_Degree of Connectivity.csv

Appendix E - High Priority Victorian Parks and Reserves (A1 and A2)

The following information has been determined from Parks Victoria's Level of Protection framework.

Park Group A1

- Alpine National Park
- Black Range State Park
- Chiltern-Mt Pilot National Park
- Coopracambra National Park
- Croajingolong National Park
- Discovery Bay Coastal Park
- Errinundra National Park
- Grampians National Park
- Great Otway National Park
- Hattah - Kulkyne National Park
- Little Desert National Park
- Lower Glenelg National Park
- Mitchell River National Park
- Mount Arapiles-Tooan State Park
- Mount Buffalo National Park
- Murray - Sunset National Park
- Snowy River National Park
- Wilsons Promontory National Park
- Wyperfeld National Park
- Yarra Ranges National Park

Park Group A2

- Barmah National Park
- Belfast Coastal Reserve Coastal Reserve
- Brisbane Ranges National Park
- Burrowa - Pine Mountain National Park
- Cape Conran Coastal Park
- Cape Liptrap Coastal Park
- Corner Inlet Marine and Coastal Park
- Dergholm State Park
- French Island National Park
- Heathcote-Graytown National Park
- Jilpanger Nature Conservation Reserve
- Kinglake National Park
- Kings Billabong Park
- Koorangie (The Marshes & Avoca Floodway) Wildlife Reserve
- Lake Albacutya Park
- Lake Connewarre Wildlife Reserve
- Lake Tyers
- Mornington Peninsula National Park
- Mount Lawson State Park
- Nooramunga Marine & Coastal Park
- Plenty Gorge Parklands
- Point Cook Coastal Park
- Port Campbell National Park
- Reef Hills State Park
- Terrick Terrick National Park
- Tooloy-Lake Mundi Wildlife Reserve
- Warby-Ovens National Park

Appendix F - Representative Rivers for Victoria (Doeg 2001)

River Region		Representative River	LCC Recommendations		Basin Number	ISC Reach Number
Number	Name		Heritage River	Representative River		
1	Alps	Dargo River		C3	24	26, 27
		Wonnangatta River	A12		24	13, 14, 15
2	North-east uplands	Snowy Creek		C2	1	5, 6
3	North-east floodplains	Koetong Creek			1	13
4	North Central uplands	Ovens River			3	5, 6, 7
		Acheron			5	62, 63
		Yea			5	54, 55, 56, 57
		Murrindindi			5	58, 59
5	North Central midlands	Ovens River			3	3, 4
6	North Central floodplains	Ovens River	A2		3	1, 2
7	Northern-west uplands	Avoca River (upper)		C9	8	7, 8
		Axe Creek			6	12
8	North-west floodplains	Avoca River (lower)			8	1, 2, 3, 4, 5, 6
9	Grampians	Upper Glenelg River			38	12, 13
		Jimmy Creek			38	-
10	Glenelg catchment	Glenelg River (estuarine section)	A17		38	1
		Glenelg River b/n Mathers Creek & Harrow			38	10, 11
11	Otway Ranges	Aire River	A16		35	27, 28

River Region		Representative River	LCC Recommendations		Basin Number	ISC Reach Number
Number	Name		Heritage River	Representative River		
12	South west floodplains	Hopkins River between Blind Creek and Grey Creek			36	6
13	South Central	Lerderderg River	A15	C10	31	14, 15
		Curdies Creek			35	-
14a	East Gippsland east of the Snowy River - uplands	Thurra River (upper)		C6	21	25
14b	South-central uplands	Latrobe River catchment			26	6, 7
15	South-eastern slopes	Wonnangatta River	A12		24	8, 9, 10, 11, 12
16a	East Gippsland east of the Snowy River - lowlands	Thurra River (lower)		C6	21	24
16b	Strzelecki's	Tarra River		C13	27	34, 35
17	South-eastern plains	Mitchell River	A12		24	4, 5
18	Wilsons Promontory	Mt. Vereker Creek			27	-
19	South-central lowlands	Bunyip River (lower)				-

Source: DNRE (2002a)

Appendix G - Waterway Dependent Significant Fauna

Waterway Dependent Significant Fauna was identified through GIS query of the Victorian Biodiversity Atlas (VBA). Only Post 1980 records were included. Fauna species were recorded for:

- Rivers
- Wetlands
- Estuaries

The following buffers were used for mapping purposes:

- Wetlands: 200 metres from mapped boundary
- Estuaries: 300 metres from mapped boundary
- Rivers: pre-1788 EVC boundaries and within 200 metres of river centre line

Conservation Status

EX – Extinct

CE - Critically Engandered

EN – Endangered

VU – Vulnerable

NT – Near Threatened

DD – Data Deficient

L refers to listing under the provisions of Part 3 of the Victorian ***Flora and Fauna Guarantee Act 1988.*** A taxon may be listed as threatened if it has been nominated, assessed by the Scientific Advisory Committee and approved by the Minister.

Table 7 - Waterway Dependent Significant Fauna – Rivers

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
Bird - Riparian					
60196	Black Bittern	Ixobrychus flavicollis australis			L - VU
10187	Great Egret	Ardea alba			L - VU
10212	Australasian Shoveler	Anas rhynchotis			VU
60555	Brown Treecreeper	Climacteris picumnus victoriae			NT
10031	Diamond Dove	Geopelia cuneata			L – NT
10519	Eastern Bristlebird	Dasyornis brachypterus brachypterus	EN	EN	L – EN
60618	Helmeted Honeyeater	Lichenostomus melanops cassidix		EN	L – CE

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
10012	King Quail	Coturnix chinensis victoriae			L - EN
10045	Lewin's Rail	Rallus pectoralis pectoralis			L - VU
10195	Australian Little Bittern	Ixobrychus dubius			L - EN
10199	Magpie Goose (reintroduced)	Anseranas semipalmata			L - NT
10264	Red-tailed Black-Cockatoo	Calyptorhynchus banksii graptogyne		EN	L – EN
10278	Regent Parrot	Polytelis anthopeplus monarchoides		VU	L - VU
10230	Square-tailed Kite	Lophoictinia isura			L - VU
10277	Superb Parrot	Polytelis swainsonii	VU		L - EN
Bird - Waterway					
60196	Black Bittern	Ixobrychus flavicollis australis			L - VU
10187	Great Egret	Ardea alba			L - VU
10197	Australasian Bittern	Botaurus poiciloptilus	EN	EN	L - EN
10319	Azure Kingfisher	Alcedo azurea			NT
10112	Caspian Tern	Sterna caspia			L - NT
10192	Nankeen Night Heron	Nycticorax caledonicus hillii			NT
10099	Pied Cormorant	Phalacrocorax varius			NT
10226	White-bellied Sea-Eagle	Haliaeetus leucogaster			L - VU
Fish - Non-migratory					
	Agassiz's Chanda Perch	Ambassis agassizii			L – RE
	Southern Purple-spotted Gudgeon	Mogurnda adspersa			L – RE
	Barred Galaxias	Galaxias fuscus	CE	EN	L – CE
	River Blackfish upper Wannon R form	Gadopsis marmoratus upper Wannon			CE
	Trout Cod	Maccullochella macquariensis	EN	EN	L – CE

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Variegated Pigmy Perch	Nannoperca variegata		VU	L – VU
	Dwarf Galaxias	Galaxiella pusilla	VU	VU	L – EN
	Yarra Pigmy Perch	Nannoperca obscura		VU	L – VU
Fish - Migratory					
	Freshwater Herring	Potamalosa richmondia			L – RC
	Australian Mudfish	Neochanna cleaveri			L – CE
	Australian Whitebait	Lovettia sealii			L – CE
	Murray Hardyhead	Craterocephalus fluviatilis	EN	EN	L – CE
	Silver Perch	Bidyanus bidyanus	VU		L – VU
	Cox's Gudgeon	Gobiomorphus coxii			L - EN
	Freshwater Catfish	Tandanus tandanus			L – EN
	Macquarie Perch	Macquaria australasica	DD	EN	L – EN
	Murray Cod	Maccullochella peelii peelii	CE	VU	L - VU
	Australian Grayling	Prototroctes maraena	VU	VU	L – VU
	Empire Gudgeon	Hypseleotris compressa			L – VU
	Golden Perch (natural populations)	Macquaria ambigua			IN
	Unspecked Hardyhead	Craterocephalus stercusmuscarum fulvus			L[4]
	Striped Gudgeon	Gobiomorphus australis			NT
	Flat-headed Galaxias	Galaxias rostratus	VU		I- VU
	Pale Mangrove Goby	Mugiligobius platynotus			L – VU

[4] Taxon was listed at time the VBA was interrogated, but is no longer listed

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Crimson-spotted Rainbowfish (Murray-Darling Rainbowfish)	Melanotaenia fluviatilis			L – VU
Mammal					
11357	Southern Myotis	Myotis macropus			NT
11280	Grey-headed Flying Fox	Pteropus poliocephalus	VU	VU	L – VU
11034	Swamp Antechinus	Antechinus minimus			L – NT
11438	Broad-toothed Rat	Mastacomys fuscus	NT		N – EN
11050	Gile's Planigale	Planigale gilesi			L - NT
Reptile - Aquatic					
	Broad-shelled Turtle	Macrochelodina expansa			L – EN
	Murray River Tortoise	Emydura macquarii			V
12557	Eastern Water Skink	Eulamprus quoyii			NT[5]
Reptile - Riparian					
12550	Alpine Water Skink	Eulamprus kosciuskoi			L - CE
62958	Corangamite Water Skink	Eulamprus tympanum marnieae		EN	L - CE
12992	Alpine Bog Skink	Pseudemoia cryodroma			L - EN
62969	Carpet Python	Morelia spilota metcalfei			L – EN
19001	De Vis' Banded Snake	Denisonia devisi			CE
12283	Lace Monitor	Varanus varius			EN
12669	Red-naped Snake	Furina diadema			L – VU
12407	Swamp Skink	Lissolepis (formerly Egernia) coventryi			L - VU

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Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
Amphibian					
63907	Alpine Tree Frog	Litoria verreauxii alpina		VU	L – CE
13106	Baw Baw Frog	Philoria frosti	CE	EN	L – CE
13168	Booroolong Tree Frog	Litoria booroolongensis		EN	L – CE
13060	Giant Bullfrog	Limnodynastes interioris			L – CE
13073	Southern Barred Frog	Mixophyes balbus	VU	VU	L – CE
13195	Spotted Tree Frog	Litoria spenceri		EN	L – CE
13117	Brown Toadlet	Pseudophryne bibronii	NT		L - EN
13207	Growling Grass Frog	Litoria raniformis	EN	VU	L – EN
13042	Giant Burrowing Frog	Heleioporus australiacus	VU	VU	L – CE
13166	Green and Golden Bell Frog	Litoria aurea		VU	I - VU
13151	Rugose Toadlet	Uperoleia rugosa			L – EN
13125	Southern Toadlet	Pseudophryne semimarmorata			VU
13120	Dendy's Toadlet	Pseudophryne dendyi			DD
13936	Large Brown Tree Frog	Litoria littlejohni		VU	L – EN
13930	Martin's Toadlet	Uperoleia martini	DD		CE
13931	Tyler's Toadlet	Uperoleia tyleri			DD
13158	Smooth Toadlet	Uperoleia laevigata			DD
13059	Barking Marsh Frog	Limnodynastes fletcheri			DD[6]
Invertebrate - Aquatic					
	Alpine Darner	Austroaeschna flavomaculata			VU
	Alpine Redspot	Austropetalia tonyana			NT
	Alpine Stonefly	Thaumatoperla alpina			L - VU
	Ancient Greenling	Hemiphlebia mirabilis			L - EN

[6] Taxon was listed at time the VBA was interrogated, but is no longer listed

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Aquatic Beetle	Hygrobia australasiae			L - VU
	Aquatic Beetle	Notomicrus tenellus			VU
	Caddisfly	Tanjistomella verna			CE
	Caddisfly	Triaenodes vespertina			CE
	Caddisfly	Ecnomus neboissi			VU
	Caddisfly	Ecnomus nibbor			VU
	Caddisfly	Leptocerus souta			VU
	Caddisfly	Notoperata sparsa			VU
	Caddisfly	Plectrotarsus gravenhorstii			VU
	Caddisfly	Ramiheithrus virgatus			VU
	Caddisfly	Tamasia furcilla			VU
	Caddisfly	Taskiria otwayensis			L - VU
	Caddisfly	Triaenodes cuspiosa			VU
	Caddisfly	Triaenodes resima			VU
	Caddisfly	Triaenodes uvida			VU
	Caddisfly	Westriplectes pedderensis			VU
15015	Caddisfly	Orphinotrichia justini			NT
	Caddisfly	Archaeophylax canarus			L - DD
	Caddisfly	Ecnomus karakoi			DD
	Caddisfly	Ecnomus karawalla			DD
	Caddisfly	Notalina gungarra			DD
	Caddisfly	Oecetis asmanista			DD
	Grey-chested Flatwing Dragonfly	Griseargiolestes eboracus			DD
	Inland Ringtail	Austrolestes aridus			NT
	Kallista Flightless Stonefly	Leptoperla kallistae			L - CE
	Large Riverdamsel	Caliagrion billinghursti			EN
	Mayfly	Pseudocloeon hypodelum			VU
	Mayfly	Wundacaenis flabellum			VU

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Mount Donna Buang Stonefly	Riekoperla darlingtoni	VU		L - CE
	Mt Stirling Stonefly	Thaumatoperla flaveola			VU
	Murray River Hunter	Archaeophylax canarus			DD
	Otway Stonefly	Eusthenia nothofagi	DD	D	NT
	Stonefly	Riekoperla isosceles	VU		L - CE
	Stonefly	Riekoperla intermedia			L - EN
	Stonefly	Dinotoperla walkeri			VU
	Stonefly	Thaumatoperla robusta			DD
	Stonefly	Thaumatoperla timmsi			DD
	Swamp Bluet	Coenagrion lyelli			NT
	Wide-faced Darner	Dendroaeschna conspersa			DD
	Alpine Spiny Cray	Euastacus crassus	EN		L - EN
	Calanoid copepod	Calamoecia australica			VU
	Clayton's Spiny Cray	Euastacus claytoni			VU
	Common Yabby subspecies	Cherax destructor albidus			DD
	Dairy Creek Austropyrgus Snail	Austropyrgus grampianensis			L - CE
	Dandenong Freshwater Amphipod	Austrogammarus australis	EX		L – CE
	East Gippsland Spiny Cray	Euastacus bidawalus			VU
	Eastern Freshwater Shrimp	Australatya striolata			L - VU
	Flatworm	Spathula tryssa			VU
	Glenelg Freshwater Mussel	Hyridella glenelgensis			L - CE

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Harpactacoid copepod	Canthocamptus longipes, C. mammillifurca, C. sublaevis	VU		DD
	Harpactacoid copepod	Fibulacamptus gracilior	VU		DD
	Murray River Spiny Cray	Euastacus armatus	VU		L - NT
	Otways Cray	Geocharax gracilis			EN
	Phreatoicid isopod	Naiopegia xiphagrostis, Gariwerdeus beehivensis, G. ingletonensis, G. turretensis			VU
15107	River snail	Notopala sublineata	EN		L - CE
	Sherbrooke Amphipod	Austrogammarus haasei			L - VU
1637	South Gippsland Spiny Cray	Euastacus neodiversus	VU		L - EN
	Variable Spiny Cray	Euastacus yanga			VU
	Western Cray	Geocharax falcata			EN
	Brackish Jellyfish	Australonmedusa baylii			VU
Invertebrate - Riparian					
1679	Curve-tail Burrowing Cray	Engaeus curvisuturus	EN		L - EN
1685	Dandenong Burrowing Cray	Engaeus urostrictus	EN		L - CE
1678	Gippsland Burrowing Cray	Engaeus hemicirratulus			L - EN
15004	Gippsland Giant Earthworm	Megascolides australis	VU	VU	L - EN
1646	Glenelg River Spiny Cray	Euastacus bispinosis			L – EN
1692	Hairy Burrowing Cray	Engaeus sericatus			VU
1686	Lilly Pilly Burrowing Cray	Engaeus australis	EN		I
1694	Mallacoota Burrowing Cray	Engaeus mallacoota	EN		L -VU

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Narracan Burrowing Cray	Engaeus phyllocercus	VU		L - EN
1675	South Gippsland Burrowing Cray	Engaeus karnanga			EN
1683	Strzelecki Burrowing Cray	Engaeus rostrogaleatus	EN		L - EN
1693	Warragul Burrowing Cray	Engaeus sternalis	EN		L - CE
1684	Western Burrowing Cray	Engaeus merosetosus			EN
	Western Swamp Cray	Gramastacus insolitus			L - CE

Table 8 - Waterway Dependent Fauna – Wetlands

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	FFG Advisory List
Amphibian					
63907	Alpine Tree Frog	Litoria verreauxii alpina			L – CE
13059	Barking Marsh Frog	Limnodynastes fletcheri			DD[7]
13106	Baw Baw Frog	Philoria frosti	CE		L - CE
13168	Booroolong Tree Frog	Litoria booroolongensis			L - CE
13117	Brown Toadlet	Pseudophryne bibronii	NT		L –EN
13166	Green and Golden Bell Frog	Litoria aurea		VU	IN
13207	Growling Grass Frog	Litoria raniformis	EN		L - EN
13060	Giant Bullfrog	Limnodynastes interioris			L – CE
13936	Large Brown Tree Frog	Litoria littlejohni			L – EN
13930	Martin's Toadlet	Uperoleia martini	DD		CE
13125	Southern Toadlet	Pseudophryne semimarmorata			VU
13195	Spotted Tree Frog	Litoria spenceri			L – CE
13931	Tyler's Toadlet	Uperoleia tyleri			DD
Bird					
10197	Australasian Bittern	Botaurus poiciloptilus	EN	EN	L - EN
10212	Australasian Shoveler	Anas rhynchotis			VU
10170	Australian Painted-Snipe	Rostratula benghalensis		VU	L - CE
10173	Australian Pratincole	Stiltia isabella			NT
10319	Azure Kingfisher	Alcedo azurea			NT
10050	Baillon's Crake	Porzana pusilla			L - VU
60196	Black Bittern	Ixobrychus flavicollis australis			L – VU

[7] Taxon was listed at time the VBA was interrogated, but is no longer listed

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
10098	Black-faced Cormorant	Phalacrocorax fuscescens			NT
	Black-tailed Godwit	Limosa limosa			VU
10216	Blue-billed Duck	Oxyura australis			L - EN
10177	Brolga	Grus rubicunda			L - VU
10198	Cape Barren Goose	Cereopsis novaehollandiae			L - NT[8]
10112	Caspian Tern	Sterna caspia			L – NT
10157	Common Sandpiper	Actitis hypoleucos			VU
10149	Eastern Curlew	Numenius madagascariensis			VU
10118	Fairy Tern	Sterna nereis		VU	L - EN
10214	Freckled Duck	Stictonetta naevosa			L - EN
10178	Glossy Ibis	Plegadis falcinellus			NT
10187	Great Egret	Ardea alba			L – VU
10165	Great Knot	Calidris tenuirostris			L - EN
10141	Greater Sand Plover	Charadrius leschenaultii			CE
10136	Grey Plover	Pluvialis squatarola			EN
10155	Grey-tailed Tattler	Heteroscelus brevipes			L - CE
10111	Gull-billed Tern	Sterna nilotica			L - EN
	Hardhead	Aythya australis			VU
10138	Hooded Plover	Thinornis rubricollis			L - VU
10145	Inland Dotterel	Charadrius australis			VU
10186	Intermediate Egret	Ardea intermedia			L - EN
10168	Latham's Snipe	Gallinago hardwickii			N - NT
10139	Lesser Sand Plover	Charadrius mongolus			CE
10045	Lewin's Rail	Rallus pectoralis			L – VU
10195	Little Bittern	Ixobrychus minutus			L – EN

[8] Taxon was listed at time the VBA was interrogated, but is no longer listed

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
10185	Little Egret	Egretta garzetta			EN
10117	Little Tern	Sterna albifrons			L - VU
10199	Magpie Goose	Anseranas semipalmata			L – NT
10217	Musk Duck	Biziura lobata			VU
10192	Nankeen Night Heron	Nycticorax caledonicus			NT
10305	Orange-bellied Parrot	Neophema chrysogaster		CR	L – CE
	Pacific Golden Plover	Pluvialis fulva			VU
60126	Pacific Gull	Larus pacificus			NT
10978	Pectoral Sandpiper	Calidris melanotos			NT
10099	Pied Cormorant	Phalacrocorax varius			NT
10164	Red Knot	Calidris canutus			EN
10278	Regent Parrot	Polytelis anthopeplus		VU	L – VU
10181	Royal Spoonbill	Platalea regia			NT
10166	Sanderling	Calidris alba			NT
10131	Sooty Oystercatcher	Haematopus fuliginosus			NT
10277	Superb Parrot	Polytelis swainsonii	VU		L - EN
10160	Terek Sandpiper	Xenus cinereus			L - EN
10150	Whimbrel	Numenius phaeopus			VU
10110	Whiskered Tern	Chlidonias hybridus			NT
10226	White-bellied Sea-Eagle	Haliaeetus leucogaster			L – VU
10109	White-winged Black Tern	Chlidonias leucopterus			NT
10154	Wood Sandpiper	Tringa glareola			VU
Fish					
	Australian Grayling	Prototroctes maraena	VU	VU	L – VU
	Golden Perch	Macquaria ambigua			IN

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
	Murray Hardyhead	Craterocephalus fluviatilis	EN	EN	L – CE
	Agassiz's Chanda Perch	Ambassis agassizii			L – RE
	Australian Mudfish	Neochanna cleaveri			L – CE
	Crimson-spotted Rainbowfish (Murray-Darling Rainbowfish)	Melanotaenia fluviatilis			L - VU
	Freshwater Catfish	Tandanus tandanus			L – EN
	River Blackfish upper Wannon R form	Gadopsis marmoratus upper Wannon			CE
	Southern Purple-spotted Gudgeon	Mogurnda adspersa			L – RE
	Striped Gudgeon	Gobiomorphus australis			NT
	Unspecked Hardyhead	Craterocephalus stercusmuscarum fulvus			DD[9]
	Variegated Pigmy Perch	Nannoperca variegata		VU	L – VU
	Yarra Pigmy Perch	Nannoperca obscura		VU	L – VU
Reptile - Riparian					
12992	Alpine Bog Skink	Pseudemoia cryodroma			L – EN
12550	Alpine Water Skink	Eulamprus kosciuskoi			L – CE
62969	Carpet Python	Morelia spilota metcalfei			L – EN
62958	Corangamite Water Skink	Eulamprus tympanum marnieae		EN	L - CE
12557	Eastern Water Skink	Eulamprus quoyii			NT[10]
12407	Swamp Skink	Egernia coventryi			L - VU

[9] Taxon was listed at time the VBA was interrogated, but is no longer listed.

[10] Taxon was listed at time the VBA was interrogated, but is no longer listed.

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
Reptile - Aquatic					
	Broad-shelled Turtle	Macrochelodina expansa			L - EN
Invertebrates					
	Swamp Bluet	Coenagrion lyelli			NT
	Ancient Greenling	Hemiphlebia mirabilis	EN		L – EN
	Caddisfly	Triaenodes vespertina			CE
	Harpactacoid copepod	Fibulacamptus gracilior	VU		DD
75167	Isopod	Phreatoicopsis raffae			VU
	Western Swamp Cray	Gramastacus insolitus	NT		L - CE
Mammals					
11357	Southern Myotis	Myotis macropus			NT

Table 9 - Waterway Dependent Fauna – Estuaries

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	FFG Advisory List
Bird					
10197	Australasian Bittern	Botaurus poiciloptilus	EN	EN	L - EN
10319	Azure Kingfisher	Alcedo azurea			NT
60196	Black Bittern	Ixobrychus flavicollis australis			L - VU
	Black-tailed Godwit	Limosa limosa			VU
10149	Eastern Curlew	Numenius madagascariensis			VU
10118	Fairy Tern	Sterna nereis nereis		VU	L – EN
10187	Great Egret	Ardea alba			L – VU
10165	Great Knot	Calitris tenuirostris			L – EN
10136	Grey Plover	Pluvialis squatarolaulva			EN
10155	Grey-tailed Tattler	Heteroscelus brevipes			L – CE

Taxon Code	Common Name	Scientific Name	IUCN Listed	EPBC Listed	Advisory List
10111	Gull-billed Tern	Sterna nilotica macrotarsa			L – EN
10186	Intermediate Egret	Ardea intermedia			L – EN
10185	Little Egret	Egretta garzetta nigripes			EN
10117	Little Tern	Sterna albifrons sinensis			L – VU
10192	Nankeen Night Heron	Nycticorax caledonicus hillii			NT
	Pacific Golden Plover	Pluvialis fulva			VU
10164	Red Knot	Calitris canutus			EN
10181	Royal Spoonbill	Platalea regia			NT
10131	Sooty Oystercatcher	Haematopus fuliginosus			NT
10160	Terek Sandpiper	Xenus cinereus			L – EN
10150	Whimbrel	Numenius phaeopus			VU
10110	Whiskered Tern	Chlidonias hybridus javanicus			NT
10109	White-winged Black Tern	Chlidonias leucopterus			NT
Fish - Resident					
	Pale Mangrove Goby	Mugilogobius platynotus			L – VU
Fish - Dependent					
	Empire Gudgeon	Hypseleotris compressa			L – VU
	Freshwater Herring	Potamalosa richmondia			L - RE
	Cox's Gudgeon	Gobiomorphus coxii			L – EN
	Australian Grayling	Prototroctes maraena	VU	VU	L – VU
	Australian Mudfish	Neochanna cleaveri			L – CE
	Australian Whitebait	Lovettia sealii			L – CE
Reptile					
12407	Swamp Skink	Lissolepis (formerly Egernia) coventryi			L – VU
12683	Glossy Grass Skink	Pseudemoia rawlinsoni			VU

Appendix H - Waterway Dependent Significant Flora

Waterway Dependent Significant Flora was identified through GIS query of the Victorian Biodiversity Atlas. Only post-1980 records were included. Flora species were divided into groups which were:

- River Terrestrial
- River Aquatic
- Wetland
- Estuary Terrestrial
- Estuary Aquatic

The following buffers were used for mapping purposes:

- Wetlands: 100 metres from mapped boundary
- Estuaries: 200 metres from mapped boundary
- Rivers: pre-1788 EVC boundaries and within 200 metres of river centre line

Table 10 - Waterway Dependent Significant Flora - River Terrestrial

River Terrestrial		
Sp No	Scientific Name	Common Name
4199	Abutilon oxycarpum var. malvaefolium	Mallow-leaf Lantern-flower
0010	Acacia amoena	Boomerang Wattle
0016	Acacia boormanii	Snowy River Wattle
0023	Acacia dallachiana	Catkin Wattle
3631	Acacia irrorata subsp. irrorata	Green Wattle
5092	Acacia lanigera var. gracilipes	Woolly Wattle
0070	Acacia oswaldii	Umbrella Wattle
0073	Acacia pendula	Weeping Myall
0093	Acacia subporosa	Bower Wattle
0096	Acacia trineura	Three-nerve Wattle
0116	Acronychia oblongifolia	Yellow-wood
0130	Adiantum capillus-veneris	Venus-hair Fern
0131	Adiantum diaphanum	Filmy Maidenhair
0132	Adiantum formosum	Black Stem
0133	Adiantum hispidulum	Rough Maidenhair

River Terrestrial		
Sp No	Scientific Name	Common Name
5449	Adiantum hispidulum var. hispidulum	Rough Maidenhair
5450	Adiantum hispidulum var. hypoglaucum	Rough Maidenhair
0135	Adriana urticoides var. urticoides	Eastern Bitter-bush
4218	Adriana urticoides var. urticoides (glabrous form)	Eastern Bitter-bush
4217	Adriana urticoides var. urticoides (pubescent form)	Eastern Bitter-bush
0170	Alchemilla sp. 1	Lady's Mantle
0171	Alectryon subcinereus	Native Quince
5096	Alternanthera sp. 1 (Plains)	Plains Joyweed
0195	Amaranthus macrocarpus var. macrocarpus	Dwarf Amaranth
0202	Ammannia multiflora	Jerry-jerry
0204	Ammobium alatum	Winged Everlasting
5168	Amyema pendula subsp. longifolia	Drooping Mistletoe
4148	Aphanopetalum resinosum	Gum Vine
0250	Arabidella nasturtium	Yellow Cress
0277	Asperula ambleia	Stiff Woodruff
0280	Asperula gemella	Twin-leaf Bedstraw
0296	Astelia australiana	Tall Astelia
0333	Atriplex holocarpa	Pop Saltbush
0322	Atriplex limbata	Spreading Saltbush
4231	Atriplex lindleyi subsp. conduplicata	Baldoo
4243	Atriplex lindleyi subsp. lindleyi	Flat-top Saltbush
4233	Atriplex nummularia subsp. omissa	Dwarf Old-man Saltbush
0330	Atriplex pseudocampanulata	Mealy Saltbush
0331	Atriplex rhagodioides	Silver Saltbush
4245	Atriplex vesicaria subsp. minor	Bladder Saltbush
4257	Australina pusilla subsp. pusilla	Small Shade-nettle
4179	Austrodanthonia setacea var. breviseta	Short-bristle Wallaby-grass
0352	Babingtonia crenulata	Fern-leaf Baeckea
0368	Barbarea grayi	Native Wintercress

River Terrestrial		
Sp No	Scientific Name	Common Name
0372	Bauera sessiliflora	Grampians Bauera
0386	Bergia ammannioides	Jerry Water-fire
0387	Bergia trimera	Small Water-fire
0389	Bertya cunninghamii subsp. pubiramula	Sticky Bertya
0390	Bertya findlayi	Mountain Bertya
5951	Bertya grampiana	Grampians Bertya
5953	Bertya tasmanica subsp. vestita (fine-haired variant)	Mitchell Bertya (fine-haired variant)
5954	Bertya tasmanica subsp. vestita (glabrous ovary variant)	Mitchell Bertya (glabrous ovary variant)
3165	Berula erecta	Water Parsnip
0393	Beyeria lasiocarpa	Wallaby-bush
0396	Beyeria viscosa	Pinkwood
0412	Blechnum vulcanicum	Mountain Water-fern
4669	Bolboschoenus fluviatilis	Tall Club-sedge
0426	Boronia ledifolia	Showy Boronia
0441	Bossiaea riparia	River Leafless Bossiaea
5217	Brachyscome aff. gracilis (Kings Billabong)	Billabong Daisy
3654	Brachyscome chrysoglossa	Yellow-tongue Daisy
0459	Brachyscome gracilis	Dookie Daisy
0465	Brachyscome muelleroides	Mueller Daisy
0476	Brachyscome riparia	Snowy River Daisy
4395	Brachyscome sp. aff. readeri	Murray Daisy
0561	Callistemon brachyandrus	Prickly Bottlebrush
4684	Callistemon forresterae	Forrester's Bottlebrush
5208	Callistemon genofluvialis	Genoa River Bottlebrush
4571	Callistemon kenmorrisonii	Betka Bottlebrush
0567	Callistemon subulatus	Dwarf Bottlebrush
5098	Calostemma luteum	Yellow Garland-lily
0592	Calostemma purpurea s.l.	Garland Lily

River Terrestrial		
Sp No	Scientific Name	Common Name
5936	Calostemma purpureum s.s.	Garland Lily
0594	Calotis cuneifolia	Blue Burr Daisy
5028	Cardamine lineariloba	Western Bitter-cress
5029	Cardamine microthrix	Eastern Bitter-cress
5032	Cardamine moirensis	Riverina Bitter-cress
5034	Cardamine papillata	Forest Bitter-cress
5035	Cardamine paucijuga s.s.	Annual Bitter-cress
0617	Cardamine tenuifolia	Slender Bitter-cress
5445	Cardamine tenuifolia (large-flower form)	Slender Bitter-cress
5444	Cardamine tenuifolia (small-flower form)	Slender Bitter-cress
0622	Carex alsophila	Forest Sedge
0632	Carex chlorantha	Green-top Sedge
4673	Carex gunniana var. brevior	Swamp Sedge
0650	Carex tasmanica	Curly Sedge
0682	Casuarina obesa	Swamp Sheoak
5616	Centipeda nidiformis	Cotton Sneezeweed
0709	Centipeda thespidioides s.l.	Desert Sneezeweed
5617	Centipeda thespidioides s.s.	Desert Sneezeweed
2094	Cephalomanes caudatum	Jungle Bristle-fern
0738	Chenopodium carinatum	Keeled Goosefoot
0742	Chenopodium erosum	Papery Goosefoot
0768	Christella dentata	Binung
0802	Commersonia rossii	Blackfellow's Hemp
5887	Convolvulus recurvatus subsp. recurvatus	Recurved Bindweed
0828	Correa aemula	Hairy Correa
5466	Correa lawrenceana var. cordifolia	Pink Mountain-correa
4365	Correa lawrenceana var. genoensis	Genoa River Correa
0835	Corybas aconitiflorus	Spurred Helmet-orchid
0841	Corybas hispidus	Bristly Helmet-orchid

River Terrestrial		
Sp No	Scientific Name	Common Name
5622	Corybas sp. aff. diemenicus 4 (Mountains)	Mountain Helmet-orchid
4646	Craspedia haplorrhiza	Plains Billy-buttons
0874	Crinum flaccidum	Darling Lily
7177	Ctenopteris heterophylla X Grammitis billardierei	Gipsy X Finger Fern hybrid
2769	Cullen australasicum	Native Scurf-pea
2770	Cullen cinereum	Hoary Scurf-pea
2773	Cullen parvum	Small Scurf-pea
2776	Cullen tenax	Tough Scurf-pea
5241	Cuscuta australis	Australian Dodder
0896	Cyathea cunninghamii	Slender Tree-fern
0897	Cyathea leichhardtiana	Prickly Tree-fern
0898	Cyathea X marcescens	Skirted Tree-fern
4149	Cynodon dactylon var. pulchellus	Native Couch
0913	Cyperus bifax	Downs Nutgrass
0915	Cyperus concinnus	Trim Flat-sedge
0920	Cyperus flaccidus	Lax Flat-sedge
0921	Cyperus flavidus	Yellow Flat-sedge
4620	Cyperus fulvus	Sticky Sedge
3678	Cyperus gracilis	Slender Flat-sedge
0927	Cyperus nervulosus	Annual Flat-sedge
0929	Cyperus pygmaeus	Dwarf Flat-sedge
0930	Cyperus rigidellus	Curly Flat-sedge
0934	Cyperus squarrosus	Bearded Flat-sedge
0939	Cyperus victoriensis	Yelka
0949	Dactyloctenium radulans	Finger Grass
0313	Deparia petersenii subsp. congrua	Japanese Lady-fern
1007	Desmodium brachypodum	Large Tick-trefoil
4425	Desmodium varians	Slender Tick-trefoil
4611	Deyeuxia nudiflora	Climbing Bent-grass

River Terrestrial		
Sp No	Scientific Name	Common Name
4266	Dianella porracea	Riverine Flax-lily
7399	Dianella sp. aff. longifolia (Riverina)	Pale Flax-lily
5786	Dichondra sp. 1 (s.l.)	Silky Kidney-weed
1041	Digitaria ammophila	Silky Umbrella-grass
1045	Digitaria divaricatissima	Umbrella Grass
1071	Discaria nitida	Shining Anchor Plant
1072	Discaria pubescens	Australian Anchor Plant
1512	Diuris ochroma	Pale Golden Moths
1003	Dockrilla striolata subsp. striolata	Streaked Rock-orchid
1091	Dodonaea rhombifolia	Broad-leaf Hop-bush
1105	Drosera indica	Flycatcher
4674	Eleocharis macbarronii	Grey Spike-sedge
5619	Eleocharis obicis	Striate Spike-sedge
1143	Eleocharis pallens	Pale Spike-sedge
1583	Elymus multiflorus	Short-awned Wheat-grass
1158	Enneapogon gracilis	Slender Bottle-washers
1172	Epaltes cunninghamii	Tall Nut-heads
5252	Eragrostis exigua	Slender Love-grass
1190	Eragrostis lacunaria	Purple Love-grass
5253	Eragrostis leptocarpa	Drooping Love-grass
1195	Eragrostis setifolia	Bristly Love-grass
1198	Eremophila bignoniiflora	Bignonia Emu-bush
1200	Eremophila divaricata subsp. divaricata	Spreading Emu-bush
1204	Eremophila maculata var. maculata	Spotted Emu-bush
1206	Eremophila polyclada	Twiggy Emu-bush
3706	Eriochloa crebra	Tall Cup-grass
1238	Eryngium paludosum	Long Eryngium
1244	Eucalyptus aggregata	Black Gum
4892	Eucalyptus alligatrix subsp. alligatrix	Silver Stringybark

River Terrestrial		
Sp No	Scientific Name	Common Name
1256	Eucalyptus brookeriana	Brooker's Gum
3707	Eucalyptus cadens	Warby Range Swamp-gum
1265	Eucalyptus crenulata	Buxton Gum
5175	Eucalyptus fulgens	Green Scentbark
4491	Eucalyptus globulus subsp. globulus	Southern Blue-gum
1284	Eucalyptus globulus subsp. maidenii	Maiden's Gum
5176	Eucalyptus ignorabilis s.s.	Grey Scentbark
1301	Eucalyptus neglecta	Omeo Gum
1309	Eucalyptus perriniana	Spinning Gum
4558	Eucalyptus strzeleckii	Strzelecki Gum
1326	Eucalyptus yarraensis	Yarra Gum
1475	Euchiton umbricola	Cliff Cudweed
1327	Eucryphia moorei	Eastern Leatherwood
1333	Euphorbia planiticola	Plains Spurge
4468	Euphrasia collina subsp. muelleri	Purple Eyebright
4472	Euphrasia collina subsp. trichocalycina	Purple Eyebright
1343	Euphrasia scabra	Rough Eyebright
1344	Eupomatia laurina	Bolwarra
1364	Ficus coronata	Sandpaper Fig
1367	Fimbristylis aestivalis	Summer Fringe-sedge
1369	Fimbristylis velata	Veiled Fringe-sedge
1390	Gahnia grandis	Brickmakers' Sedge
1396	Gahnia subaequiglumis	Bog Saw-sedge
4678	Gentianella gunniana	Gunn's Forest-gentian
1429	Geranium neglectum	Red-stem Cranesbill
5337	Geranium solanderi var. solanderi s.s.	Austral Cranesbill
1456	Glycine latrobeana	Clover Glycine
1514	Goodenia stelligera	Spiked Gooodenia
4600	Goodia lotifolia var. pubescens	Silky Golden-tip

River Terrestrial		
Sp No	Scientific Name	Common Name
3742	Grammitis magellanica subsp. nothofageti	Beech Finger-fern
1521	Grammitis poeppigiana	Alpine Finger-fern
1523	Gratiola pedunculata	Stalked Brooklime
3753	Gratiola pumilo	Dwarf Brooklime
1529	Grevillea barklyana	Gully Grevillea
1543	Grevillea miqueliana	Oval-leaf Grevillea
4922	Grevillea neurophylla	Granite Grevillea
5772	Grevillea neurophylla subsp. fluviatilis	Granite Grevillea
5773	Grevillea neurophylla subsp. neurophylla	Granite Grevillea
3745	Grevillea obtecta	Fryerstown Grevillea
4550	Grevillea parvula	Genoa Grevillea
5490	Grevillea polychroma	Tullach Ard Grevillea
4066	Grevillea rosmarinifolia subsp. rosmarinifolia	Rosemary Grevillea
4551	Grevillea victoriae s.s.	Royal Grevillea
1554	Grevillea willisii	Rock Grevillea
3756	Gynatrix macrophylla	Gippsland Hemp Bush
1582	Haloragis exalata subsp. exalata var. exalata	Square Raspwort
4655	Helichrysum aff. rutidolepis (Lowland Swamps)	Pale Swamp Everlasting
1685	Hibiscus brachysiphonius	Low Hibiscus
3767	Hovea corrickiae	Glossy Hovea
4929	Hovea pannosa s.s. [notably rheophytic Omeo form]	Rusty Velvet-pods
3787	Hovea purpurea	Tall Hovea
2084	Huperzia varia	Long Clubmoss
3776	Hypolepis elegans subsp. elegans	Elegant Ground-fern
3777	Hypoxis exilis	Swamp Star
1757	Hypsela tridens	Hypsela
1771	Isolepis australiensis	Inland Club-sedge
5265	Isolepis cernua var. setiformis	Bristle Club-sedge
1773	Isolepis congrua	Slender Club-sedge

River Terrestrial		
Sp No	Scientific Name	Common Name
1789	Isolepis wakefieldiana	Tufted Club-sedge
4435	Juncus bassianus	Bass Rush
1832	Juncus phaeanthus	Dark-flower Rush
1836	Juncus psammophilus	Sand Rush
7040	Kunzea leptospermoides	Yarra Burgan
4687	Kunzea peduncularis X phylicoides	River Burgan
7063	Kunzea phylicoides	Slender Burgan
4220	Lachnagrostis filifolia var. 2	Wetland Blown-grass
0159	Lachnagrostis scabra	Ruddy Blown-grass
1877	Lastreopsis decomposita	Trim Shield-fern
1878	Lastreopsis hispida	Bristly Shield-fern
1879	Lastreopsis microsora subsp. microsora	Creeping Shield-fern
3782	Leiocarpa leptolepis	Pale Plover-daisy
1799	Leiocarpa tomentosa	Woolly Plover-daisy
1901	Lepidium fasciculatum	Bundled Peppercress
1903	Lepidium hyssopifolium	Basalt Peppercress
1905	Lepidium monoplocoides	Winged Peppercress
1906	Lepidium papillosum	Warty Peppercress
1908	Lepidium pseudohyssopifolium	Native Peppercress
1060	Leptochloa fusca subsp. fusca	Brown Beetle-grass
1941	Leptorhynchos elongatus	Lanky Buttons
1944	Leptorhynchos orientalis	Annual Buttons
1953	Leptospermum emarginatum	Twin-flower Tea-tree
4799	Leptospermum glabrescens s.s.	Smooth Tea-tree
1967	Lepyrodia flexuosa	Twisting Scale-rush
1970	Lespedeza juncea subsp. sericea	Chinese Lespedeza
1990	Leucopogon riparius	River Beard-heath
2000	Libertia paniculata	Branching Grass-flag
2020	Lipocarpha microcephala	Button Rush

River Terrestrial		
Sp No	Scientific Name	Common Name
2023	Livistona australis	Cabbage Fan-palm
2032	Logania ovata	Oval-leaf Logania
2057	Lotus australis	Austral Trefoil
2096	Maireana aphylla	Leafless Bluebush
3865	Maireana microphylla	Small-leaf Bluebush
2117	Malacocera tricornis	Goat Head
0399	Marianthus bignoniacea	Orange Bell-climber
1892	Marsdenia australis	Doubah
2124	Marsdenia flavescens	Yellow Milk-vine
2145	Melaleuca armillaris subsp. armillaris	Giant Honey-myrtle
4925	Melicytus sp. aff. dentatus (East Gippsland variant)	Montane Shrub-violet
4734	Menkea crassa	Fat Spectacles
2196	Mimulus prostratus	Small Monkey-flower
2199	Minuria cunninghamii	Bush Minuria
2200	Minuria denticulata	Woolly Minuria
2201	Minuria integerrima	Smooth Minuria
4055	Mollugo verticillata	Indian Chickweed
3859	Monotoca glauca	Currant-wood
2226	Muehlenbeckia axillaris	Matted Lignum
2229	Muehlenbeckia gracillima	Slender Lignum
2240	Myoporum montanum	Waterbush
3881	Neobassia proceriflora	Soda Bush
2347	Ophioglossum polyphyllum	Upright Adder's-tongue
2346	Ophioglossum reticulatum	Stalked Adder's-tongue
2385	Oxalis magellanica	Snowdrop Wood-sorrel
2397	Pachycornia triandra	Desert Glasswort
2428	Paspalidium gracile	Slender Panic
4902	Pellaea calidirupium	Inland Sickle-fern
4812	Pellaea nana	Dwarf Sickle-fern

River Terrestrial		
Sp No	Scientific Name	Common Name
5287	Persicaria attenuata	Velvet Knotweed
5476	Phebalium glandulosum subsp. 2 (Snowy River)	Snowy River Phebalium
2499	Phyllanthus australis	Pointed Spurge
3924	Phyllanthus lacunellus	Sandhill Spurge
5659	Picris barbarorum	Plains Picris
4827	Picris squarrosa	Squat Picris
4533	Pimelea curviflora var. aff. subglabrata	Curved Rice-flower
2519	Pimelea drupacea	Cherry Rice-flower
2528	Pimelea pauciflora	Poison Rice-flower
2542	Pittosporum revolutum	Rough-fruit Pittosporum
2574	Plectorrhiza tridentata	Tangle Orchid
2578	Pneumatopteris pennigera	Lime Fern
4868	Poa labillardierei var. (Volcanic Plains)	Basalt Tussock-grass
4867	Poa sp. aff. tenera (Hairy)	Soft Slender Tussock-grass
2623	Polygala japonica	Dwarf Milkwort
2642	Polyscias murrayi	Pencil Cedar
2644	Polystichum formosum	Broad Shield-fern
2647	Pomaderris andromedifolia subsp. andromedifolia	Andromeda Pomaderris
2649	Pomaderris apetala subsp. apetala	Grampians Pomaderris
2652	Pomaderris betulina subsp. betulina	Birch Pomaderris
3942	Pomaderris brunnea	Rufous Pomaderris
2653	Pomaderris costata	Veined Pomaderris
2655	Pomaderris discolor	Eastern Pomaderris
2657	Pomaderris eriocephala	Woolly-head Pomaderris
3944	Pomaderris halmaturina subsp. continentis	Glenelg Pomaderris
2659	Pomaderris helianthemifolia	Blunt-leaf Pomaderris
5426	Pomaderris helianthemifolia subsp. helianthemifolia	Blunt-leaf Pomaderris
5427	Pomaderris helianthemifolia subsp. hispida	Blunt-leaf Pomaderris
5428	Pomaderris helianthemifolia subsp. minor	Blunt-leaf Pomaderris

River Terrestrial		
Sp No	Scientific Name	Common Name
2662	Pomaderris ligustrina subsp. ligustrina	Privet Pomaderris
3945	Pomaderris oblongifolia	Snowy River Pomaderris
2713	Pomaderris oraria	Bassian Pomaderris
3946	Pomaderris oraria subsp. calcicola	Limestone Pomaderris
2667	Pomaderris pauciflora	Mountain Pomaderris
4836	Pomaderris phylicifolia subsp. ericoides	Slender Pomaderris
4837	Pomaderris phylicifolia subsp. phylicifolia	Slender Pomaderris
2669	Pomaderris pilifera	Striped Pomaderis
2672	Pomaderris sericea	Bent Pomaderris
2674	Pomaderris subcapitata	Convex Pomaderris
2706	Prasophyllum diversiflorum	Gorae Leek-orchid
2722	Prasophyllum niphopedium	Marsh Leek-orchid
5443	Prasophyllum sp. aff. frenchii 3 / B	Summer Leek-orchid
3925	Prostanthera incisa	Cut-leaf Mint-bush
2571	Prostanthera lasianthos X spinosa (Cultivation Creek)	Victoria Range Mint-bush
2760	Pseudanthus orbicularis	Tangled Pseudanthus
2778	Pteris comans	Netted brake
2781	Pteris vittata	Chinese Brake
2782	Pterostylis aestiva	Long-tongue Summer-greenhood
3916	Pterostylis cheraphila	Floodplain Rustyhood
5912	Pterostylis cucullata subsp. sylvicola	Tall Leafy Greenhood
2798	Pterostylis grandiflora	Cobra Greenhood
2794	Pterostylis oreophila	Blue-tongue Greenhood
2819	Pterostylis tenuissima	Swamp Greenhood
4727	Pterostylis X aenigma	Enigmatic Greenhood
2800	Pterostylis X ingens	Sharp Greenhood
2828	Ptilotus nobilis var. nobilis	Yellow Tails
2830	Ptilotus polystachyus var. polystachyus	Long Tails
2836	Pultenaea altissima	Tall Bush-pea

River Terrestrial		
Sp No	Scientific Name	Common Name
2858	Pultenaea luehmannii	Thready Bush-pea
2866	Pultenaea polifolia	Dusky Bush-pea
4909	Ranunculus pumilio var. politus	Ferny Small-flower Buttercup
2915	Ranunculus undosus	Swamp Buttercup
2929	Rhagodia parabolica	Fragrant Saltbush
1649	Rhodanthe polygalifolia	Milkwort Sunray
1651	Rhodanthe stricta	Slender Sunray
2935	Rhynchospora brownii	Grassy Beak-sedge
2940	Ripogonum album	White Supplejack
2944	Rorippa eustylis	Dwarf Bitter-cress
4908	Rumex crystallinus s.s.	Glistening Dock
3962	Rumex stenoglottis	Tongue Dock
1242	Rytidosperma australe	Southern Sheep-grass
2995	Salvia plebeia	Austral Sage
2998	Sambucus australasica	Yellow Elderberry
3002	Samolus valerandii	Water Pimpernel
3005	Santalum leptocladum	Southern Sandalwood
3007	Santalum obtusifolium	Blunt Sandalwood
3015	Sauropus trachyspermus	Slender Spurge
3010	Sarcochilus falcatus	Orange-blossom Orchid
3026	Schelhammera undulata	Lilac Lily
3049	Schoenus melanostachys	Black Bog-sedge
3058	Scirpus polystachyus	Large-head Club-sedge
3071	Sclerolaena decurrens	Green Copperburr
3073	Sclerolaena divaricata	Tangled Copperburr
3074	Sclerolaena intricata	Poverty Bush
3075	Sclerolaena lanicuspis	Woolly Copperburr
4974	Sclerolaena muricata var. muricata	Black Roly-poly
4975	Sclerolaena muricata var. semiglabra	Dark Roly-poly

River Terrestrial		
Sp No	Scientific Name	Common Name
3079	Sclerolaena patenticuspis	Spear-fruit Copperburr
3083	Sclerolaena ventricosa	Salt Copperburr
3090	Scutellaria mollis	Soft Skullcap
7136	Senecio campylocarpus	Floodplain Fireweed
3103	Senecio diaschides	Shingle Fireweed
7028	Senecio distalilobatus	Distal-lobe Fireweed
7144	Senecio glomeratus subsp. longifructus	Annual Fireweed
7163	Senecio lanibracteus	Branching Groundsel
3139	Sicyos australis	Star Cucumber
3143	Sida intricata	Twiggy Sida
3180	Solanum lacunarium	Lagoon Nightshade
3170	Solanum silvestre	Violet Nightshade
3220	Sphaerolobium acanthos	Grampians Globe-pea
3227	Sporobolus caroli	Yakka Grass
3228	Sporobolus creber	Western Rat-tail Grass
5333	Stellaria sp. 2	Rangeland Starwort
4984	Stemodia glabella s.s.	Smooth Blue-rod
3261	Sticherus flabellatus var. flabellatus	Shiny Fan-fern
5334	Sticherus tener s.s.	Tasman Fan-fern
3319	Swainsona adenophylla	Violet Swainson-pea
3316	Swainsona greyana	Hairy Darling-pea
4048	Swainsona luteola	Dwarf Darling-pea
3321	Swainsona murrayana	Slender Darling-pea
3323	Swainsona phacoides	Dwarf Swainson-pea
4945	Swainsona reticulata	Kneed Swainson-pea
3330	Symplocos thwaitesii	Buff Hazelwood
3334	Taraxacum aristum	Mountain Dandelion
4981	Tetragonia eremaea s.s.	Desert Spinach
5002	Teucrium albicaule	Scurfy Germander

River Terrestrial		
Sp No	Scientific Name	Common Name
3383	Thelymitra circumsepta	Naked Sun-orchid
3386	Thelypteris confluens	Swamp Fern
3389	Thesium australe	Austral Toad-flax
3390	Thismia rodwayi	Fairy Lanterns
3403	Tmesipteris elongata	Slender Fork-fern
3404	Tmesipteris ovata	Oval Fork-fern
3405	Tmesipteris parva	Small Fork-fern
3419	Trema tomentosa var. viridis	Peach-leaf Poison-bush
3452	Trigonella suavissima	Sweet Fenugreek
3473	Uncinia nemoralis	River Hook-sedge
5048	Verbena officinalis var. gaudichaudii	Native Verbena
7222	Verbena officinalis var. montana	Mountain Verbena
5700	Veronica grosseserrata	Eastern Speedwell
3527	Viola caleyana	Swamp Violet
4060	Wahlenbergia tumidifructa	Mallee Annual-bluebell
3570	Westringia glabra	Violet Westringia
3576	Wittsteinia vacciniacea	Baw Baw Berry
3603	Zieria cytisoides	Downy Zieria
3604	Zieria robusta	Round-leaf Zieria
3605	Zieria smithii subsp. smithii	Sandfly Zieria

Table 11 - Waterway Dependent Significant Flora - River Aquatic

River Aquatic		
Sp No	Scientific Name	Common Name
0185	Alternanthera nodiflora	Common Joyweed
3623	Amphibromus fluitans	River Swamp Wallaby-grass
0487	Brasenia schreberi	Water-shield
0568	Callitriche brachycarpa	Short Water-starwort
0569	Callitriche cyclocarpa	Western Water-starwort

River Aquatic		
Sp No	Scientific Name	Common Name
0572	Callitriche palustris	Swamp Water-starwort
0723	Ceratophyllum demersum	Common Hornwort
1450	Glossostigma cleistanthum	Small-flower Mud-mat
3874	Myriophyllum lophatum	Crested Water-milfoil
2262	Najas tenuifolia	Water Nymph
2687	Potamogeton australiensis	Thin Pondweed
4840	Potamogeton perfoliatus s.s.	Perfoliate Pondweed
3210	Sparganium subglobosum	Floating Bur-reed
5010	Triglochin dubia	Slender Water-ribbons
4537	Triglochin microtuberosa	Eastern Water-ribbons

Table 12 - Waterway Dependent Significant Flora – Wetland

Wetland		
Sp No	Scientific Name	Common Name
0001	Abrotanella nivigena	Snow-wort
0034	Acacia farinosa	Mealy Wattle
0125	Actinotus bellidioides	Tiny Flannel-flower
0150	Agrostis australiensis	Tiny Bent
0157	Agrostis muelleriana	Mueller's Bent
5879	Agrostis propinqua	Mountain Bent
5877	Agrostis thompsoniae	Alpine Bent
1049	Almaleea capitata	Slender Parrot-pea
2862	Almaleea paludosa	Marsh Bush-pea
5096	Alternanthera sp. 1 (Plains)	Plains Joyweed
0202	Ammannia multiflora	Jerry-jerry
3623	Amphibromus fluitans	River Swamp Wallaby-grass
3624	Amphibromus pithogastrus	Plump Swamp Wallaby-grass
3625	Amphibromus sinuatus	Wavy Swamp Wallaby-grass
0227	Angianthus brachypappus	Spreading Angianthus

Wetland		
Sp No	Scientific Name	Common Name
1615	Argentipallium dealbatum	Silver Everlasting
1467	Argyrotegium nitidulum	Shining Cudweed
1475	Argyrotegium poliochlorum	Grey-green Cudweed
3627	Asperula charophyton	Elongate Woodruff
0280	Asperula gemella	Twin-leaf Bedstraw
0282	Asperula minima	Mossy Woodruff
5640	Asperula wimmerana	Wimmera Woodruff
4233	Atriplex nummularia subsp. omissa	Dwarf Old-man Saltbush
0327	Atriplex papillata	Coral Saltbush
0330	Atriplex pseudocampanulata	Mealy Saltbush
4244	Atriplex vesicaria subsp. macrocystidia	Bladder Saltbush
4938	Austrodanthonia aff. caespitosa (South-west Swamp)	Porphyry Wallaby-grass
3297	Austrostipa tuckeri	Tucker's Spear-grass
4267	Baeckea latifolia	Subalpine Baeckea
0355	Baeckea linifolia	Swamp Baeckea
5466	Banksia croajingolensis	Gippsland Banksia
0378	Baumea laxa	Lax Twig-sedge
3722	Baumea planifolia	Rough Twig-sedge
3165	Berula erecta	Water Parsnip
4669	Bolboschoenus fluviatilis	Tall Club-sedge
5213	Boronia anemonifolia subsp. variabilis	Coast Boronia
0468	Brachyscome obovata	Baw Baw Daisy
0473	Brachyscome radicans	Marsh Daisy
0474	Brachyscome readeri	Reader's Daisy
5612	Brachyscome sp. 1	Peat Daisy
3656	Brachyscome tadgellii	Tadgell's Daisy
0480	Brachyscome trachycarpa	Inland Daisy
0487	Brasenia schreberi	Water-shield
0513	Burnettia cuneata	Lizard Orchid

Wetland		
Sp No	Scientific Name	Common Name
0771	Caladenia insularis	French Island Spider-orchid
0544	Caladenia pumila	Dwarf Spider-orchid
0556	Calandrinia volubilis	Twining Purslane
0569	Callitriche cyclocarpa	Western Water-starwort
0572	Callitriche palustris	Swamp Water-starwort
0575	Callitriche umbonata	Winged Water-starwort
0591	Calorophus elongatus	Long Rope-rush
5025	Cardamine astoniae	Spreading Bitter-cress
5026	Cardamine franklinensis	Franklin Bitter-cress
5033	Cardamine gunnii s.s.	Tuberous Bitter-cress
5027	Cardamine lilacina s.s.	Lilac Bitter-cress
5028	Cardamine lineariloba	Western Bitter-cress
5029	Cardamine microthrix	Eastern Bitter-cress
0617	Cardamine tenuifolia	Slender Bitter-cress
5445	Cardamine tenuifolia (large-flower form)	Slender Bitter-cress
5444	Cardamine tenuifolia (small-flower form)	Slender Bitter-cress
5448	Cardamine trysa (sp. aff. franklinensis)	Small-seed Bitter-cress
0624	Carex archeri	Archer's Sedge
0626	Carex blakei	Alpine Sedge
0633	Carex canescens	Short Sedge
0630	Carex capillacea	Hair Sedge
0631	Carex cephalotes	Wire-head Sedge
0637	Carex echinata	Star Sedge
4618	Carex hypandra	Alpine Fen-sedge
0644	Carex jackiana	Carpet Sedge
0646	Carex paupera	Dwarf Sedge
0649	Carex raleighii	Raleigh Sedge
0650	Carex tasmanica	Curly Sedge
0652	Carpha alpina	Small Flower-rush

Wetland		
Sp No	Scientific Name	Common Name
0653	Carpha nivicola	Broad-leaf Flower-rush
4358	Cassinia rugata	Wrinkled Cassinia
0682	Casuarina obesa	Swamp Sheoak
0693	Celmisia sericophylla	Silky Snow-daisy
4637	Celmisia tomentella	Silver Snow-daisy
5618	Centipeda crateriformis subsp. compacta	Compact Sneezeweed
5616	Centipeda nidiformis	Cotton Sneezeweed
0723	Ceratophyllum demersum	Common Hornwort
0766	Chorizandra australis	Southern Bristle-sedge
0767	Chorizandra sphaerocephala	Roundhead Bristle-sedge
0793	Colobanthus affinis	Alpine Colobanth
0806	Conospermum taxifolium	Variable Smoke-bush
5888	Convolvulus clementii	Desert Bindweed
5887	Convolvulus recurvatus subsp. recurvatus	Recurved Bindweed
0818	Coprosma moorei	Turquoise Coprosma
0821	Coprosma perpusilla subsp. perpusilla	Creeping Coprosma
5248	Coprosma pumila	Dwarf Coprosma
2040	Corunastylis ciliata	Fringed Midge-orchid
2700	Corunastylis nuda	Tiny Midge-orchid
2727	Corunastylis pumila	Green Midge-orchid
5263	Corunastylis nudiscapa (Otways)	Brownish Midge-orchid
0840	Corybas fordhamii	Swamp Pelican-orchid
5249	Corybas sp. aff. diemenicus 1 (Coastal)	Late Helmet-orchid
0856	Craspedia alba	White Billy-buttons
4643	Craspedia canens	Grey Billy-buttons
5935	Craspedia lamicola	Bog Billy-buttons
3675	Cryptandra ericoides	Heathy Cryptandra
0881	Cryptostylis erecta	Bonnet Orchid
0882	Cryptostylis hunteriana	Leafless Tongue-orchid

Wetland		
Sp No	Scientific Name	Common Name
2769	Cullen australasicum	Native Scurf-pea
2770	Cullen cinereum	Hoary Scurf-pea
5241	Cuscuta australis	Australian Dodder
0920	Cyperus flaccidus	Lax Flat-sedge
0927	Cyperus nervulosus	Annual Flat-sedge
0930	Cyperus rigidellus	Curly Flat-sedge
0935	Cyperus subulatus	Pointed Flat-sedge
0938	Cyperus vaginatus	Stiff Flat-sedge
0983	Darwinia micropetala	Small Darwinia
3508	Derwentia nivea	Milfoil Speedwell
1006	Deschampsia caespitosa	Tufted Hair-grass
1009	Deyeuxia affinis	Allied Bent-Grass
1012	Deyeuxia carinata	Keeled Bent-Grass
1015	Deyeuxia decipiens	Devious Bent-grass
4422	Deyeuxia parviseta var. boormanii	Fine Bent-grass
5484	Deyeuxia quadriseta (slender flaccid variant)	Slender Reed Bent-grass
3785	Deyeuxia talariata	Skirted Bent-grass
5086	Dianella callicarpa	Swamp Flax-lily
5786	Dichondra sp. 1 (s.l.)	Silky Kidney-weed
1064	Diplaspis nivis	Snow Pennywort
1074	Dissocarpus biflorus var. biflorus	Twin-flower Saltbush
1082	Diuris palustris	Swamp Diuris
1084	Diuris punctata var. punctata	Purple Diuris
1078	Diuris X fastidiosa	Proud Diuris
1101	Drosera arcturi	Alpine Sundew
1115	Dysphania simulans	Spiked Pigweed
3702	Elachanthus glaber	Smooth Elachanth
1135	Elachanthus pusillis	Small Elachanth
4674	Eleocharis macbarronii	Grey Spike-sedge

Wetland		
Sp No	Scientific Name	Common Name
5619	Eleocharis obicis	Striate Spike-sedge
1143	Eleocharis pallens	Pale Spike-sedge
1144	Eleocharis plana	Flat Spike-sedge
1152	Elytrophorus spicatus	Spike Grass
3790	Entolasia stricta	Upright Panic
4633	Epacris celata	Cryptic Heath
1164	Epacris glacialis	Reddish Bog-heath
5251	Epacris microphylla s.s.	Coral Heath
5250	Epacris microphylla var. microphylla	Coast Coral Heath
1163	Epacris microphylla var. rhombifolia	Mountain Coral Heath
1170	Epacris petrophila	Snow Heath
1175	Epilobium brunnescens subsp. beaugleholei	Bog Willow-herb
1177	Epilobium curtisiae	Bald-seeded Willow-herb
1182	Epilobium tasmanicum	Snow Willow-herb
1183	Epilobium willisii	Carpet Willow-herb
1184	Eragrostis australasica	Cane Grass
1190	Eragrostis lacunaria	Purple Love-grass
1195	Eragrostis setifolia	Bristly Love-grass
1197	Eragrostis trachycarpa	Rough-grain Love-grass
4483	Erigeron tasmanicus	Tasmanian Fleabane
1217	Eriocaulon australasicum	Southern Pipewort
1217	Eriocaulon scariosum	Common Pipewort
5666	Eriochlamys behrii s.s.	Woolly Mantle
3706	Eriochloa crebra	Tall Cup-grass
1238	Eryngium paludosum	Long Eryngium
1244	Eucalyptus aggregata	Black Gum
3707	Eucalyptus cadens	Warby Range Swamp-gum
1265	Eucalyptus crenulata	Buxton Gum
1275	Eucalyptus fasciculosa	Pink Gum

Wetland		
Sp No	Scientific Name	Common Name
1290	Eucalyptus kitsoniana	Bog Gum
1309	Eucalyptus perriniana	Spinning Gum
1475	Euchiton traversii	Mat Cudweed
1333	Euphorbia planiticola	Plains Spurge
1337	Euphrasia caudata	Tailed Eyebright
4468	Euphrasia collina subsp. muelleri	Purple Eyebright
4472	Euphrasia collina subsp. trichocalycina	Purple Eyebright
1340	Euphrasia eichleri	Bogong Eyebright
1343	Euphrasia scabra	Rough Eyebright
1369	Fimbristylis velata	Veiled Fringe-sedge
1372	Frankenia crispa	Hoary Sea-heath
1373	Frankenia foliosa	Leafy Sea-heath
1374	Frankenia serpyllifolia	Bristly Sea-heath
1377	Frankenia sessilis	Small-leaf Sea-heath
4760	Gentianella bawbawensis	Baw Baw Snow-gentian
4762	Gentianella cunninghamii subsp. cunninghamii	Cunningham's Snow-gentian
4764	Gentianella muelleriana subsp. willisiana	Mt Buller Snow-gentian
1429	Geranium neglectum	Red-stem Cranesbill
1433	Geranium sessiliflorum subsp. brevicaule	Alpine Cranesbill
5348	Geranium sp. 7	Alpine Swamp Cranesbill
1436	Gingidia harveyana	Slender Gingidia
1446	Glossodia minor	Small Wax-lip Orchid
1450	Glossostigma cleistanthum	Small-flower Mud-mat
4615	Glossostigma diandrum	Small-flower Mud-mat
1448	Glossostigma drummondii	Small-flower Mud-mat
0773	Gnephosis drummondii	Slender Cup-flower
0774	Gnephosis tenuissima	Dwarf Cup-flower
4885	Gonocarpus micranthus subsp. ramosissimus	Branching Raspwort
1488	Gonocarpus serpyllifolius	Flat Raspwort

Wetland		
Sp No	Scientific Name	Common Name
1494	Goodenia bellidifolia subsp. bellidifolia	Daisy Goodenia
1513	Goodenia macbarronii	Narrow Goodenia
1514	Goodenia stelligera	Spiked Gooodenia
1522	Gratiola nana	Matted Brooklime
1523	Gratiola pedunculata	Stalked Brooklime
3753	Gratiola pumilo	Dwarf Brooklime
1173	Haegiela tatei	Small Nut-heads
3766	Haloragis glauca f. glauca	Bluish Raspwort
1585	Haloragis myriocarpa	Prickly Raspwort
3761	Halosarcia flabelliformis	Bead Glasswort
1590	Halosarcia lylei	Wiry Glasswort
1591	Halosarcia nitida	Shining Glasswort
4585	Halosarcia pergranulata subsp. divaricata	Blackseed Glasswort
1594	Halosarcia pterygosperma subsp. pterygosperma	Whiteseed Glasswort
1595	Halosarcia syncarpa	Fused Glasswort
4655	Helichrysum aff. rutidolepis (Lowland Swamps)	Pale Swamp Everlasting
1655	Hemichroa diandra	Mallee Hemichroa
1658	Herpolirion novae-zelandiae	Sky Lily
5087	Hibbertia humifusa subsp. debilis	Dergholm Guinea-flower
1676	Hibbertia rufa	Brown Guinea-flower
1679	Hibbertia sessiliflora	Heathy Guinea-flower
5080	Hibbertia torulosa	Knobby Guinea-flower
1689	Hierochloe submutica	Alpine Holy-grass
1709	Huperzia australiana	Fir Clubmoss
1712	Hybanthus vernonii subsp. vernonii	Erect Violet
1713	Hydrilla verticillata	Hydrilla
2186	Hydrorchis orbicularis	Swamp Onion-orchid
4590	Hypoxis hygrometrica var. splendida	Golden Weather-glass
1757	Hypsela tridens	Hypsela

Wetland		
Sp No	Scientific Name	Common Name
4575	Isoetes drummondii subsp. anomala	Plain Quillwort
4538	Isoetes pusilla	Small Quillwort
4675	Isolepis alpina	Tasman Club-sedge
1771	Isolepis australiensis	Inland Club-sedge
5265	Isolepis cernua var. setiformis	Bristle Club-sedge
1773	Isolepis congrua	Slender Club-sedge
4676	Isolepis gaudichaudiana	Benambra Club-sedge
1781	Isolepis montivaga	Fog Club-sedge
1804	Juncus antarcticus	Cushion Rush
1809	Juncus brevibracteus	Alpine Rush
1816	Juncus falcatus	Sickle-leaf Rush
1832	Juncus phaeanthus	Dark-flower Rush
1839	Juncus revolutus	Creeping Rush
3801	Juncus thompsonianus	Snowfield Rush
1851	Kippistia suaedifolia	Fleshy Minuria
0148	Lachnagrostis adamsonii	Adamson's Blown-grass
4220	Lachnagrostis filifolia var. 2	Wetland Blown-grass
0156	Lachnagrostis meionectes	Alpine Blown-grass
4222	Lachnagrostis punicea subsp. filifolia	Purple Blown-grass
4206	Lachnagrostis punicea subsp. punicea	Purple Blown-grass
4223	Lachnagrostis robusta	Salt Blown-grass
0159	Lachnagrostis scabra	Ruddy Blown-grass
1889	Laxmannia gracilis	Slender Wire-lily
3099	Lawrencia spicata	Salt Lawrencia
1894	Lemna trisulca	Ivy-leaf Duckweed
1897	Lepidium aschersonii	Spiny Peppercress
1905	Lepidium monoplocoides	Winged Peppercress
1906	Lepidium papillosum	Warty Peppercress
1908	Lepidium pseudohyssopifolium	Native Peppercress

Wetland		
Sp No	Scientific Name	Common Name
1924	Lepidosperma limicola	Razor Sword-sedge
3846	Lepilaena patentifolia	Spreading Water-mat
1949	Leptorhynchos waitzia	Button Immortelle
1966	Lepyrodia anarthria	Broom Scale-rush
1967	Lepyrodia flexuosa	Twisting Scale-rush
1979	Leucopogon esquamatus	Swamp Beard-heath
1989	Leucopogon pilifer	Thready Beard-heath
3832	Levenhookia pusilla	Midget Stylewort
1998	Levenhookia sonderi	Slender Stylewort
2006	Limonium australe	Yellow Sea-lavender
2020	Lipocarpha microcephala	Button Rush
2733	Lobelia beaugleholei	Showy Lobelia
2729	Lobelia gelida	Snow Pratia
2064	Luzula acutifolia subsp. acutifolia	Sharp-leaf Woodrush
2065	Luzula alpestris	Tussock Woodrush
2066	Luzula atrata	Slender Woodrush
2083	Lycopodiella serpentina	Bog Clubmoss
2082	Lycopodium scariosum	Spreading Clubmoss
2106	Maireana oppositifolia	Heathy Bluebush
2117	Malacocera tricornis	Goat Head
2129	Marsilea mutica	Smooth Nardoo
2145	Melaleuca armillaris subsp. armillaris	Giant Honey-myrtle
2149	Melaleuca halmaturorum subsp. halmaturorum	Salt Paperbark
2180	Microlepidium pilosulum	Hairy Shepherd's Purse
4657	Microseris scapigera s.s. (sp. 1)	Plains Yam-daisy
2196	Mimulus prostratus	Small Monkey-flower
2199	Minuria cunninghamii	Bush Minuria
4056	Montia fontana subsp. amporitana	Water Blinks
4057	Montia fontana subsp. fontana	Water Blinks

Wetland		
Sp No	Scientific Name	Common Name
2230	Muehlenbeckia horrida subsp. horrida	Spiny Lignum
2234	Mukia micrantha	Mallee Cucumber
3870	Myriophyllum alpinum	Alpine Water-milfoil
4517	Myriophyllum gracile var. lineare	Slender Water-milfoil
3874	Myriophyllum lophatum	Crested Water-milfoil
2257	Myriophyllum porcatum	Ridged Water-milfoil
3869	Myriophyllum striatum	Striped Water-milfoil
2261	Najas marina	Prickly Water-nymph
2262	Najas tenuifolia	Water Nymph
3881	Neobassia proceriflora	Soda Bush
2289	Nymphoides geminata	Open Marshwort
2288	Nymphoides montana	Entire Marshwort
4894	Nymphoides spinulosperma	Marbled Marshwort
2293	Olax stricta	Olax
3903	Olearia suffruticosa	Clustered Daisy-bush
2347	Ophioglossum polyphyllum	Upright Adder's-tongue
2346	Ophioglossum reticulatum	Stalked Adder's-tongue
2356	Oreobolus oxycarpus subsp. oxycarpus	Tuft-rush
2357	Oreobolus pumilio subsp. pumilio	Alpine Tuft-rush
2362	Oreomyrrhis pulvinifica	Cushion Caraway
2373	Oschatzia cuneifolia	Wedge Oschatzia
2385	Oxalis magellanica	Snowdrop Wood-sorrel
1605	Ozothamnus alpinus	Alpine Everlasing
2408	Panicum simile	Two-colour Panic
2417	Parantennaria uniceps	Parantennaria
2447	Pelargonium littorale	Coast Stork's-bill
4679	Pelargonium sp. 1	Omeo Stork's-bill
5287	Persicaria attenuata	Velvet Knotweed
2464	Persoonia levis	Smooth Geebung

Wetland		
Sp No	Scientific Name	Common Name
2494	Philydrum lanuginosum	Woolly Waterlily
2502	Phyllanthus lacunarius	Lagoon Spurge
2531	Pimelea simplex subsp. simplex	Desert Rice-flower
2548	Plantago alpestris	Veined Plantain
2559	Plantago glacialis	Small Star-plantain
2563	Plantago muelleri	Star Plantain
2577	Plinthanthesis paradoxa	Wiry Wallaby-grass
2585	Poa clivicola	Fine-leaf Snow-grass
4868	Poa labillardierei var. (Volcanic Plains)	Basalt Tussock-grass
3891	Poa sallacustris	Salt-lake Tussock-grass
2687	Potamogeton australiensis	Thin Pondweed
4504	Prasophyllum aff. odoratum L	White Leek-orchid
4153	Prasophyllum appendiculatum	Tailed Leek-orchid
7235	Prasophyllum chasmogamum	Sale Plain Leek-orchid
2706	Prasophyllum diversiflorum	Gorae Leek-orchid
2709	Prasophyllum frenchii	Maroon Leek-orchid
7628	Prasophyllum gilgai (sp. aff. pyriforme 4 / D)	Gilgai Leek-orchid
4564	Prasophyllum hygrophyllum (sp. Nagambie)	Swamp Leek-orchid
2722	Prasophyllum niphopedium	Marsh Leek-orchid
2719	Prasophyllum parviflorum	Slender Leek-orchid
7285	Prasophyllum readii (sp. aff. pyriforme 3 / E)	Streatham / Painted Leek-orchid
5901	Prasophyllum sp. aff. frenchii 2 (Wilsons Promontory)	Promontory Leek-orchid
5443	Prasophyllum sp. aff. frenchii 3 / B	Summer Leek-orchid
7627	Prasophyllum sp. aff. petilum 2	Petite Leek-orchid
2763	Pseudoraphis paradoxa	Slender Mud-grass
0601	Psychrophila introloba	Alpine Marsh-marigold
2785	Pterostylis baptistii	King Greenhood
4876	Pterostylis lustra (sp. aff. furcata (Woolly Tea-tree))	Small / Tea-tree Sickle Greenhood

Wetland		
Sp No	Scientific Name	Common Name
2794	Pterostylis oreophila	Blue-tongue Greenhood
2809	Pterostylis pedoglossa	Prawn Greenhood
2819	Pterostylis tenuissima	Swamp Greenhood
2784	Pterostylis uliginosa	Marsh Greenhood
2800	Pterostylis X ingens	Sharp Greenhood
2840	Pultenaea capitellata	Hard-head Bush-pea
2847	Pultenaea fasciculata	Alpine Bush-pea
4856	Pultenaea juniperina s.s.	Pungent Bush-pea
2858	Pultenaea luehmannii	Thready Bush-pea
2876	Pultenaea tenella	Delicate Bush-pea
2881	Pultenaea weindorferi	Swamp Bush-pea
4863	Pultenaea williamsonii	Highland Bush-pea
2885	Quinetia urvillei	Quinetia
5019	Ranunculus amplus	Feather-leaf Buttercup
2887	Ranunculus collinus	Strawberry Buttercup
4314	Ranunculus diminutus	Brackish Plains Buttercup
2888	Ranunculus eichlerianus	Eichler's Buttercup
2892	Ranunculus gunnianus	Gunn's Alpine Buttercup
2895	Ranunculus millanii	Dwarf Buttercup
2896	Ranunculus muelleri	Felted Buttercup
2900	Ranunculus papulentus	Large River Buttercup
4911	Ranunculus sessiliflorus var. pilulifer	Annual Buttercup
2915	Ranunculus undosus	Swamp Buttercup
3961	Ranunculus victoriensis	Victorian Buttercup
1649	Rhodanthe polygalifolia	Milkwort Sunray
2935	Rhynchospora brownii	Grassy Beak-sedge
3969	Rhytidosporum inconspicuum	Alpine Marianth
2937	Richea victoriana	Victorian Richea
2965	Rulingia prostrata	Dwarf Kerrawang

Wetland		
Sp No	Scientific Name	Common Name
4908	Rumex crystallinus s.s.	Glistening Dock
3962	Rumex stenoglottis	Tongue Dock
4097	Ruppia maritima s.s.	Water Tassel
2980	Ruppia tuberosa	Tuberous Tassel
1242	Rytidosperma australe	Southern Sheep-grass
0971	Rytidosperma nivicolum	Snow Wallaby-grass
4410	Sagina namadgi	Native Pearlwort
5308	Salsola tragus subsp. pontica	Coast Saltwort
2208	Schizacme montana var. montana	Mountain Mitrewort
3032	Schizeilema fragoseum	Alpine Pennywort
3034	Schoenoplectus dissachanthus	Blunt Club-sedge
3043	Schoenus carsei	Wiry Bog-sedge
3994	Schoenus ericetorum	Heathy Bog-sedge
4036	Schoenus lepidosperma subsp. pachylepis	Slender Bog-sedge
3050	Schoenus nanus	Tiny Bog-sedge
3053	Schoenus sculptus	Gimlet Bog-sedge
3082	Sclerolaena uniflora	Two-spined Copperburr
3085	Sclerostegia moniliformis	Ruby Glasswort
3101	Senecio behrianus	Stiff Groundsel
3104	Senecio cunninghamii var. cunninghamii	Branching Groundsel
7028	Senecio distalilobatus	Distal-lobe Fireweed
3122	Senecio pectinatus var. major	Alpine Groundsel
4659	Senecio psilocarpus	Swamp Fireweed
3180	Solanum lacunarium	Lagoon Nightshade
3207	Sowerbaea juncea	Rush Lily
3210	Sparganium subglobosum	Floating Bur-reed
3225	Spirodela polyrhiza	Large Duckweed
3243	Stackhousia nuda	Wiry Stackhousia
3245	Stackhousia pulvinaris	Alpine Stackhousia

Wetland		
Sp No	Scientific Name	Common Name
4970	Stylidium calcaratum var. ecorne	Book Triggerplant
4722	Stylidium montanum	Montane Swamp Triggerplant
3321	Swainsona murrayana	Slender Darling-pea
3327	Swainsona purpurea	Purple Swainson-pea
4981	Tetragonia eremaea s.s.	Desert Spinach
3349	Tetrarrhena turfosa	Smooth Rice-grass
5224	Tetratheca procumbens	Mountain Pink-bells
4007	Thelionema umbellatum	Clustered Lily
4012	Thelymitra alpicola m.s. (erosa subsp. 2)	Alpine Sun-orchid
5588	Thelymitra atronitida	Black-hooded Sun-orchid
3363	Thelymitra azurea	Azure Sun-orchid
3383	Thelymitra circumsepta	Naked Sun-orchid
3367	Thelymitra epipactoides	Metallic Sun-orchid
5012	Thelymitra incurva m.s. (erosa subsp. 1)	Swamp Sun-orchid
7204	Thelymitra inflata	Blue-star Sun-orchid
4996	Thelymitra longiloba	Marsh Sun-orchid
5913	Thelymitra lucida	Glistening Sun-orchid
3375	Thelymitra luteocilium	Fringed Sun-orchid
3380	Thelymitra mucida	Plum Orchid
4005	Thelymitra X merraniae	Merran's Sun-orchid
3386	Thelypteris confluens	Swamp Fern
5003	Trachymene humilis subsp. breviscapa	Alpine Trachymene
1476	Trichanthodium baracchianum	Dwarf Yellow-heads
1478	Trichanthodium skirrophorum	Woolly Yellow-heads
5010	Triglochin dubia	Slender Water-ribbons
3445	Triglochin hexagona	Six-point Arrowgrass
4537	Triglochin microtuberosa	Eastern Water-ribbons
3446	Triglochin minutissima	Tiny Arrowgrass
3447	Triglochin mucronata	Prickly Arrowgrass

Wetland		
Sp No	Scientific Name	Common Name
5009	Triglochin sp. B	Spurred Arrowgrass
5510	Triglochin trichophora	Torpedo Arrowgrass
3452	Trigonella suavissima	Sweet Fenugreek
5030	Uncinia compacta	Compact Hook-sedge
5031	Uncinia sulcata	Small Hook-sedge
3481	Utricularia monanthos	Tasmanian Bladderwort
4032	Utricularia uniflora	Single Bladderwort
3482	Utricularia violacea	Violet Bladderwort
5366	Verbena officinalis var. africana	Inland Verbena
4100	Villarsia umbricola var. umbricola	Lax Marsh-flower
3527	Viola caleyana	Swamp Violet
5057	Viola fuscoviolacea	Dusky Violet
4060	Wahlenbergia tumidifructa	Mallee Annual-bluebell
3576	Wittsteinia vacciniacea	Baw Baw Berry
3577	Wolffia angusta	Narrow Duckweed
5107	Wurmbea dioica subsp. lacunaria	Swamp Early Nancy
3583	Wurmbea uniflora	One-flower Early Nancy
3763	Xerochrysum palustris	Swamp Everlasting
3596	Xyris juncea	Dwarf Yellow-eye
3616	Zygophyllum compressum	Rabbit-ears Twin-leaf

Table 13 - Waterway Dependent - Significant Flora - Estuary Terrestrial

Estuary Terrestrial		
Sp No	Scientific Name	Common Name
0326	Atriplex paludosa subsp. paludosa	Marsh Saltbush
5241	Cuscuta australis	Australian Dodder
1839	Juncus revolutus	Creeping Rush
3099	Lawrencia spicata	Salt Lawrencia
1908	Lepidium pseudohyssopifolium	Native Peppercress

Estuary Terrestrial		
Sp No	Scientific Name	Common Name
2006	Limonium australe	Yellow Sea-lavender
2149	Melaleuca halmaturorum subsp. halmaturorum	Salt Paperbark
3446	Triglochin minutissima	Tiny Arrowgrass
3447	Triglochin mucronata	Prickly Arrowgrass
3610	Zoysia macrantha subsp. walshii	Walsh's Couch

Table 14 - Waterway Dependent Significant Flora - Estuary Aquatic

Estuary Aquatic		
Sp No	Scientific Name	Common Name
0345	Avicennia marina subsp. australasica	Grey Mangrove
2980	Ruppia tuberosa	Tuberous Tassel

Appendix I - Waterway-Dependent EVCs

Waterway Dependent Significant EVCs were identified through GIS query.

The following buffers were used:

- Wetlands: 100 metres from mapped boundary
- Estuaries: 600 metres from mapped boundary
- Rivers: 600 metres from river centre line

EVCs were divided into:

- Rivers
- Wetlands
- Estuaries

Table 15 - Waterway Dependent EVCs - Rivers

EVC No.	EVC Name
17	Riparian Scrub/Swampy Riparian Woodland Complex
18	Riparian Forest
19	Riparian Shrubland
29	Damp Forest
30	Wet Forest
31	Cool Temperate Rainforest
32	Warm Temperate Rainforest
33	Cool Temperate Rainforest/Warm Temperate Rainforest Overlap
40	Montane Riparian Woodland
41	Montane Riparian Thicket
53	Swamp Scrub
56	Floodplain Riparian Woodland
59	Riparian Thicket
67	Alluvial Terraces Herb-rich Woodland
68	Creekline Grassy Woodland
81	Alluvial Terraces Herb-rich Woodland/Creekline Grassy Woodland Mosaic
82	Riverine Escarpment Scrub
83	Swampy Riparian Woodland
84	Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment Scrub Mosaic

EVC No.	EVC Name
103	Riverine Chenopod Woodland
106	Grassy Riverine Forest
110	Riverine Chenopod Woodland/Plains Grassland Mosaic
123	Riparian Forest/Warm Temperate Rainforest Mosaic
126	Swampy Riparian Complex
164	Creekline Herb-rich Woodland
168	Drainage-line Aggregate
191	Riparian Scrub
198	Sedgy Riparian Woodland
208	Sub-alpine Riparian Shrubland
212	Swampy Riparian Woodland/Perched Boggy Shrubland Mosaic
237	Riparian Forest/Swampy Riparian Woodland Mosaic
238	Plains Grassy Woodland/Creekline Grassy Woodland/Floodplain Riparian Woodland Mosaic
240	Plains Grassy Woodland/Creekline Grassy Woodland/Wetland Formation Mosaic
250	Floodplain Riparian Woodland/Plains Grassy Woodland Mosaic
255	Riverine Grassy Woodland/Sedgy Riverine Forest/Wetland Formation Mosaic
256	Floodplain Riparian Woodland/Floodplain Wetland Mosaic
269	Riparian Shrubland/Swampy Riparian Woodland Mosaic
272	Swampy Riparian Woodland/Spring Soak Woodland Mosaic
280	Floodplain Thicket
285	Dry Creekline Woodland
293	Riparian Forest/Creekline Grassy Woodland Mosaic
295	Riverine Grassy Woodland
321	Riverine Chenopod Woodland/Lignum Swamp Mosaic
322	Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland/Riverine Escarpment Scrub/Blackthorn Scrub Complex
380	Herb-rich Foothill Forest/Sedgy Riparian Woodland Complex
385	Lowland Forest/Riparian Forest Complex
386	Lowland Forest/Riparian Scrub Complex
387	Lowland Forest/Riparian Shrubland Complex
396	Heathy Dry Forest/Sedgy Riparian Woodland Complex

EVC No.	EVC Name
410	Valley Grassy Forest/Sedgy Riparian Woodland Complex
421	Damp Sands Herb-rich Woodland/Sedgy Riparian Woodland Complex
422	Damp Sands Herb-rich Woodland/Sedgy Riparian Woodland Mosaic
423	Damp Sands Herb-rich Woodland/Dry Creekline Woodland Complex
430	Floodplain Thicket/Riparian Scrub Complex
431	Floodplain Thicket/Sedgy Riparian Woodland Complex
432	Floodplain Thicket/Shallow Freshwater Marsh Complex
434	Floodplain Thicket/Damp Heathland Complex
449	Shrubby Woodland/Riparian Scrub Complex
450	Shrubby Woodland/Sedgy Riparian Woodland Complex
467	Heathy Woodland/Riparian Scrub Complex
468	Heathy Woodland/Sedgy Riparian Woodland Complex
504	Wet Heathland/Riparian Scrub Complex
505	Damp Heathland/Riparian Scrub Complex
506	Riparian Forest/Sedgy Riparian Woodland Complex
509	Riparian Scrub/Heathland Thicket Mosaic
510	Riparian Scrub/Sedgy Riparian Woodland Complex
512	Riparian Scrub/Seasonally Inundated Shrubby Woodland Mosaic
514	Sedgy Riparian Woodland/Lowland Forest Complex
515	Sedgy Riparian Woodland/Riparian Shrubland Complex
516	Sedgy Riparian Woodland/Dry Creekline Woodland Complex
519	Shallow Freshwater Marsh/Floodplain Thicket Mosaic
522	Riparian Shrubland/Riparian Scrub Complex
553	Floodplain Thicket/Seasonally Inundated Shrubby Woodland Mosaic
585	Floodplain Thicket/Wet Heathland Complex
588	Riparian Scrub/Riparian Forest Complex
596	Riparian Scrub/Sedgy Riparian Woodland Mosaic
607	Riparian Scrub/Heathland Thicket Complex
637	Swamp Scrub/Damp Sands Herb-rich Woodland/Wet Heathland Mosaic
638	Swamp Scrub/Wet Heathland Mosaic
639	Swamp Scrub/Plains Grassy Forest Mosaic

EVC No.	EVC Name
640	Creekline Sedgy Woodland
641	Riparian Woodland
654	Creekline Tussock Grassland
656	Brackish Wetland
658	Riverine Grassy Woodland/Sedgy Riverine Forest/Aquatic Herbland Mosaic
659	Plains Riparian Shrubby Woodland
666	Riparian Shrubland/Escarpment Shrubland/Grassy Woodland Mosaic
668	Riparian Woodland/Escarpment Shrubland Mosaic
674	Sandy Stream Woodland
679	Drainage-line Woodland
688	Swampy Riparian Woodland/Swamp Scrub Mosaic
690	Floodplain Riparian Woodland/Billabong Wetland Mosaic
705	Basalt Creekline Shrubby Woodland
774	Sedgy Riparian Woodland/Damp Sands Herb-rich Woodland Mosaic
775	Floodplain Thicket/Shrubby Woodland Mosaic
798	Sedgy Riparian Woodland/Riparian Scrub Mosaic
804	Rushy Riverine Swamp
809	Floodplain Grassy Wetland
810	Floodway Pond Herbland
811	Grassy Riverine Forest/Floodway Pond Herbland Complex
812	Grassy Riverine Forest/Riverine Swamp Forest Complex
814	Riverine Swamp Forest
815	Riverine Swampy Woodland
816	Sedgy Riverine Forest
817	Sedgy Riverine Forest/Riverine Swamp Forest Complex
818	Shrubby Riverine Woodland
823	Lignum Swampy Woodland
851	Stream Bank Shrubland
863	Floodplain Reedbed
869	Creekline Grassy Woodland/Red Gum Swamp Mosaic
870	Riverine Grassy Woodland/Plains Woodland Complex

EVC No.	EVC Name
871	Riverine Grassy Woodland/Plains Woodland/Gilgai Wetland Complex
872	Riverine Grassy Woodland/Plains Woodland/Riverine Chenopod Woodland Complex
873	Riverine Grassy Woodland/Riverine Chenopod Woodland/Wetland Mosaic
902	Gully Woodland
928	Riparian Woodland/Stream-bank Shrubland Mosaic
945	Floodway Pond Herbland/Riverine Swamp Forest Complex
946	Riverine Swampy Woodland/Lignum Swamp Mosaic
975	Riverine Ephemeral Wetland
1015	Grassy Riverine Forest/Drainage-line Aggregate Mosaic
1016	Grassy Riverine Forest/Plains Grassy Woodland/Grassy Woodland Mosaic
1017	Grassy Riverine Forest/Riverine Grassy Woodland Mosaic
1019	Mosaic of Grassy Riverine Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex
1020	Mosaic of Grassy Riverine Forest/Floodway Pond Herbland-Riverine Swamp Forest Complex
1021	Mosaic of Drainage-line Aggregate/Grassy Riverine Forest-Riverine Swamp Forest Complex
1022	Drainage-line Aggregate/Riverine Swamp Forest Mosaic
1023	Drainage-line Aggregate/Sedgy Riverine Forest Mosaic
1024	Mosaic of Drainage-line Aggregate/Sedgy Riverine Forest-Riverine Swamp Forest Complex
1025	Drainage-line Aggregate/Tall Marsh Mosaic
1027	Riverine Grassy Woodland/Grassy Riverine Forest-Riverine Swamp Forest Complex
1028	Riverine Grassy Woodland/Riverine Swamp Forest Mosaic
1029	Grassy Riverine Forest/Floodway Pond Herbland Mosaic
1030	Grassy Riverine Forest/Riverine Swamp Forest Mosaic
1031	Floodplain Riparian Woodland/Grassy Riverine Forest Mosaic
1032	Floodplain Riparian Woodland/Riverine Grassy Woodland Mosaic
1033	Floodplain Riparian Woodland/Floodway Pond Herbland Mosaic
1034	Floodplain Riparian Woodland/Riverine Swamp Forest Mosaic
1035	Floodplain Riparian Woodland/Sedgy Riverine Forest Mosaic
1037	Floodplain Riparian Woodland/Tall Marsh Mosaic

EVC No.	EVC Name
1040	Riverine Grassy Woodland/Riverine Swampy Woodland Mosaic
1041	Riverine Grassy Woodland/Sedgy Riverine Forest Mosaic
1042	Mosaic of Riverine Grassy Woodland/Floodway Pond Herbland-Riverine Swamp Forest Complex
1067	Riverine Swamp Forest/Riverine Swampy Woodland Mosaic
1068	Riverine Swamp Forest/Sedgy Riverine Forest Mosaic
1069	Riverine Swamp Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex
1070	Riverine Swamp Forest/Spike-sedge Wetland Mosaic
1071	Riverine Swamp Forest/Tall Marsh Mosaic
1073	Riverine Swampy Woodland/Sedgy Riverine Forest Mosaic
1074	Mosaic of Riverine Swampy Woodland/Sedgy Riverine Forest-Riverine Swamp Forest Complex
1075	Mosaic of Sedgy Riverine Forest/Sedgy Riverine Forest-Riverine Swamp Forest Complex
1076	Sedgy Riverine Forest/Spike-sedge Wetland Mosaic
1077	Sedgy Riverine Forest/Tall Marsh Mosaic
1078	Mosaic of Sedgy Riverine Forest/Floodway Pond Herbland-Riverine Swamp Forest Complex
1079	Mosaic of Sedgy Riverine Forest-Riverine Swamp Forest Complex/Tall Marsh
1080	Mosaic of Sedgy Riverine Forest-Riverine Swamp Forest Complex/Floodway Pond Herbland-Riverine Swamp Forest Complex
1082	Tall Marsh/Riverine Swamp Forest Mosaic
1085	Mountain Valley Riparian Woodland
1088	Riverine Grassland
1099	Riverine Swampy Woodland/Plains Grassy Wetland Mosaic

Table 16 - Waterway Dependent EVCs – Wetland

EVC No.	EVC name
8	Wet Heathland
9	Coastal Saltmarsh Aggregate
10	Estuarine Wetland
11	Coastal Lagoon Wetland
12	Wet Swale Herbland

EVC No.	EVC name
13	Brackish Sedgeland
40	Montane Riparian Woodland
41	Montane Riparian Thicket
49	Swamp Heathland Aggregate
53	Swamp Scrub
56	Floodplain Riparian Woodland
59	Riparian Thicket
74	Wetland Formation
80	Spring Soak Woodland
83	Swampy Riparian Woodland
101	Samphire Shrubland
103	Riverine Chenopod Woodland
104	Lignum Swamp
106	Grassy Riverine Forest
107	Lake Bed Herbland
124	Grey Clay Drainage-line Aggregate
125	Plains Grassy Wetland
136	Sedge Wetland
140	Mangrove Shrubland
148	Montane Sedgeland
171	Alpine Fen
172	Floodplain Wetland Aggregate
185	Perched Boggy Shrubland Aggregate
191	Riparian Scrub
195	Seasonally Inundated Shrubby Woodland
196	Seasonally Inundated Sub-saline Herbland
210	Sub-alpine Wet Heathland
239	Alpine Creekline Herbland
280	Floodplain Thicket
281	Sedge-rich Wetland
283	Plains Sedgy Woodland

EVC No.	EVC name
284	Claypan Ephemeral Wetland
288	Alpine Heath Peatland
291	Cane Grass Wetland
292	Red Gum Swamp
306	Aquatic Grassy Wetland
307	Sand Heathland/Wet Heathland Mosaic
308	Aquatic Sedgeland
318	Montane Swamp
334	Billabong Wetland Aggregate
369	Black Box Wetland
537	Brackish Aquatic Herbland
538	Brackish Herbland
539	Brackish Lake Bed Herbland
591	Calcareous Wet Herbland
602	Cane Grass Wetland/Aquatic Herbland Complex
606	Cane Grass Wetland/Brackish Herbland Complex
636	Brackish Lake Aggregate
647	Plains Sedgy Wetland
648	Saline Lake-verge Aggregate
651	Plains Swampy Woodland
653	Aquatic Herbland
656	Brackish Wetland Aggregate
657	Freshwater Lignum Shrubland
673	Dune Soak Woodland
676	Salt Paperbark Woodland
678	Ephemeral Drainage-line Grassy Wetland
707	Sedgy Swamp Woodland
708	Hypersaline Inland Saltmarsh Aggregate
717	Saline Lake Aggregate
718	Freshwater Lake Aggregate
721	Fern Swamp

EVC No.	EVC name
723	Forest Bog
728	Forest Creekline Sedge Swamp
755	Plains Grassy Wetland/Aquatic Herbland Complex
767	Plains Grassy Wetland/Brackish Herbland Complex
784	Plains Swampy Woodland/Lignum Swamp Complex
804	Rushy Riverine Swamp
806	Alluvial Plains Semi-arid Grassland
808	Lignum Shrubland
809	Floodplain Grassy Wetland
810	Floodway Pond Herbland
811	Grassy Riverine Forest/Floodway Pond Herbland Complex
812	Grassy Riverine Forest/Riverine Swamp Forest Complex
813	Intermittent Swampy Woodland
814	Riverine Swamp Forest
815	Riverine Swampy Woodland
816	Sedgy Riverine Forest
817	Sedgy Riverine Forest/Riverine Swamp Forest Complex
819	Spike-sedge Wetland
820	Sub-saline Depression Shrubland
821	Tall Marsh
822	Intermittent Swampy Woodland/Riverine Grassy Woodland Complex
823	Lignum Swampy Woodland
842	Saline Aquatic Meadow
845	Sea-grass Meadow
857	Stony Rises Pond Aggregate
875	Blocked Coastal Stream Swamp
883	Sedge Wetland/Calcareous Wet Herbland Complex
888	Plains Saltmarsh
905	Alpine Short Herbland
908	Sink-hole Wetland Aggregate

EVC No.	EVC name
914	Estuarine Flats Grassland
917	Sub-alpine Wet Sedgeland
918	Submerged Aquatic Herbland
920	Sweet Grass Wetland
931	Wet Heathland/Sedge Wetland Complex
932	Wet Verge Sedgeland
934	Brackish Grassland
937	Swampy Woodland
945	Floodway Pond Herbland/Riverine Swamp Forest Complex
947	Brackish Lignum Swamp
949	Dwarf Floating Aquatic Herbland
952	Estuarine Reedbed
953	Estuarine Scrub
954	Freshwater Lignum-Cane Grass Swamp
958	Plains Grassy Wetland/Calcareous Wet Herbland Complex
959	Plains Grassy Wetland/Sedge-rich Wetland Complex
960	Plains Grassy Wetland/Spike-sedge Wetland Complex
961	Plains Rushy Wetland
963	Sedge Wetland/Aquatic Sedgeland Complex
964	Shell Beach Herbland
966	Montane Bog
968	Gahnia Sedgeland
973	Brackish Shrubland
975	Riverine Ephemeral Wetland
976	Coastal Ephemeral Wetland
990	Unvegetated (open water/bare soil/mud)
999	Unknown/Unclassified
1010	Plains Sedgy Wetland/Sedge Wetland Complex
1011	Alpine Hummock Peatland
1111	Alkaline Basaltic Wetland Aggregate
1112	Granite Rock-pool Wetland

EVC No.	EVC name
1113	Sedge Wetland/Brackish Herbland Complex
1114	Brackish Sedgy Shrubland
2004	Swamp Scrub/Gahnia Sedgeland Complex

Table 17 - Waterway Dependent EVCs – Estuary

EVC No.*	EVC name
9	Coastal Saltmarsh
10	Estuarine Wetland
13	Brackish Sedgeland
18	Riparian Forest
53	Swamp Scrub
83	Swampy Riparian Woodland
140	Mangrove Shrubland

* 196, 538, 842, 845, 914, 934, 952, 953 Not mapped in EVC BCS layer

Appendix J - Rules for Applying Water Quality and Aquatic Invertebrate Community Condition Data

Naturalness: Aquatic Invertebrate Community Condition

Each site usually had at least two years of data; an average was calculated (one for the edge and one for the riffle) for each of the four measures, and it was assessed whether the Biological Objectives for Rivers and Streams (Metzeling et al 2004) were met (pass) or were not met (fail) for each measure. Where a reach crossed into another region separate averages were calculated. The following rules were applied to combine the edge and riffle information for each measure:

- Where edge and riffle both pass = pass
- Where edge and riffle both fail = fail
- Where one of edge or riffle fails = fail (and noted in the rationale)

Degraded Water Quality: Measure 1 – SIGNAL Objectives

Each site usually had at least two years of data; an average was calculated (one for the edge and one for the riffle habitats) and it was assessed whether the Biological Objectives for Rivers and Streams (Metzeling et al 2004) for SIGNAL were met (Meets SEPP) or were not met (Fails SEPP). Where a reach crossed into another region separate averages were calculated. The following rules were applied to determine the overall score for AVIRA:

Whole reach within region

- Where edge and riffle both pass = Meets SEPP (WoV)
- Where edge and riffle both fail = Fails SEPP (WoV)
- Where one of edge or riffle fails = Fails SEPP (WoV) (and noted in the rationale)

Where reach crosses 2 regions:

- If 3 pass and 1 fail = Meets SEPP (WoV)
- If 2 pass and 1 fail = Fails SEPP (WoV)
- If 2 pass and 2 fail = Fails SEPP (WoV)

Degraded Water Quality: Measure 2 – EPA Victoria Water Quality Objectives at VWQMN Sites

The data from Victorian Water Quality Monitoring Network (VWQMN) was used to populate this metric, using the following as a guide:

- Data considered for use was from the period starting January 2004 until December 2009. This time frame was used so as to be consistent with the 3ISC.
- The parameters considered were pH, turbidity, total Phosphorus and Electrical Conductivity. These parameters were used so as to be consistent with the 3ISC.
- The thresholds used to determine whether a site had met the objectives were taken from the EPA Nutrient Objectives for Rivers and Streams (Tiller and Newall 2003) and the EPA Water Qaulity Objectives for Rivers and Streams (Goudey 2003). Thresholds vary according to the region in which the reach occurs.
- If the reach crossed a region boundary an assessment was made to determine which region the majority of the reach occurred in, the thresholds for this region were then used.
- As the AVIRA metric is the number of objectives failed out of four, only sites where the four parameters were collected on a regular basis were included in the analysis.

- Only sites where a reasonable number of samples were collected were used to ensure that there was an adequate number of samples to accurately characterise the water quality at that site. Once the threshold of 24 samples over the six year period was met data was automatically accepted for use. Data with a lower sample size was sometimes accepted if it had a suitable spread across the six years and was judged to be representative.

Degraded Water Quality: Measure 3 – EPA Victoria Water Quality Objectives using Waterwatch Data

Waterwatch data was used to populate this metric, using the following as a guide:

- Data considered for use was from the period starting January 2004 until December 2009. This time frame was used so as to be consistent with the 3ISC.
- The parameters considered were pH, turbidity, total Phosphorus and Electrical Conductivity. These parameters were used so as to be consistent with the 3ISC.
- The thresholds used to determine whether a site had met the objectives were taken from the EPA Nutrient Objectives for Rivers and Streams (Tiller and Newall 2003) and the EPA Water Qaulity Objectives for Rivers and Streams (Goudey 2003). Thresholds vary according to the region in which the site occurs.
- If the reach crossed a region boundary an assessment was made to determine which region the majority of the reach occurred in, the thresholds for this region were then used.
- As the AVIRA metric is the number of objectives failed out of four, only sites where the four parameters were collected on a regular basis were included in the analysis.
- Only sites where a reasonable number of samples were collected were used to ensure that there was an adequate number of samples to accurately characterise the water quality at that site. Once the threshold of 24 samples over the six year period was met data was automatically accepted for use. Data with a lower sample size was sometimes accepted if it had a suitable spread across the six years and was judged to be representative.

Appendix K - Victorian Regional Fishery Management Plans

Bendigo Region Fisheries Management Plan

The *Bendigo Region Fisheries Management Plan* (DNRE 2002d) gives priority to the following waters:

River Reaches	Wetlands	Estuaries
• Campaspe River (from the outflow of Lake Eppalock to Echuca) • Jim Crow Creek • Loddon River (from the outflow of Laanecoorie Reservoir to Bridgewater)	• Upper Coliban storages • Upper Coliban Reservoir • Lauriston Reservoir • Malmsbury Reservoir) • Lake Eppalock • Cairn Curran Reservoir • Barkers Creek Reservoir • Tullaroop Reservoir	• Not applicable

Glenelg Hopkins Fishery Management Plan

The *Glenelg Hopkins Fishery Management Plan* (DPI 2006a) indicates the following waterways as the most popular fisheries in the region:

River Reaches	Wetlands	Estuaries
Recreational fishing effort is considered to be: • low to medium for most rivers of Glenelg River management unit • medium for the Wannon River • low for most of the rivers in the Moyne management unit, apart from the Moyne River • low (in upper reaches) to medium (in lower reaches) of rivers in the Hopkins River management unit*	None cited	Recreational fishing effort is relatively high in most estuaries of the Glenelg Hopkins Region.

* Definition: lower reaches (0 - 200 m Above Sea Level (ASL)), upper reaches (>200 m ASL). Where an ISC river reach cuts across the 200m ASL, it will be categorised as upper or lower based on its majority stream length (ie >50% above or below 200m ASL).

North East Fishery Management Plan

The *North East Fishery Management Plan* (DPI 2006b) indicates the following waterways as the most popular fisheries in the region:

River Reaches	Wetlands	Estuaries
None cited	None cited	Not applicable

Goulburn-Eildon Region Fisheries Management Plan

The *Goulburn-Eildon Region Fisheries Management Plan* (DNRE 2002e) indicates the following waterways as the most popular fisheries in the region:

River Reaches	Wetlands	Estuaries
• Big River • Delatite River • Goulburn River • Howqua River • Jamieson River • Rubicon River • Royston River • Acheron River • Steavenson River • Yea River • Murrindindi River • King Parrot Creek • Hughes Creek	• Lake Eildon • Eildon Pondage • Lake Nagambie	• Not applicable

West Gippsland Fishery Management Plan

The *West Gippsland Fisheries Management Plan* (DPI 2008a) indicates the following waterways as the most popular fisheries in the region:

River Reaches	Lakes and Wetlands	Estuaries
• Tarwin River • Macalister River • Tanjil River • Thomson River • Latrobe River • lower reaches* of: o Franklin River o Albert River o Avon River o Tarra River o Merrimans Creek	• Blue Rock Lake • Lake Glenmaggie • Lake Narracan • Lake Tali Karng • Cowwarr Weir • Hazelwood Pondage • Lake Guthridge • Lake Guyatt • Heyfield Racecourse • Hyland Lake • Morwell Lake	• Avon River • Latrobe River • Powlett River • Tarwin River • Screw Creek • Merrimans Creek

* Definition: lower reaches (0 - 200 m ASL), upper reaches (>200 m ASL). Where an ISC river reach cuts across the 200m ASL, it will be categorised as upper or lower based on its majority stream length (ie >50% above or below 200m ASL).

Corangamite Fishery Management Plan (draft)

The *draft Corangamite Fishery Management Plan* (DPI 2008b) identifies the following waterways as the key fisheries in the region:

River Reaches	Wetlands	Estuaries
• Aire River	• Lake Bullen Merri	• Barwon River
• Ford River	• Lake Purrumbete	• Curdies River
• Barham River	• Wurdiboluc Reservoir	• Thompson River
• Gellibrand River	• Deep Lake	• Barham River
• Curdies River	• West Barwon Dam	• Gellibrand River
• Barwon River	• Lake Colac	• Painkalac Creek
• Carlisle River	• Lake Murdeduke	• Anglesea River
• Moorabool River	• Lake Modewarre	• Kennett River
	• Lake Wendouree	• Wye River
	• Lake Tooliorook	• Erskine River
		• Aire River
		• Hovells Creek
		• Spring Creek

Other Plans

- Anderson Inlet Fisheries Reserve Management Plan 2006 (DPI 2006c)
- Lake Tyers Fisheries Reserve Management Plan 2007 (DPI 2007b)
- Mallacoota Inlet Fisheries Reserve Management Plan 2006 (DPI 2006d)

Appendix L - Non-Motor Boating In Victoria

Canoeing/Kayaking

Canoeing/kayaking activities take a number of forms and are generally divided into two categories: white-water and flat-water. White-water activities require fast-flowing water and are usually undertaken in the upper mountainous reaches of rivers. Flat-water activities generally occur on the lower, flatter reaches of rivers, estuaries and in lakes.

Some canoeing/kayaking activities are competitive. Canoeing Victoria cites the following freshwater event types:

- white-water (slalom, wildwater, freestyle)
- flat-water (sprint, marathon, canoe polo)

An example of the key waterways for one of these event types – slalom - is described below.

Canoe/ Kayak Slalom

Canoe/kayak slalom involves a race through a series of gates suspended over a course of whitewater rapids. Slalom events are held on the following waterways:

- Yarra River (Warburton, Warrandyte, Templestowe, Eltham, Abbotsford)
- Big River (near Lake Eildon)
- King River (near Cheshunt)
- Goulburn River (below Lake Eildon)

The Victorian State Slalom Championships are held on the Goulburn River at Eildon in December each year (Canoeing Victoria ~2008).

White-Water Rafting

White-water rafting is an extreme sport requiring fast-flowing waters, usually in the upper reaches of rivers. Popular rivers for white-water rafting include:

- Mitta Mitta River;
- King River;
- Mitchell River; and
- Howqua and Delatite rivers.

Rowing

Rowing is a competitive, club-based activity involving year-round training (LCC 1991). Optimal conditions are met in the lower reaches of rivers and small open water bodies such as:

- Barwon River, Geelong
- Lake Weeroona, Bendigo
- Maribyrnong River
- Yarra River
- Lake Nagambie
- Goulburn River Warrnambool
- Lake Wendouree, Ballarat
- Lake Colac
- Albert Park Lake
- Lake Hamilton
- Murray River
- Lake Moodemere, Rutherglen
- Wimmera River, Horsham
- Mitchell River, Bairnsdale
- Thompson River, Sale
- Patterson Lakes, Carrum

Appendix M - Motor Boating in Victoria

Water-Skiing

Popular water-skiing locations include:

- Lake Eildon;
- Lower Glenelg River;
- Murray River;
- Gippsland Lakes;
- Lower Barwon River; and
- Lake Boga.

Power Boat Racing

Power boat racing events occur at:

- Lake Eppalock;
- Lake Glenmaggie; and
- Murray River.

Appendix N - Special Water Supply Catchment Areas in Victoria

The following SWSCs are listed in Schedule 5 of the *Catchment and Land Protection Act 1994*.

- Upper Barwon
- Parwan
- Upper Goulburn
- Glenmaggie
- Rocklands
- Wimmera Systems
- Riddells Creek
- Gisborne-Sunbury
- Lancefield
- Romsey
- Woodend
- Mount Macedon
- Macedon
- Eppalock
- Cairn Curran
- Sunbury
- Djerriwarrh
- Tyers River
- Kilmore
- Bunyip River
- Trawalla Creek
- Lorne
- Healesville
- Upper Kiewa
- Mirboo North
- Orbost (Rocky River)
- Lake Merrimu
- McCraes Creek
- Billys Creek
- Buffalo River (Lake Buffalo)
- Seven Creeks & Mountain Hut Creek (Euroa)
- Fifteen Mile Creek (Glenrowan)
- Lake Hume (Victorian section)
- Loddon River (Laanecoorie)
- Merino
- Mollison Creek (Pyalong)
- Bemm River
- Little Bass River (Poowong–Loch–Nyora)
- Brodribb River
- Bellview & Ness Creeks (Korumburra)
- Ruby Creek (Leongatha)
- Battery Creek (Fish Creek)
- Deep Creek (Foster)
- Agnes River
- Ovens River (Wangaratta)
- Fiery Creek Tributaries (Beaufort)
- Drouin
- Tarago River
- Lake Nillahcootie
- Lake Merrimu (Goodmans Creek)
- Gellibrand River
- Ryans Creek
- Rosslynne Reservoir (Jacksons Creek)
- Tarra River
- Rosslynne Reservoir (Riddells Creek)
- Micks Creek
- Lal Lal Reservoir
- Betka River
- Thomson River (Stages 1, 1(a) & 2)
- Lake Merrimu (Lerderderg River)
- Avoca Town Water Supply
- Nicholson River
- Honeysuckle Creek
- Cann River
- Running Creek
- Moorabool River (Sheoaks)
- Stony Creek
- Painkalac Creek (Aireys Inlet)
- Lance Creek
- Tennent Creek (Candowie Reservoir)
- Nine Mile, Clear and Hurdle Creeks
- Musical Gully and Troy Reservoirs (Beaufort)
- Langi Ghiran Reservoir
- Picnic Road (Ararat)
- Crusoe Group Reservoirs (Bendigo)
- Spring Gully Reservoir (Bendigo)
- Teddington Reservoir
- Barwon Downs Wellfield Intake Area (Geelong)
- Yuppeckiar Creek Reservoir (Glenthompson)
- Konong Wootong Reservoir (Coleraine)
- Mortlake Spring (Mortlake)
- Wannon River Tributaries (Lake Bellfield)
- Mason Creek (Willaura)
- Serra Range Tributaries (Dunkeld)
- Bakers Gully (Bright)
- Creswick
- King River (Lake William Hovell)
- Buckland River
- Monument Creek
- Gellibrand River (South Otway)
- Tanjil River
- Ballarat
- Tullaroop Reservoir
- Britania Creek
- Pennyroyal, Matthews & Gosling Creeks
- Sunny Creek
- Narracan Creek
- Skenes Creek
- Mitchell River
- Rollo Creek
- Bealiba
- West Barham River
- McCallum Creek
- Walkley Creek (Boolarra)
- Thomson River (Stage 3)
- Tambo River
- Boggy Creek (Nowa Nowa)
- Buchan River (Buchan)
- Diddah Diddah Creek (Springhurst)
- Ovens River (Bright)
- Tomahawk Creek (Gembrook)
- Sunday Creek (Broadford-Kilmore)
- Little Tea Tree Creek Tributaries (Hamilton)
- Pykes Creek Reservoir and Werribee River
- Nine Mile Creek (Longwood)
- Barambogie Creek (Chiltern)
- Candowie Reservoir North
- Tarwin River (Meeniyan)
- Merrimans Creek (Seaspray)
- Deep Creek & Loch River (Noojee)
- Redbank Creek (Redbank)
- Forest Creek (Amphitheatre)
- Learmonth Borefield
- St Enochs Spring (Skipton)

Appendix O - Irrigation Districts in Victoria

Bacchus Marsh Irrigation District

The Bacchus Marsh Irrigation District (BMID) is located around the thriving community of Bacchus Marsh, on a fertile floodplain of the Werribee River. This region which, at the time of European settlement, was a large swamp is now a highly developed agricultural district specialising in dairy farming, horticulture and market gardening (SRW ~2008).

The BMID receives its irrigation supply via a weir on the Werribee River just east of Ballan, which diverts water to Myers Creek. This creek in turn discharges to Pykes Creek Reservoir. Releases from the storage are to the Werribee River via the Korweinguboora Creek. A second Diversion Weir located west of Bacchus Marsh on the Werribee River diverts irrigation supplies into the BMID.

Central Goulburn Irrigation Area

This Area covers 173,053ha (113,106ha irrigated) and is one of the largest irrigated areas in Northern Victoria. A diverse range of irrigated agriculture can be found in Central Goulburn. Dairying is the most common enterprise along with cropping, grazing and horticulture (stone and pomme fruits) (GMW ~2008).

Water Rights in the Area are supplied mainly from Lake Eildon. Releases make a two day journey along the Goulburn River to the major diversion point at Goulburn Weir near Nagambie (GMW ~2008).

Macalister Irrigation District

The largest irrigation area south of the Great Dividing Range, the Macalister Irrigation District (MID) is located in central Gippsland, and takes its name from the Macalister River, main source of the district's irrigation water. The MID extends around the river for 53,000ha from Lake Glenmaggie to near Sale. Approximately 33,500ha is currently used for irrigation, and of this 90% is under pasture (SRW ~2008).

Water Rights in the Area are supplied mainly from Lake Eildon. Releases make a two day journey along the Goulburn River to the major diversion point at Goulburn Weir near Nagambie (GMW ~2008).

Murray Valley Irrigation Area

The Murray Valley Irrigation Area covers 128,372ha (88,969ha irrigated) in Northern Victoria. A range of irrigated agriculture can be found in this Area, with dairying the most common enterprise around Katunga, Nathalia, Strathmerton and Waaia (47% of Area land use). Horticultural holdings (mainly stone fruits) dominate around Cobram (8% of Area land use), while cropping and grazing are carried out on broad acre farms near Katamatite and Picola (45% of Area land use) (GMW ~2008).

Water supplies are released into the River Murray at Hume Dam. Water released at Hume Dam moves downriver to Lake Mulwala, the receival point for irrigation water, behind Yarrawonga Weir. At Yarrawonga Weir, on the Victorian side, the water is diverted into the Yarrawonga Main Channel and from there into the Murray Valley channel system. Irrigation customers also pump water from the Broken/Nine Mile Creek systems. Bulk water from the system is also supplied to towns within the Area (GMW ~2008).

Pyramid - Boort Irrigation Area

The Pyramid-Boort Irrigation Area covers 166,215ha (126,400ha suitable for irrigation) in Northern Victoria. Water is released from Waranga Basin into the Waranga Western Channel to supply the Rochester and Pyramid-Boort Irrigation areas. Water can also enter the Pyramid-Boort Irrigation area from the Loddon River at Loddon Weir, Fernihurst. Pumped supplies are also drawn from the Loddon River and are managed by Diversion Operations in Kerang (GMW ~2008).

The Pyramid Hill district is traditionally renowned for wool and fat lamb production while the dairy industry remains prominent around areas such as Yarrawalla, Calivill and Dingee. The district also produces hay and includes some summer and winter cropping. There are also some diverse industries such as salt harvesting, apples and cherries. The Boort district has a diversity of industry crops including olives, tomatoes, corn and lucerne. Emerging industries within the area include aquaculture, grape growing and value adding olive products are increasingly prominent (GMW ~2008).

Rochester - Campaspe Irrigation Area

A range of irrigated agriculture can be found in the Rochester-Campaspe Area with dairying being the major enterprise. There is also a large percentage of tomato crops grown in the Rochester-Campaspe Area, with other mixed farming such as summer cropping and sheep and cattle grazing. The major sources of water supply are Lake Eildon and Lake Eppalock with supplementary supplies taken from Greens Lake (GMW ~2008).

Shepparton Irrigation Area

The Shepparton Irrigation Area covers 81,750ha (51,000ha irrigated) in Northern Victoria. Dairying and horticulture (mostly stone fruit) are the most common irrigated enterprises in this Area. However, mixed cropping and grazing enterprises make up over half of the irrigated farms, with a significant number of them being 'hobby farms', especially close to Shepparton (GMW ~2008).

Torrumbarry Irrigation Area

The Torrumbarry Irrigation Area covers 167,000ha (150,000ha suitable for irrigation) in Northern Victoria. Dairy farms dominate around Cohuna, while mixed farming is more common around Kerang where fat lambs and beef cattle are raised extensively, and cereal, fodder, lucerne and oil seed crops are also widely produced. As well as dairying, fruit and vegetables are a significant part of irrigated production around Swan Hill. The sandy hills at Tresco and along the River Murray downstream from Swan Hill to Nyah are planted to horticulture - vineyards, stonefruit and market gardening (GMW ~2008)

Water supplies for the Torrumbarry Area are released into the River Murray at Hume Dam. Water released at Hume Dam takes ten days to move downriver to the Torrumbarry Weir pool, behind Torrumbarry Weir which is the diversion point for the Area's irrigation water. A unique feature of the area is the multiple uses made of the natural water bodies that are prevalent throughout the Torrumbarry Irrigation Area (GMW ~2008).

Werribee Irrigation District

The Werribee Irrigation District (WID) is one of Melbourne's vegetable gardens, located on the estuarine floodplain of the Werribee River. The WID receives its irrigation supply from the combination of three storages at Pykes Creek, Lake Merrimu and Melton Reservoir. These storages impound water from both the Werribee and Lerderderg River systems (SRW ~2008).

Other Districts

- First Mildura Irrigation Trust
- Wimmera Mallee Water
- Sunraysia Rural Water Authority
- Swan Hill Pumped Districts

Appendix P - Victorian Water Storages

Basin	Reservoir	Full Storage Capacity (ML)
Avoca	None	n/a
Barwon	Wurdee Boluc Reservoir	40,431
Barwon	West Barwon Dam	21,000
Barwon	White Swan Reservoir	14,107
Barwon	Gong Gong Reservoir	1,902
Broken	Lake Mokoan	362,450
Broken	Lake Nillacootie	39,950
Broken	Loombah-McCall Say	1,813
Bunyip	Tarago Reservoir	25,000
Campaspe	Lake Eppalock	304,651
Campaspe	Upper Coliban Reservoir	37,480
Campaspe	Lauriston Reservoir	19,790
Campaspe	Malmsbury Reservoir	17,780
Campaspe	Campaspe Weir	2,624
Corangamite	None	n/a
East Gippsland	None	n/a
Gippsland	Candowie Reservoir	2,207
Gippsland	Western Reservoir	1,137
Gippsland	Hyland Reservoir	671
Glenelg	Rocklands Reservoir	348,310
Glenelg	Moora Moora Reservoir	6,300
Glenelg	Hayes Reservoir	2,700
Glenelg	Konongwootong Reservoir	1,920
Goulburn	Lake Eildon	3,334,158
Goulburn	Waranga Basin	432,632
Goulburn	Greens' Lake	32,440
Goulburn	Goulburn Weir	25,500
Goulburn	Sunday Creek Reservoir	1,700
Hopkins	None	n/a
Kiewa	Rocky Valley	28,294
Kiewa	Lake Guy	1,416
Kiewa	Pretty Valley Basin	500

Basin	Reservoir	Full Storage Capacity (ML)
Kiewa	Clover Pondage	255
Latrobe	Blue Rock	208,188
Latrobe	Moondarra Reservoir	30,300
Latrobe	Lake Narracan	8,000
Loddon	Cairn Curran Reservoir	147,130
Loddon	Tullaroop Reservoir	72,950
Loddon	Laanecoorie Reservoir	7,940
Loddon	Newlyn Reservoir	3,215
Loddon	Hepburn Lagoon	3,001
Loddon	Sandhurst Reservoir	2,590
Loddon	Spring Gully Reservoir	1,680
Loddon	Evansford Reservoir	1,351
Mallee	None	n/a
Maribyrnong	Rosslynne Reservoir	25,368
Millicent Coast	None	n/a
Mitchell	None	n/a
Moorabool	Lal Lal Reservoir	64,495
Moorabool	Upper Stoney Creek Reservoir	9,494
Moorabool	Bostock Reservoir	7,480
Moorabool	Moorabool Reservoir	6,738
Moorabool	Korweinguboora Reservoir	2,100
Moorabool	Wilsons Reservoir	1,010
Murray	Lake Dartmouth (Victoria's share only)	1,953,795
Murray	Lake Hume (Victoria's share only)	1,518,250
Murray	Menindee Lakes (Victoria's share only)(1)	865,500
Murray	Lake Victoria (Victoria's share only)	338,500
Murray	Lake Cullulerraine	5,270
Otway Coast	West Gellibrand Reservoir	1,856
Ovens	Lake Buffalo	23,900
Ovens	Lake William Hovell	13,710
Portland Coast	None	n/a
Snowy	None	n/a
South	Lance Creek Reservoir	4,200
Tambo	None	n/a
Thomson	Thomson Reservoir	1,068,000
Thomson	Lake Glenmaggie	190,410

Basin	Reservoir	Full Storage Capacity (ML)
Werribee	Merrimu Reservoir	32,516
Werribee	Pykes Creek Reservoir	22,119
Werribee	Melton Reservoir	14,364
Werribee	Djerriwarrh Reservoir	983
Wimmera	Toolondo Reservoir	92,430
Wimmera	Lake Bellfield	78,560
Wimmera	Lake Lonsdale	65,480
Wimmera	Pine Lake	62,000
Wimmera	Taylors Lake	33,700
Wimmera	Wartook Reservoir	29,300
Wimmera	Fyans Lake	18,460
Wimmera	Green Lake	5,350
Wimmera	Dock Lake	4,420
Wimmera	Batyo Lake	2,250
Yarra	Cardinia Reservoir	287,000
Yarra	Upper Yarra Reservoir	200,000
Yarra	Sugarloaf Reservoir	96,000
Yarra	Silvan Reservoir	40,000
Yarra	Yan Yean Reservoir	30,000
Yarra	Greenvale Reservoir	27,000
Yarra	Maroondah Reservoir	22,000
Yarra	O'Shannassy Reservoir	3,000

Source: DSE (2008c)

Appendix Q - Key Hydro-Electric Power Stations Operating in Victoria

Dartmouth Power Station - 180 MW single generator located at the foot of the Dartmouth Dam on the Mitta Mitta River (AGL ~2008).

Eildon Power Station - two 67MW generators and two 7.5MW generators (AGL ~2008).

Banimboola Power Station - total capacity of 12.2 MW located on the regulating pondage (Lake Banimboola) of Dartmouth Power Station (AGL ~2008).

Kiewa Hydroelectric Scheme - total capacity of 241MW (AGL ~2008). The three power stations in the scheme are:

- McKay Creek Power Station (150MW);
- Clover Power Station (29MW); and
- West Kiewa Power Station (62MW).

Rubicon Power Stations – 13MW based on the use of the waters of the Rubicon and Royston Rivers, and tributaries of the Goulburn River (AGL ~2008).

Cairn Curran Power Station – 2MW at the Cairn Curran Reservoir on the Loddon River (AGL ~2008).

Blue Rock Power Station - 2.6MW located in the Latrobe Valley.

Cardinia Dam Power Station - 3.5MW on Menzies Creek.

Yarrawonga Weir Power Station – 9.5MW at Lake Mulwala.

Thompson Hydroelectric Power Station.

Lake William Hovell – 1.6MW on the King River.

Lake Glenmaggie

Lake Eppalock – 2.4MW (Pacific Hydro ~2008).

Appendix R - Eel Fishery Access Licences

Access Licence No.	Allocated Waters	Basin Name (No.)
1	Tarwin River downstream from Mardon Rd Bridge (West Branch).	South Gippsland (27)
	Albert River downstream from the railway bridge 2.4 km west of Alberton. Gippsland Lakes.	South Gippsland (27)
2	Eumeralla River downstream from the Princes Highway Bridge, including Lake Yambuk. Shared allocation.	Portland (37)
3	Lake Purrumbete.	Otway Coast (35)
4	Lower Barwon River between Queen's Park and Grab Hole Drain.	Barwon (33)
	Reedy Lake Section of Lake Connewarre.	Barwon (33)
	Lake Connewarre.	Barwon (33)
5	Lower Barwon River (inc. section of Connewarre Game reserve).	Barwon (33)
6	No specific allocation.	
7	Tarra River downstream from Pound Rd Bridge. Gippsland Lakes.	South Gippsland (27)
	Lower Lake Mallacoota.	East Gippsland (21)
8	Shared allocation.	
9	Lake Gillear.	Hopkins (36)
	Shared allocation.	
10	Merri River (inc. Kelly Swamp), downstream from the Wollaston Weir.	Hopkins (36)
	Shared allocation.	
11	No specific allocation.	
12	Aire River downstream from the Great Ocean Road.	Otway Coast (35)
	Lake Corangamite.	Lake Corangamite (34)
13	Hospital Swamp.	Hopkins (36)
	Lake Learmonth.	Hopkins (36)
14	No specific allocation.	

Access Licence No.	Allocated Waters	Basin Name (No.)
15	Deep Lake.	Hopkins (36)
	Lake Tooliorook.	Hopkins (36)
16	LaTrobe River downstream from Yallourn Storage Dam to the Swing Bridge at Sale.	LaTrobe (26)
	Moe Drain downstream from the Princes Highway Bridge.	LaTrobe (26)
	Gippsland Lakes.	
17	No specific allocation.	
18	Curdies River downstream from “The Narrows”.	Otway Coast (35)
	Curdies Inlet.	
	Gellibrand River downstream from the Great Ocean Road.	Otway Coast (35)

Source: DNRE (2002f)

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