River Murray Wetland Classification Project

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Department of Land, Water & Biodiversity Conservation
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Acronyms

AE Aquatic Ecosystem
ASSRAP Acid Sulfate Soils Risk Assessment Project
DEH Department for Environment and Heritage
DEM Digital Elevation Model
DIWA Directory of Important Wetlands
DWMBC Department of Water, Land and Biodiversity Conservation
FIM Flood Inundation Model
HCVAE High Conservation Value Aquatic Ecosystems
ML Megalitres
MDBA Murray Darling Basin Authority
RRP Riverine Recovery Project
SAAE South Australian Aquatic Ecosystems
SAMDBNRM South Australian Murray Darling Basin Natural Resource Management Board
SKM Sinclair Knight Mertz
SLU Soil Landscape Units
SQL Structured Query Language
WPP Wetland Prioritisation Project

Acknowledgements

This work builds on the contribution provided by many data collection and modelling projects over time as referred to in the text. The authors of this report would also like to acknowledge the valuable input, advice and review provided by Ben Fee, Tumi Bjomssen, Mike Harper, Dr Nick Souter, Rebecca Turner, Andrew Wilson and Paul Wainwright.
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1. Introduction

The goal of this project is to classify wetland types of the River Murray for two complementary projects; a) the Wetlands Prioritisation project (WPP) funded by the South Australian Murray-Darling Basin Natural Resources Management Board (SA MDBNRM) and b) the Riverine Recovery Project (RRP), managed by the Department of Water, Land and Biodiversity Conservation which is funded by the Commonwealth Government Murray Futures Program.

This characterisation of aquatic ecosystems is important in understanding the ecological assets of the system and to inform a prioritisation approach to the allocation of environmental water. These aspects are essential in improving the management of the River Murray in SA as well as informing further research and policy development in the Murray-Darling Basin and for investment decisions regarding national High Conservation Value Aquatic Ecosystems (HCVAE).

The WPP is currently in a validation stage with a number of changes being suggested by the steering committee. This project is in response to one of those changes and is also designed to feed into further investigations for the RRP. It should be noted that the timing of the final outputs from the WPP should be considered with any application of this projects outputs to RRP objectives. Section 2.8 provides more on the implications and connectivity between these projects.

1.1. Aim

The aim of the project is to define character types of aquatic ecosystems of the River Murray, according to the methodology developed by the South Australian Aquatic Ecosystems classification project (SAAE). This classification uses the geomorphological, hydrological and ecological characteristics of aquatic ecosystems to define different wetland types that exist in South Australia. It has been developed in consultation with representatives from Natural Resource Management Boards across the state. This is essentially the first application of the SAAE to a specific region. The results of the classification were incorporated into the Wetland Prioritisation project methodology to assign conservation-threat rankings to aquatic ecosystems, by geomorphic reach.
2. Method

2.1. Study area

The study area includes the aquatic ecosystems of the River Murray floodplain within the boundary of the 1956 flood, from the South Australian border to Wellington (Figure 1). This includes mapped wetlands and watercourses but the floodplain itself is excluded, i.e. those areas not bounded by polygons and where water would not remain upon recession of flood events.

![Figure 1 Location of the study area](image)

2.2. Data sources

A summary of data sources used to aid interpretation of the aquatic ecosystem attributes, can be found in Appendix A.

2.2.1. Wetlands mapping

The wetlands mapping for the River Murray floodplain that forms the basis of the classification project was created as part of the Floodplain Prioritisation Project (2007), which took existing wetland mapping from various sources and combined and aligned it to 2005 ortho-photography (Frankewicz, 2008). Each wetland polygon has a unique wetland number (AUSWETNR). Both wetland and watercourse polygons are included in this dataset. The wetlands polygons that were located between the SA border and Wellington were selected for classification, which included a total of 1,428 polygons.

While the wetland polygons are an integration of all previous mapping efforts, it has been identified that it contains errors and omissions. Such “errors and omissions” are relative to what one thinks should be included. An agreed definition of what mapped polygons should represent (i.e. for wetlands and floodplains) has not been approached. However some gross changes have been applied to some
polygons (e.g. old disposal basins that no longer hold the amount of water they used to). In addition, ongoing dialogue with floodplain managers may see an improved understanding and application of wetland mapping through development of improved information systems being developed by NRM Board and Murray Futures program. A further example of this is whether the balance of the ‘floodplain’ that exists outside of wetland polygons but within the 1956 flood level should be mapped as entities with unique identifiers. For completeness and in the context of South Australian aquatic ecosystem mapping - this makes sense. It would also allow a standard way of defining and naming floodplains as areas of potential or active management.

2.2.2. Vegetation mapping
The South Australian vegetation mapping data layer from the DEH corporate spatial database (SDE) contains extant native vegetation community mapping. It records the spatial extent, and describes the structural formation and composition of the vegetation communities across South Australia. The data has generally been captured by digitising on screen over aerial photography, with field studies providing floristic information. The imagery used for the mapping of the River Murray Floodplain was captured at 1:20,000 scale.

The vegetation mapping is used to attribute the presence of emergent, aquatic vegetation within an aquatic ecosystem and also to indicate likely salinity levels. The limitations of this data are that the mapping is based on the extrapolation of point based vegetation sampling (completed in 2003) and the interpretation of aerial photography, and not all mapping is verified in the field. Aquatic plant species and inundated vegetation are generally not mapped, so many aquatic ecosystems do not contain vegetation mapping. Due to the scale of the mapping, not all features visible in the latest imagery are represented in the vegetation mapping.

2.2.3. Flood Inundation Model (FIM)
The Flood Inundation Model (FIM) (Overton, 2006) predicts the extent of inundation of the River Murray floodplain under different flow conditions. The model is based on hydrological modelling and Landsat satellite imagery. The output from the model is a 30m raster grid. Each cell represents the amount of water in ML/day that is modelled commence to flow in that location. The FIM was used as an aid to attribute the hydrology and water regime fields, by showing aquatic ecosystems likely to be permanently connected to the River Murray. The limitations of this dataset are that it was produced at the floodplain scale (30m pixels), which is coarser than the scale of the aquatic ecosystems polygons. This means that very small or skinny watercourses and wetlands are not well represented in the data.

2.2.4. River Murray Digital Elevation Model (DEM)
The digital elevation model of the River Murray is a composite dataset produced by stitching together a series of 2m DEMS from over the floodplain (acquired through the Imagery Baseline Data Program, DWLBC, 2008). The DEM was used as an aid to attribute the Hydrology field and was used in a number of ways. It was used by draping a hillshade produced from the raw data over the top of imagery to create a 3D view of the landscape, by querying the raw data directly for the height of features, and in some cases by producing a profile graph across individual features to see the relative heights of channels and banks.
2.2.5. Soil Landscape Units

The Soil Landscape Units mapping (Soil and Land Program, 2009) contains information on soil types found in the agricultural regions of South Australia. The data is based on the interpretation of 1:40,000 stereo colour aerial photography and limited field inspections by soil scientists. Soil landscape boundaries were drawn onto 1:50,000 or 1:100,000 base maps and digitised or scanned into a spatial data layer in a GIS. The soil type information was used to interpret the Substrate field. Due to the scale of the mapping and the assumptions and interpretation used in the creation of the data, there was very little variation in soil type across the River Murray floodplain, and the majority of aquatic ecosystems were attributed with mineral-clay soil types.

2.2.6. Salinity Threat

Salinity threat raster data is an output from a project to model groundwater levels and salinity threat from land uses such as irrigated horticulture and native vegetation clearance (Floodplain Risk Methodology, Holland et al 2005). The data categorises the salinity threat into high, medium and low classes. This data was used to aid interpretation of the water source attribute, as an indication of unconfined groundwater being a possible water source for an Aquatic Ecosystem. The limitations of this data are that conditions may have changed since this data was captured.

2.2.7. Other data and information

Other sources of information were generally made available by SAMDB NRM Board, DWLBC and DEH staff.

- Various wetland Management Plans
- SAMDB NRM Wetlands Baseline Survey
- Permanent wetlands disconnected
- Wetlands with regulators
- Fish barriers (Leigh and Zampatti, 2005)
- DIWA classification of the River Murray wetlands
- Evaporation basins
- Watercourses
- Expert knowledge from wetland managers

2.3. Imagery sources

The primary imagery used in this project is the River Murray 2008, ortho-rectified infra-red imagery, it has 50cm pixels and the photography was taken in March 2008. Additional, ortho-rectified, colour and infrared aerial photography also with 50cm pixels, taken in 2005 was used to confirm some features.

2.4. SAAE Classification

The SAAE Classification is being developed by the Department of Water, Land and Biodiversity (DWLBC) in consultation with DEH, NRM board staff and others (Fee and Scholz 2009). This project is the
first practical application of the classification. There have been some changes to the classification as a result of this project and it is possible that further refinements will occur in the future.

The classification system is split into three themes: wetlands, watercourses and estuaries. Only the wetland and watercourse themes are applicable to the study area. The themes have some shared, and some unique attributes. The attributes for each theme can be broadly grouped into landscape, hydrological and other.

**Landscape attributes**

<table>
<thead>
<tr>
<th>Wetlands</th>
<th>Watercourses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Climate</td>
</tr>
<tr>
<td>Landscape setting</td>
<td>Landscape setting</td>
</tr>
<tr>
<td>Landform</td>
<td>Instream type</td>
</tr>
<tr>
<td>Size/scale</td>
<td></td>
</tr>
<tr>
<td>Substrate</td>
<td></td>
</tr>
</tbody>
</table>

**Hydrological attributes**

<table>
<thead>
<tr>
<th>Wetlands</th>
<th>Watercourses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology</td>
<td>Hydrological connectivity</td>
</tr>
<tr>
<td>Water source</td>
<td>Water source</td>
</tr>
<tr>
<td>Water regime: Inflows</td>
<td>Water regime: Inflows</td>
</tr>
<tr>
<td>Water regime: Persistence</td>
<td>Water regime: Persistence</td>
</tr>
<tr>
<td>Salinity</td>
<td>Salinity</td>
</tr>
</tbody>
</table>

**Other attributes**

<table>
<thead>
<tr>
<th>Wetlands</th>
<th>Watercourses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation presence</td>
<td></td>
</tr>
<tr>
<td>Artificial</td>
<td>Regulated</td>
</tr>
<tr>
<td>Managed</td>
<td></td>
</tr>
</tbody>
</table>

Twelve AE types have been identified for the River Murray corridor (Table 1). The classification for the types relevant to the River Murray (regional level) can be found in Appendix B, and Appendix C shows the full classification (at state level) of 28 SAAE wetland types as they stand in December 2009.

This application of the SAAE to a regional project (as distinct from a statewide approach) has highlighted that the identified state level types can be further broken down by whichever relevant attribute provides appropriate differentiation at the regional/local level. In this case, five state level types have been expanded to nine through inclusion of the hydrology attribute.
### Table 1 Aquatic Ecosystem types identified in the River Murray corridor

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain</td>
<td>FP</td>
</tr>
<tr>
<td>Permanent Lake - Terminal Branch</td>
<td>PLTB</td>
</tr>
<tr>
<td>Permanent Lake - Throughflow</td>
<td>PLTF</td>
</tr>
<tr>
<td>Permanent Swamp - Terminal Branch</td>
<td>PSTB</td>
</tr>
<tr>
<td>Permanent Swamp - Throughflow</td>
<td>PSTF</td>
</tr>
<tr>
<td>Saline Swamp</td>
<td>SSw</td>
</tr>
<tr>
<td>Temporary Wetland - Overbank Flow</td>
<td>TWOB</td>
</tr>
<tr>
<td>Temporary Wetland - Terminal Branch</td>
<td>TWTB</td>
</tr>
<tr>
<td>Temporary Wetland - Throughflow</td>
<td>TWTF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Watercourse Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Reach</td>
<td>PR</td>
</tr>
<tr>
<td>Seasonal Reach</td>
<td>SR</td>
</tr>
<tr>
<td>Ephemeral Reach</td>
<td>ER</td>
</tr>
</tbody>
</table>

#### 2.5. Creation of the data entry tables

The classification of the aquatic ecosystems occurred in two separate, geodatabase data entry tables which are related to the wetlands polygons based on the AUWETNR field. There are two data entry tables, one for wetlands and one for watercourses, due to the different attributes recorded for each theme. The data entry tables were set up in a binary fashion, with one column for each attribute, which was filled in with either a 0 or 1, depending on whether that attribute was applicable to the aquatic ecosystem. In the following example, (Table 2) the aquatic ecosystem has been classified as Macro in size.

### Table 2 Example of the data entry tables

<table>
<thead>
<tr>
<th>Mega</th>
<th>Macro</th>
<th>Meso</th>
<th>Micro</th>
<th>Lepto</th>
<th>Nano</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
2.6. Application of the SAAE Classification

Each aquatic ecosystem (polygon) was determined to be a ‘wetland’ or a ‘watercourse’ according to the following definition (sourced from Fee and Scholz, 2009).

**Wetlands** are aquatic ecosystems that are not channelised flow through systems (i.e. watercourses) and do not occur at the interface between inland waters and marine waters (i.e. estuarine). An on-stream flow-through wetland is wider than the median width (+10%) of the watercourse reaches at either end.

**Watercourses** are channelised flow-through systems but do not occur at the interface between inland waters and marine waters (i.e. estuarine). Waterholes (≤ ± 10% of watercourse reach median width) are deep pools or groundwater fed sections of watercourses where water persists beyond normal watercourses drying cycles.

Attributes were then entered into the data entry tables for each aquatic ecosystem (polygon). The following sections outline the intent of each attribute, how and what data was used and any apparent limitations.
2.6.1. Wetland attributes

**Climate**

*Valid options:* Desert, Grassland, Temperate.

*Data Source:* Koppen climate map (Jpeg).

*Description:* The climate attribute describes the Koppen climate class that the wetland falls within.

*Method:* By comparing the Koppen climate map with the location of the River Murray wetlands, it can be seen that all of the wetlands above Wellington fall in the category of Grassland.

*Limitations:* The Koppen climate mapping is very broad and provides no differentiation for the wetlands in the Murray corridor. This attribute is more relevant to state scale differentiation, however may play a role in classifying aquatic ecosystems of the Lower Lakes and Coorong region.
**Landscape setting**

**Valid options:** Flat, Dune, Hills, Subterranean, Other.

**Data Source:** DEM.

**Description:** Landscape setting refers to the land surrounding the wetland, not the landform within the polygon extent.

**Method:** The whole of the floodplain is ‘flat’ and all polygons were attributed as such.

**Limitations:** This attribute is very broad, but appropriate for a landscape scale classification. It also provides no differentiation for the wetlands in the Murray corridor.

**Example:**

![Figure 3 Example of a 'Flat' landscape setting outside polygons](image-url)
**Landform**

**Valid options:** Basin, Flat, Subterranean, Mound, Other.

**Description:** The Landform attribute is used to describe the landform of the wetland itself (i.e. within the polygon extent).

**Data Source:** DEM.

**Method:** In general, the wetlands in the River Murray floodplain all form basins, except for the floodplain which is not mapped discretely. Some of the wetlands are very shallow, little more than a depression in the ground. ‘Basin’ was therefore assigned to every polygon as a default.

**Limitations:** The floodplain itself is not in the current wetlands mapping. This is an omission in the wetlands mapping.

**Example:**

![Figure 4 Example of the 'Basin' landform within polygons](image.png)
**Size and scale**

**Valid options:** Mega, Macro, Meso, Micro, Lepto, Nano.

**Description:** The mapped extent (in hectares) of the wetland.

**Data source:** Wetland polygons.

**Method:** The size was calculated automatically using ArcMap tools.

<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mega</td>
<td>$\geq 10,000$ ha</td>
</tr>
<tr>
<td>Macro</td>
<td>$10,000$ to $100$ ha</td>
</tr>
<tr>
<td>Meso</td>
<td>$100$ to $25$ ha</td>
</tr>
<tr>
<td>Micro</td>
<td>$25$ to $1$ ha</td>
</tr>
<tr>
<td>Lepto</td>
<td>$1$ to $0.01$ ha</td>
</tr>
<tr>
<td>Nano</td>
<td>$\leq 0.01$ ha</td>
</tr>
</tbody>
</table>

**Limitations:** The size of wetlands is a geomorphic driver of hydrological and ecological function along with water/basin depth, but while the size is easily calculated based on wetlands mapping, depth is difficult to measure remotely and there is not a comprehensive source of depth for wetlands in the River Murray floodplain.
**Substrate**

**Valid options:** Granite, Bedrock, Mineral Sand, Mineral Clay, Organic, Other.

**Description:** The substrate of the mapped extent of the wetland.

**Data source:** Soil Landscape Units mapping.

**Method:** Most of the wetlands within the floodplain are described in the Soil Landscape Units (SLU) mapping as overlying either ‘Cracking clay soils’, ‘Wet soils’ or ‘Water’. A small number overlay ‘Highly leached sands’, ‘Deep sands’ or ‘Calcareous soils’. The majority of polygons were attributed the value of Mineral Clay, with Mineral Sands added where appropriate.

**Limitations:** The scale of the mapping is very broad, but this does match the scale of the classification. Mapping only covers the agricultural regions, so excludes the Chowilla area. Extrapolation of the understanding gained in using the SLU mapping was applied to this area.

**Example:**

![Figure 5 Example of the substrate (soil) mapping](image-url)
Hydrology

**Valid options:** Throughflow, Overbank flow, Retained, Unconnected, Terminal Branch, End of System, Other.

**Data Source:** Aerial photography, Wetlands mapping, DEM, FIM.

**Description:** Hydrology refers to the hydrological connectedness of wetlands to other Aquatic Ecosystems.

**Method:** The shape of the wetland polygon, in addition to information from the DEM, is used to distinguish the hydrology.

**Throughflow**

Wetlands with more than one connection to watercourses from which water enters and exits.

For permanent wetlands, the permanent connections are counted and the non-permanent connections are ignored, and for seasonal or ephemeral wetlands all connections are counted. The presence in the imagery or DEM of a defined channel (or a watercourse in the watercourse data layer) is used to distinguish throughflow.

![Figure 6 Example of throughflow](image-url)
Figure 7 Example of overbank flow

**Retained.**
Either organic substrate or geomorphic properties (e.g. multiple branching of a watercourse) impedes flow so that residency time of water within the wetland exceeds that expected for unimpeded flow. Pooling of water alone is not considered retained. No examples.

**Unconnected**
There is no surface or subsurface hydrological connections to other Aquatic Ecosystems. No examples.

**Terminal branch**
Water enters from one point but does not exit at another point (i.e. one connection) but it is not the end of the system.

Figure 8 Example of a terminal branch
End of system
The final point in the path of a watercourse (e.g., Lake Eyre. Does not include dead-end side branches in the path of a watercourse that continues beyond the AE). No examples.

Limitations: The wetlands mapping is not complete, i.e., not all watercourses are mapped, so it is sometimes difficult to count connections. The polygon boundary may not fully represent the hydrology of the wetland, so multiple sources of information need to be viewed to get a clear idea of what is happening on the ground.

Water source
Valid options: Local runoff, Catchment fed, Unconfined groundwater, Artesian groundwater, Other.

Description: The origin of the primary water source for the Aquatic Ecosystem.

Data source: Salinity threat, Evaporation basins, Wetlands mapping, Watercourses.

Method:
Local runoff means that the wetland is predominantly filled from rainfall in the local area, (or when artificially modified it could be from salinity interception schemes). The watercourses data layer was used to define wetlands that received water from local runoff.

Surface water (or catchment fed) means that the wetland is filled from a river either at pool level or from flooding events. The wetlands mapping was used to define which wetlands received surface water. The majority of wetlands in the River Murray floodplain are catchment fed (SW).

Unconfined groundwater filled wetlands are significantly filled from groundwater that is close to the surface (and is not artesian or under pressure). The salinity threat layer was used to distinguish areas that have a high risk of groundwater located close to the surface. Wetlands with at least 50% of their area surrounded by a salinity threat rating of 1 or 2, had the water source recorded as GW (groundwater) in addition to SW (catchment fed).

Artesian GW is groundwater from the artesian basin, and is only relevant to Artesian Springs.

Limitations: The definition of the water source attribute is the primary source of water for the aquatic ecosystem, but the method used describes all water sources, without showing the relative contribution of these water sources to the aquatic ecosystem.

Water Regime Inflows
Valid options: Permanent, Seasonal, Ephemeral.

Description: The frequency and constancy of water flowing into the Aquatic Ecosystem.

Permanent means that water constantly flows into the Aquatic Ecosystem (it is connected at pool level).
Seasonal means that water flows into the Aquatic Ecosystem at least, or more than, once a year.
Ephemeral means that water flows into the Aquatic Ecosystem less than once a year.

**Data source:** DIWA, Aerial photography.

**Method:**
- Imagery and the DIWA classification can be used to determine if inflows are permanent. If the imagery shows that the wetland has water in it, and is connected to the river at pool level, it is recorded as permanent. If the AE is being managed (with a structure such as a bank, stoplog or sluice gate) and is temporarily dry, but is otherwise able to be connected at pool level, it is still recorded as having permanent inflows. Managed wetlands are recorded in a separate field.
- Ephemeral wetlands are those that are dry on the imagery, or the DIWA classification records them as seasonal, episodic or temporary.

**Limitations:**
The 2008 imagery shows the landscape in an exceptionally dry period with weir pool levels below normal. Many large wetlands appear dry. The 2005 imagery shows many of the same wetlands ‘wet’ at pool level (and DIWA also records them this way). This particularly occurs between Lock 1 and Wellington. Given that the classification is about recording the normal or desirable situation, these wetlands are recorded as permanent if they are wet in the 2005 imagery and are identified by the term ‘Pool level’ in the comments field. This action has been taken because of the water level drop in this stretch of the River Murray due to continuing dry conditions and does not represent normal operating river levels.

**Water Regime Persistence**

**Valid options:** Permanent, Years, Annual.

**Description:** The persistence of water in the Aquatic Ecosystem after inundation.
- Permanent means that water is always present in the Aquatic Ecosystem.
- Years means that the water remains present in the AE for longer than one year but is not permanent.
- Annual means that the water remains present in the AE for less than one year after inundation.

**Data source:** DIWA, Aerial photography.

**Method:** If the inflow is permanent, the persistence will be permanent too. It has been generalised that if the inflow is ephemeral it is unlikely to persist longer than one year.

**Limitations:** Attribution is based on generalisations.
Salinity

Valid options: Freshwater, Brackish, Saline.

Description: Salt concentration in the water of the Aquatic Ecosystem.

<table>
<thead>
<tr>
<th>Salinity</th>
<th>mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater</td>
<td>&lt;1,000</td>
</tr>
<tr>
<td>Brackish</td>
<td>1,000-10,000</td>
</tr>
<tr>
<td>Saline</td>
<td>&gt;10,000</td>
</tr>
</tbody>
</table>

This item describes the broad salinity range of the wetland, and refers to the salinity of the wetland in the ‘wet’ phase, not after drawdown.


Method:
- If the wetland is a permanent wetland, and surrounded by or supporting freshwater dependent vegetation (e.g. Muehlenbeckia florulenta, Eucalyptus camaldulensis forests, Phragmites or Typha grasslands) then the wetland is recorded as ‘Fresh’.
- If there is halophytic vegetation present (e.g. Sarcocornia (Glasswort), Dispyhma (Pigface), Tectocornia (Samphire)) then the wetland is recorded as ‘Brackish’.
- If the wetland has been used as an evaporation basin, or other data sources describe the salinity level in the wetland as >10,000mg/L, then it is recorded as ‘Saline’.

Limitations: The salinity levels in wetlands in the River Murray system vary considerably over time. There is also not a lot of easily accessible water quality data to refer to for a desktop assessment, therefore the vegetation data was used as a surrogate. Sometimes the different sources of information gave conflicting results.

The ASSRAP data represented a sample at a single point-in-time which does not necessarily reflect the average salinity for the wetland over its wet phase. Not all wetlands in the study area were sampled, and where the wetland was dry, water salinity was not able to be recorded. Where the wetland had shallow water, salinity readings were very high indicating that evapo-concentration had occurred. This data was therefore used with caution.

The baseline surveys also did not sample every wetland in the study area, but salinity recordings were taken across multiple dates, giving a better indication of the range of salinities that could occur at a wetland.

Vegetation Presence

Valid options: Vegetated, Unvegetated.

Description: Presence of native, amphibious (tolerates flooding and drying), emergent vegetation (i.e. Lignum, sedges, reeds).

Vegetated means than more than 10% of the inner, plan view extent of the wetland is covered by such vegetation.
Unvegetated means than less than 10% of the inner, plan view extent of the wetland is covered by such vegetation.

This item is used to distinguish between lakes with open, deep water and swamps with emergent, water dependant vegetation. It does not refer to fringing vegetation.

**Data source:** Aerial photography, Vegetation mapping.

**Method:** Visual interpretation from aerial photography and vegetation type information from vegetation mapping.

**Limitations:** The vegetation mapping may not define the vegetation adequately, e.g. the feature is too small to be present at the scale of the mapping.

### Artificial modifiers

**Valid options:** Artificial

**Description:** The River Murray floodplain is a highly regulated and modified environment, but this item is specifically used to distinguish between natural, somewhat modified wetlands and significantly modified, artificial wetlands. Examples of artificial or artificially modified wetlands include marinas, Salt Interception Scheme evaporation basins and reservoirs.

**Data source:** Evaporation Basins, Aerial photography.

**Method:** The comments field is used to record the artificial modifier.

### Managed Wetlands

**Valid options:** Managed

**Description:** A number of wetlands in the River Murray are hydrologically managed, through the use of banks and other structures. These structures can be used to temporarily disconnect permanently inundated wetlands for short or extended periods of time to allow them to dry out, or to initiate/extend periods of inundation for temporary wetlands.

**Data source:** Managed wetlands were identified by NRM board and DEH staff via lists of names. This was enhanced by indication of polygons associated with names directly within the mapping.

**Method:** Managed wetlands are identified and the comments field is used to provide more information. A list of managed wetlands is included in Appendix E.

### 2.6.2. Watercourse attributes

The Climate, Landscape setting, Water regime: inflows, Water regime: persistence and Salinity attributes are the same as the wetland attributes explained in section 2.6.1.
**Instream type**

**Valid options:** Watercourse, Waterhole, Spring, Anabranch.

**Description:** Channel type.

**Data source:** Aerial photography, DEM, Watercourse mapping.

**Method:** Watercourses as mapped by watercourse line mapping including the River Murray main channel, and DIWA types of B1- Permanent River Stream or B2 - Seasonal River Stream.

Waterholes occur where water persists beyond the average watercourse drying cycles, due to depth of pools or groundwater flow. Waterhole width is within the median width of the watercourse reaches at either end of the waterhole (+10%).

Springs (as they relate to watercourses) are either headwaters that immediately become channelised (i.e. no wetland formation) or feed waterholes.

An anabranch is a side branch of the main channel(s) of a watercourse. Anabranches may or may not reconnect to the main channel.

**Example:**

![Figure 9 Example of a watercourse](image)

**Hydrological Connectivity**

**Valid options:** Always connected, Sometimes connected.

**Description:** Refers to the hydrological connectedness to other AE's. Connectivity does not have to be with the same AE type, nor that all AE's of one type are connected. This relates to surface water and/or groundwater connectedness.
Always connected: There are always (>80% of the time) one or more surface or sub-surface hydrological connections to other AE’s (not including marine connections for Estuarine AE’s).

Sometimes connected: There are sometimes (<80% of the time) one or more surface or sub-surface hydrological connections to other AE’s (not including marine connections for Estuarine AE’s).

**Data source:** Aerial photography, DEM, Watercourse mapping

**Method:** Always connected watercourses are connected at pool level, so the polygons are physically very close and there is water in the aquatic ecosystem.

**Limitations:** Sometimes connected watercourses may not be mapped as physically close, and may require high flows before water enters the watercourse, or is mapped as being physically close but the watercourse is dry.

**Water source**

Valid options: Local runoff, Surface water and Groundwater

As for wetlands, except for Groundwater, which refers to any groundwater source.

**Regulation**

Valid options: Regulated, Unregulated.

**Description:** Regulation refers to watercourses where flow is managed through the use of structures such as weirs, stoplogs and sluice gates.

**Data source:** Fish Barriers, Wetlands with regulators, Permanent wetlands disconnected.

**Method:** Where a watercourse is managed through artificial structures, e.g. stoplogs, the watercourse is recorded as regulated, and the comments field is used to provide more information.

**Limitations:** Not all structures may be represented in the datasets used, and the spatial accuracy of the Fish Barriers dataset did not appear to be very high.

**2.7. Classification of Wetland Type**

An ArcMap model was created and used to assign the wetland type from the information recorded in the SAAE attributes, through a series of SQL statements. The SQL statements were drafted from the SAAE Classification and refined as gaps in the original classification were noted. The structure of the model allows the wetland types to be recalculated at any time, and any changes to the SAAE Classification can be incorporated into the SQL and used to update the wetland types. A summary of the SQL can be found in Appendix D. This matches the combinations outlined in the AE types of Appendix B.
2.8. Impacts of incorporation of the SAAE classification into the Wetland Prioritisation project

The methodology for the Wetland Prioritisation project involved creating a data table of wetland records and populating the fields with relevant information from a range of sources. This was initially completed in 2008. An automated process was developed to calculate parameters from raw data scores and output frequency tables of AE type and conservation value. Alterations to account for rarity and representativeness of different AE types as outlined in 2.8.2 were performed manually, and then a second automated process used these values to calculate an initial set of priority classes.

This reclassification project has come along during the validation and review phase of the Wetlands Prioritisation (WP) project. The review identified three broad areas needing attention:

1) data/parameters
2) wetland type classification
3) removal of feasibility from method

This section outlines the impact this project has on that process and associated outputs.

2.8.1. Data/parameters

Some limitations of parameters in terms of both data collected and wording of criterion have been identified and are being scoped for revision in 2010 by the SAMDBNRM board. These future changes will influence final outcomes of the WP project as a significant revisit of some data collection activity and/or modification to parameter definitions are on the table. In the mean time, some of the more easily attainable data changes were implemented in order to provide improved outputs for the pressing needs of the Riverine Recovery project.

The WP outputs associated with this project include data/parameters as detailed in the WP documents (Butcher et al, 2007, Frankiewicz, 2008), plus:

1. Open water above Wellington was included as a structural layer. Wetlands classified as having permanent water (based on the DIWA class) and an EVC3 value of one or two (0-2 structural layers), had a structural layer added by amending the ECV3 value.

2. Where wetlands had a well vegetated littoral zone (TC5 = 1) and a single structural layer (EVC3 = 1) and the DIWA class was not one of the following; B4, B8, B10, B11 or B12), a structural layer was added by amending the EVC3 value. (i.e. allowing for habitat structure provided by littoral communities)

3. Wetlands classified as having permanent water (based on the DIWA class) were altered to ensure a habitat extent (ECV4) value of 3 (Wetlands with one or more structural layers covering >60% of the wetland area). This is to capture that open water as a habitat layer occupies the whole wetland.

Note: These interim data improvements may or may not be included in the 2010 work being scoped.

2.8.2. SAAE Classification

After the initial run of the WP method (Frankewicz, 2008), it was acknowledged that allocation of DIWA types needed revisiting and the arrival of this reclassification method was adopted as an appropriate review.
The SAAE is seen as an improvement over the DIWA typology as it focuses on differentiation of AE’s by their ecological form and function (rather than some of the more arbitrary splits in DIWA such as greater or less than 8 hectares). The SAAE classes will therefore influence the WP outputs by redefining the list of ‘types’ and thus each type’s rarity and representativeness. Section 3.1 details the new quantities of aquatic ecosystem types as allocated by this project.

Regarding rarity and representativeness, the original methodology defined these for DIWA classes in the whole study area. The revised methodology defines these by SAAE types for the geomorphic reaches. The methodology specifies that where there are less than 10% of wetland types (representativeness) within a geomorphic reach with an ecological value rank of ‘high’, then the best of lower ranked wetlands are promoted to ‘high’, based on ecological scores. Also, where there are less than ten examples of a wetland type (rarity) within a geomorphic reach, all of the wetlands are promoted to ‘high’ conservation value irrespective of ecological scores. There were forty instances of wetlands that were altered to increase their conservation value rank (detailed in Appendix G).

In a technical sense, this methodology was carried out by python scripts in ArcMap. The original script produced two frequency tables, one showing a frequency of DIWA classes for the study area, and the other categorising the DIWA classes by Conservation Rank for the study area. This script was altered to create the frequencies showing SAAE type by geomorphic reach, and SAAE type by Conservation Rank for each geomorphic reach. The results can be found in section 3.2.

2.8.3. Removal of feasibility from method

The original WP method considered three aspects of the AE in focus; ecological value, threatening processes and feasibility for remedial work. After discussion, it was decided by the steering committee that criterion captured for feasibility were not necessarily completely aligned with remedial potential of the threatening processes captured.

Feasibility was therefore suggested to be removed from the way the prioritisation was calculated. This means that the two main output products from the prioritisation method are now a conservation value (ecological value plus rarity and representativeness) and a threat value.

Now, instead of producing a protection rank and rehabilitation rank where the method attempted to inform the types of management any wetland may need, the WP method now uses the conservation value and threat ratings alone to assign a conservation-threat (CT) rank as the final priority. This in a sense removes the ‘black-box’ of combining ecological values, threats and feasibility via an automated approach based on parameters that may not necessarily have strong process linkages, and replaces it with two layers of information that can be applied together or separately to managing wetlands at site or regional scales.

Figure 10 shows how the CT ranks are arrived at when combining conservation value and threat ratings. It should still be noted that keeping the two separate may be a better application when other parameters outside the WP method are to be considered in regional wetland management strategies.
As there have been multiple changes to the methodology, any comparison of the original results from 2008 with the results of this project must be performed with due regard.

### Figure 10 Conservation value versus threat rating matrix

#### 3. Results

Outputs from this project come in three formats:

- A geodatabase of 1,428 aquatic ecosystem polygons with SAAE classification attached
- A table that relates to the 1,428 polygons using AUSWET_NR identifiers containing data, parameters, and CT rankings of WP project as they currently stand subject to data limitations described in section 2.8
- 3 series of maps (A3 size pdfs) showing wetlands coloured by SAAE types, conservation value and conservation threat ranks respectively

The following section provides some summary tables and statistics on the resulting SAAE types and priority rankings. The summary tables of SAAE types in fact describe a further breakdown using hydrology. The Permanent Lake and Permanent Swamp types have each been listed separately based on their hydrology (terminal branch and throughflow). The Temporary Wetlands have also been listed separately based on their hydrology (terminal branch, throughflow and overbank flow). This is further discussed in section 4.

#### 3.1. Wetland type classification

1,428 aquatic ecosystem polygons were classified, including 294 watercourses and 1,134 wetlands. Table 3 summarises the wetland types by geomorphic reach. The geomorphic reaches have been used to divide the study area, with the view to ensuring that wetland types (representing the variety of ecosystem function) in sections of the River Murray that have different geomorphic characteristics have an equal chance of being considered in the prioritisation. There are three geomorphic reaches along the River Murray between the Border and Wellington: Border to Overland Comer, Overland
Corner to Mannum, and Mannum to Wellington. There are 63 artificial wetland polygons recorded, which included evaporation basins and marinas.

Table 3 Wetland types by geomorphic reach (including artificial wetlands in brackets)

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Border to Overland Corner</th>
<th>Overland Corner to Mannum</th>
<th>Mannum to Wellington</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Permanent Lake – Terminal Branch</td>
<td>27</td>
<td>43 (2)</td>
<td>6 (3)</td>
<td>76</td>
</tr>
<tr>
<td>Permanent Lake – Throughflow</td>
<td>22 (1)</td>
<td>56 (1)</td>
<td>4 (1)</td>
<td>82</td>
</tr>
<tr>
<td>Permanent Swamp – Terminal Branch</td>
<td>51</td>
<td>12</td>
<td>3</td>
<td>66</td>
</tr>
<tr>
<td>Permanent Swamp – Throughflow</td>
<td>29</td>
<td>19</td>
<td>13</td>
<td>61</td>
</tr>
<tr>
<td>Saline Swamp</td>
<td>33 (28)</td>
<td>4 (2)</td>
<td>4 (1)</td>
<td>41</td>
</tr>
<tr>
<td>Temporary Wetland – Overbank Flow</td>
<td>210 (7)</td>
<td>122</td>
<td>24 (1)</td>
<td>356</td>
</tr>
<tr>
<td>Temporary Wetland – Terminal Branch</td>
<td>118 (8)</td>
<td>78</td>
<td>11(5)</td>
<td>207</td>
</tr>
<tr>
<td>Temporary Wetland – Throughflow</td>
<td>111 (2)</td>
<td>127 (1)</td>
<td>5</td>
<td>243</td>
</tr>
<tr>
<td>Permanent Reach</td>
<td>92</td>
<td>40</td>
<td>1</td>
<td>133</td>
</tr>
<tr>
<td>Seasonal Reach</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Ephemeral Reach</td>
<td>119</td>
<td>33</td>
<td>1</td>
<td>153</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>821 (46)</strong></td>
<td><strong>535 (6)</strong></td>
<td><strong>72 (11)</strong></td>
<td><strong>1,428 (63)</strong></td>
</tr>
</tbody>
</table>

Table 4 summarises the Directory of Important Wetlands (DIWA) types by geomorphic reach. It should be noted that there are a number of aquatic ecosystem polygons that have been assigned a wetland type that do not have a DIWA type. This is due to the edits to the polygon layer that occurred after the DIWA types were attributed, which resulted in the addition and deletion of a number of polygons from the wetlands dataset.
Table 4 DIWA types by geomorphic reach

<table>
<thead>
<tr>
<th>DIWA Type</th>
<th>Border to Overland Corner</th>
<th>Overland Corner to Mannum</th>
<th>Mannum to Wellington</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 – Perm Riv Stream</td>
<td>85</td>
<td>37</td>
<td></td>
<td>122</td>
</tr>
<tr>
<td>B2 – Seas Riv Stream</td>
<td>112</td>
<td>33</td>
<td>1</td>
<td>147</td>
</tr>
<tr>
<td>B3 – Inland Delta</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>B4 – Floodplain, Riv Basins, Seas Flood Grassland, Savanna</td>
<td>40</td>
<td>29</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>B5 – Perm Freshwater Lake &gt; 8ha</td>
<td>10</td>
<td>14</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>B6 – Seas Freshwater Lake &gt; 8ha</td>
<td>8</td>
<td>13</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>B7 – Perm Saline/Brackish Lake</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>B8 – Seas – Intermittent/Saline Lake</td>
<td>17</td>
<td>2</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>B9 – Perm Freshwater Pond &lt;8 ha, Marshes/Swamps with emergent Veg</td>
<td>118</td>
<td>105</td>
<td>21</td>
<td>244</td>
</tr>
<tr>
<td>B10 – Seas Freshwater ponds and Marshes, Sloughs, Potholes</td>
<td>197</td>
<td>171</td>
<td>22</td>
<td>390</td>
</tr>
<tr>
<td>B11 – Perm Saline/Brackish Marshes</td>
<td>5</td>
<td>3</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>B12 – Seasonal Saline Marshes</td>
<td>209</td>
<td>121</td>
<td>13</td>
<td>343</td>
</tr>
<tr>
<td>C1 – Water storage areas, Resv, Barrage, gen &lt;8 ha</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>C2 – Farm ponds, Stock ponds, Small Tanks</td>
<td></td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>C6 – Sewage Farms, Settling Ponds, Oxidation Basins</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>C7 – Irrigated land, Rice Fields, Canals, Ditches</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(blank)</td>
<td>21</td>
<td>3</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>821</strong></td>
<td><strong>535</strong></td>
<td><strong>72</strong></td>
<td><strong>1,428</strong></td>
</tr>
</tbody>
</table>

*Note. Blank = new geometry not assigned to DIWA

3.2. Wetland Prioritisation

The wetland prioritisation scripts were run on the 26th November and the results are summarised in Tables 5 to 9. For the Border to Overland Corner reach, Table 5 summarises wetland types falling into high, medium and low conservation values. Table 6 and Table 7 summarise the data for the Overland Corner to Mannum and Mannum to Wellington reaches, respectively.
### Table 5 Wetland type by Conservation Value - Border to Overland Corner

<table>
<thead>
<tr>
<th>Wetland type</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Permanent Lake – Terminal Branch</td>
<td>12</td>
<td>13</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Permanent Lake – Throughflow</td>
<td>16</td>
<td>4</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Permanent Swamp – Terminal Branch</td>
<td>22</td>
<td>29</td>
<td></td>
<td>51</td>
</tr>
<tr>
<td>Permanent Swamp – Throughflow</td>
<td>17</td>
<td>12</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Saline Swamp</td>
<td>6</td>
<td>24</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>Temporary Wetland – Overbank Flow</td>
<td>25</td>
<td>153</td>
<td>30</td>
<td>208</td>
</tr>
<tr>
<td>Temporary wetland – Terminal Branch</td>
<td>16</td>
<td>86</td>
<td>12</td>
<td>114</td>
</tr>
<tr>
<td>Temporary Wetland – Throughflow</td>
<td>15</td>
<td>75</td>
<td>19</td>
<td>109</td>
</tr>
<tr>
<td>Ephemeral Reach</td>
<td>20</td>
<td>82</td>
<td>10</td>
<td>112</td>
</tr>
<tr>
<td>Seasonal Reach</td>
<td>8</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Permanent Reach</td>
<td>58</td>
<td>31</td>
<td></td>
<td>89</td>
</tr>
<tr>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>216</strong></td>
<td><strong>509</strong></td>
<td><strong>73</strong></td>
<td><strong>821</strong></td>
</tr>
</tbody>
</table>

#n/a = data not collected in first pass of WPP (see section 2.8.1)

### Table 6 Wetland type by Conservation Value - Overland Corner to Mannum

<table>
<thead>
<tr>
<th>Wetland type</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Permanent Lake – Terminal Branch</td>
<td>18</td>
<td>25</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Permanent Lake – Throughflow</td>
<td>25</td>
<td>30</td>
<td>1</td>
<td>56</td>
</tr>
<tr>
<td>Permanent Swamp – Terminal Branch</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Permanent Swamp – Throughflow</td>
<td>11</td>
<td>8</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Saline Swamp</td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Temporary Wetland – Overbank Flow</td>
<td>13</td>
<td>100</td>
<td>7</td>
<td>120</td>
</tr>
<tr>
<td>Temporary wetland – Terminal Branch</td>
<td>9</td>
<td>59</td>
<td>10</td>
<td>78</td>
</tr>
<tr>
<td>Temporary Wetland – Throughflow</td>
<td>13</td>
<td>88</td>
<td>26</td>
<td>127</td>
</tr>
<tr>
<td>Ephemeral Reach</td>
<td>5</td>
<td>22</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Permanent Reach</td>
<td>20</td>
<td>19</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>121</strong></td>
<td><strong>360</strong></td>
<td><strong>51</strong></td>
<td><strong>535</strong></td>
</tr>
</tbody>
</table>

#n/a = data not collected in first pass of WPP (see section 2.8.1)
<table>
<thead>
<tr>
<th>Wetland type</th>
<th>CV RANK</th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Lake – Terminal Branch</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Lake – Throughflow</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Swamp – Terminal Branch</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Swamp – Throughflow</td>
<td>2</td>
<td>10</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saline Swamp</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary Wetland – Overbank Flow</td>
<td>3</td>
<td>19</td>
<td>2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Temporary wetland – Terminal Branch</td>
<td>9</td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary Wetland – Throughflow</td>
<td>5</td>
<td></td>
<td></td>
<td>5</td>
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</tr>
<tr>
<td>Ephemeral Reach</td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>29</td>
<td>2</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#n/a = data not collected in first pass of WPP (see section 2.8.1)

Table 8 summarises the conservation value of wetlands within each geomorphic reach, while Table 9 summarises conservation-threat rank by geomorphic reach.

**Table 8 Conservation value by geomorphic reach (Managed wetlands in brackets)**

<table>
<thead>
<tr>
<th>Conservation value</th>
<th>Border to Overland Corner</th>
<th>Overland Corner to Mannum</th>
<th>Mannum to Wellington</th>
<th>Total wetlands</th>
<th>% of the total classified wetlands</th>
<th>Total Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>216 (10)</td>
<td>121 (6)</td>
<td>37</td>
<td>374</td>
<td>26</td>
<td>1,004</td>
</tr>
<tr>
<td>Medium</td>
<td>509 (12)</td>
<td>360 (5)</td>
<td>29</td>
<td>898</td>
<td>63</td>
<td>773</td>
</tr>
<tr>
<td>Low</td>
<td>73</td>
<td>51 (2)</td>
<td>2</td>
<td>126</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>n/a</td>
<td>23</td>
<td>3</td>
<td>4</td>
<td>30</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>821</td>
<td>535</td>
<td>72</td>
<td>1,428</td>
<td>1,816</td>
<td></td>
</tr>
</tbody>
</table>

#n/a = data not collected in first pass of WPP (see section 2.8.1)

**Table 9 Conservation-threat Rank by geomorphic reach (Managed wetlands in brackets)**

<table>
<thead>
<tr>
<th>Conservation-threat Rank</th>
<th>Border to Overland Corner</th>
<th>Overland Corner to Mannum Reach</th>
<th>Mannum to Wellington Reach</th>
<th>Total wetlands</th>
<th>% of the total classified wetlands</th>
<th>Total Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT1</td>
<td>93</td>
<td>26 (1)</td>
<td>10 (3)</td>
<td>129</td>
<td>9</td>
<td>195</td>
</tr>
<tr>
<td>CT2</td>
<td>244</td>
<td>124 (4)</td>
<td>30 (8)</td>
<td>398</td>
<td>28</td>
<td>716</td>
</tr>
<tr>
<td>CT3</td>
<td>334</td>
<td>274 (6)</td>
<td>25 (11)</td>
<td>633</td>
<td>44</td>
<td>802</td>
</tr>
<tr>
<td>CT4</td>
<td>112</td>
<td>90 (2)</td>
<td>1</td>
<td>203</td>
<td>14</td>
<td>98</td>
</tr>
<tr>
<td>CT5</td>
<td>15</td>
<td>18</td>
<td>2</td>
<td>35</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>n/a</td>
<td>23</td>
<td>3</td>
<td>4</td>
<td>30</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>821</td>
<td>535</td>
<td>72</td>
<td>1,428</td>
<td>1,816</td>
<td></td>
</tr>
</tbody>
</table>

#n/a = data not collected in first pass of WPP (see section 2.8.1)
The results show that 9% of aquatic ecosystems were in the CT1 rank, meaning that they have a high conservation value and low threat ranking, with 72% of these aquatic ecosystems occurring in the Border to Overland Corner Reach. Appendix F lists the aquatic ecosystems with a conservation-threat ranking of CT1. There are 129 aquatic ecosystems with a conservation-threat rank of CT1 and only 46 aquatic ecosystems ranked as high priority for protection (P1) in the original Wetlands Prioritisation project (Bewicz, 2009). All of the aquatic ecosystems ranked as P1 in the original list were also ranked CT1 in the current iteration.

The revised methodology has tripled the number of aquatic ecosystems categorised with a high conservation value and low threats in the Border to Wellington reaches. This is most likely to be due to the changes to the input data, described in section 2.8.1. These changes had the result of increasing the ecological values of a number of aquatic ecosystems used to calculate the final ecological score. There was an additional 83 aquatic ecosystems with a conservation value of ‘high’ and threat value of ‘low’ in the 2009 iteration of the WPP as compared to the 2008 version.

The changes to the dataset based on the rarity and representation of aquatic ecosystem types by geomorphic reach (as compared to DIWA types for the study area) did not affect the final outputs much. Only seventeen additional aquatic ecosystems had their conservation value increased to ‘high’ in the Border to Wellington reaches, as compared to the 2008 version.

While the changes to the matrix (Figure 10) generally altered the way that the final priorities were calculated and labelled, the conservation-threat rank CT1 was still calculated in the same way as the original high priority for protection (P1). The dropping of the feasibility component did not affect this particular value.

Table 10 compares the numbers of each DIWA class that was attributed with each SAAE type. This table shows that there is not a direct correlation between the two different classification systems. Some DIWA classes have a clear link to a specific wetland type such as B1- Permanent River Streams and Permanent Watercourse Reach, whereas other DIWA classes such as B9 - Permanent freshwater ponds (< 8 ha) is almost equally divided between Permanent Lake and Permanent Swamp. In most cases, even where there is a clear tendency for a DIWA class to match up with a wetland type, there are usually a few outliers that fall in a completely different type. This may be due either to the original DIWA classification being misattributed, the SAAE type being misattributed, or to the differences in the classification schemes.
### Table 10 Comparison of DIWA and SAAE classes

<table>
<thead>
<tr>
<th>DIWA</th>
<th>ER</th>
<th>FP</th>
<th>PL</th>
<th>PS</th>
<th>PR</th>
<th>SSw</th>
<th>SR</th>
<th>TW</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>4</td>
<td></td>
<td>117</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>122</td>
</tr>
<tr>
<td>B2</td>
<td>127</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>146</td>
</tr>
<tr>
<td>B3</td>
<td></td>
<td></td>
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<td></td>
<td>1</td>
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<tr>
<td>B4</td>
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<td>2</td>
<td></td>
<td></td>
<td>68</td>
<td></td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>B5</td>
<td>1</td>
<td>21</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>B6</td>
<td>5</td>
<td></td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>B7</td>
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<td></td>
<td>2</td>
</tr>
<tr>
<td>B8</td>
<td></td>
<td></td>
<td>3</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>B9</td>
<td>108</td>
<td>116</td>
<td>3</td>
<td>1</td>
<td></td>
<td>16</td>
<td></td>
<td></td>
<td>244</td>
</tr>
<tr>
<td>B10</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td></td>
<td>360</td>
<td></td>
<td></td>
<td>389</td>
</tr>
<tr>
<td>B11</td>
<td>3</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>B12</td>
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<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>15</td>
<td>315</td>
<td></td>
<td>343</td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>C7</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
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<td></td>
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<td>(blank)</td>
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<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
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<td>12</td>
<td></td>
<td>30</td>
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<tr>
<td>Total</td>
<td>154</td>
<td>2</td>
<td>158</td>
<td>127</td>
<td>41</td>
<td>8</td>
<td>806</td>
<td></td>
<td>1,428</td>
</tr>
</tbody>
</table>

**B1. Permanent rivers and streams**

96% of the AE’s in this DIWA class were attributed with the SAAE class Permanent Reach.

**B2. Seasonal and irregular rivers and streams**

87% of the AE’s in this DIWA class were attributed with the SAAE class Ephemeral Reach. 5% were attributed as Permanent Reaches and 5% as Seasonal Reaches.

**B3. Inland deltas**

Of the two aquatic ecosystems recorded with this DIWA type, one was attributed with the SAAE class Permanent Lake and the other as a Temporary Wetland.

**B4. Riverine Floodplains; includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna**

97% of the AE’s in this DIWA class were attributed with the SAAE class Temporary Wetland.

**B5. Permanent freshwater lakes (> 8 ha) includes large oxbow lakes**

86% of the AE’s in this DIWA class were attributed as SAAE class Permanent Lake.
B6. Seasonal/intermittent freshwater lakes (> 8 ha), floodplain lakes
62% of the AE’s in this DIWA class were attributed as SAAE class Temporary Wetland, with 24% attributed as Permanent Lake and 14% as Saline Swamp.

B7. Permanent saline / brackish lake
Two records (100%) of this DIWA class were attributed with the SAAE class Saline Swamp.

B8. Seasonal/intermittent saline lake
83% of the AE’s in this DIWA class were attributed with the SAAE class Temporary Wetland and 3 records (17%) were attributed as Saline swamp.

B9. Permanent freshwater ponds (< 8 ha)
44% of the AE’s in this DIWA class were attributed with the SAAE class Permanent Lake, 48% as Permanent Swamp, 7% as Temporary Wetland. A small number of records were also attributed as Permanent Reach and Saline Swamp.

B10. Seasonal/intermittent freshwater ponds and marshes
93% of the AE’s in this DIWA class were attributed with the SAAE class Temporary Wetland, 4% as Permanent Lake, 3% as Permanent Swamp and 3% as Saline Swamp.

B11. Permanent saline / brackish marshes
37.5% of the AE’s in this DIWA class were attributed with the SAAE class Saline Swamp, 37.5% as Permanent Lake and 25% as Temporary Wetland.

B12. Seasonal saline marshes
92% of the AE’s in this DIWA class were attributed with the SAAE class Temporary Wetland, 4% as Saline Swamp and 3% as Ephemeral Reach.

C1. Water storage areas, reservoirs, barrages, generally > 8 ha
There was one record in this DIWA class, and it was attributed as a Saline Swamp.

C2. Farm ponds, stock ponds and small tanks
There were 5 records in this DIWA class, all attributed as Permanent Lakes.

C6. Sewage farms, settling ponds, oxidation basins
There was one record in this DIWA class, and it was attributed as a Temporary Wetland.

C7. Irrigated Land, rice fields, canals, ditches
There were two records, one was attributed with Permanent Reach, the other as a Seasonal Reach.
4. Discussion

The following section discusses the main issues associated with limitations or results of the project – in no particular order:

The SAAE typology has been shown to be effective in this region of South Australia. In addition, this project has identified that further breakdowns of some types is relevant to distinguish finer variation at a more local scale. For example, with so many temporary wetlands, providing summaries that differentiate by hydrology provides greater detail on extant ecosystem function and habitat distribution.

The low number of Floodplain wetland types is due to the floodplain itself not being included in the wetland mapping. This definition is one being reviewed by this and other projects as mentioned in section 2.2.

The Permanent Swamp type was added to the SAAE classification to differentiate between permanent wetlands with emergent aquatic vegetation, and permanent wetlands without vegetation. This differentiation is more about the depth of the wetland, with deep permanent wetlands functioning differently to shallow permanent wetlands, but depth is not an easy attribute to apply in this area given the lack of bathymetry data available. Vegetation has therefore been used as a surrogate for depth, with deep wetlands assumed to be less likely to support emergent aquatic vegetation.

The Saline Swamp aquatic ecosystems generally reflect areas used as evaporation basins.

Salinity was difficult to attribute given the lack of consistently available data. This attribute could also benefit from a more explicit definition. It is defined as the salt concentration in the water of the aquatic ecosystem, and has been applied with the broad salinity ranges of the wetland in the ‘wet’ phase, not after drawdown. A comprehensive dataset of salinity was not available, and in any case, salinity varies over time as well as within some aquatic ecosystems. Point data of salinity readings were used with caution due to the spatial and point-in-time constraints of the data. Surrogates for salinity were found in the vegetation mapping, but this is less likely to be accurate for larger polygons. Changes to the classification saw the fresh and brackish salinity ranges grouped together with only the Saline Swamp type using a single salinity range as a defining feature.

The terms Artificial, Regulated and Managed wetlands may need to be revisited to see if their use is appropriate. Artificial wetlands have been recorded as those wetlands which have been significantly altered from their natural state in terms of their hydrology, morphology or water source and include marinas and evaporation basins. Managed wetlands have been recorded as those whose water regime has been manipulated through water control structures holding back water either from entering or exiting the wetland, in order to extend a period of inundation or temporarily dry out a permanently inundated wetland. Regulated watercourses have been recorded as those watercourses that contain a water control structure.
The DIWA and SAAE wetland types are not sufficiently similar to each other to be directly comparable.

Twenty-four aquatic ecosystems have been added to the original wetland mapping and attributed with a wetland type, but because they were not in the original dataset for the Wetlands Prioritisation project, and do not have ecological attributes collected for them, they have not received a conservation-threat rank. This will be addressed through the revised WP being scoped as mentioned in section 2.8.1.

The Lower Lakes and Tributaries geomorphic reach is not included in the prioritisation process as the SAAE wetland type has not been assigned to these wetlands. This is a work in progress being negotiated by the SAMDB NRM Board and Coorong, Lower Lakes and Murray Mouth Murray Futures program. In the first instance, due to drastic changes in that ecosystems hydrology and its management, a revision of wetland geometry is required.

5. Recommendations

1) The wetlands mapping requires completing through inclusion of floodplain identifiers. This is a key data layer that is now quite well advanced but could be improved over time to ensure that it robustly supports management of the floodplain. For completeness and in the context of South Australian aquatic ecosystem mapping – this makes sense. It would also allow a standard way of defining and naming floodplains as areas of potential or active management. The development of the Management Action Database provides an ideal vehicle for defining and managing this key data layer into the future.

2) In terms of species observation and hydrologic monitoring records, comprehensive data management for long term storage and access should be high on the agenda for Murray Futures. This must consider existing SA Government data stores, complex requirements of data curation into the future such as taxonomy and statutory requirements for data sharing and supply to commonwealth agencies. In the first instance this should include provision of funds to collate existing data (such as baseline surveys) one time only, such that future applications and research draws on a consolidated database of consistent data standards.

3) A discussion of whether the wetland types identified represent the full range of wetland types in the River Murray corridor would validate the findings of this project. In addition, a task could be funded to verify the SAAE types with known biological and survey data.

4) Maintain a list of AUSWET_NR's of managed wetlands. This process highlighted that while a managed ‘site’ may be known by a certain name, the full complement of ‘polygons’ associated with environmental water delivery can be comprehensively described and mapped using AUSWET_NR identifiers.

5) The SAAE and WP methods should be pursued in the Lower Lakes and Tributaries geomorphic reach, as well as for floodplains when they have been adequately mapped. The WP method should still yield sensible results in these areas with respect to conservation values. Threat rankings may need further scrutiny to ensure appropriate processes for the AE types are considered.

6) For rareness and representativeness, the artificial wetlands should be excluded from the conservation threat outputs, as some have been assigned a conservation-threat ranking of CT1.
7) Use of this project’s WP outputs should be propagated to other projects with care and in due consideration with the final implementation of data improvements discussed in section 2.8 (as well as data entry recommended in 2 above).

6. Conclusion
This project has demonstrated that the South Australian Aquatic Ecosystem Classification can be applied to aquatic ecosystems in the River Murray, and has resulted in twelve different wetland types being identified. This includes five (state level) wetland types which were further divided into nine sub-classes, and three watercourse types. The division into sub-classes demonstrates that the SAAE Classification can be augmented at the regional scale by including other relevant attributes of differentiation.

The revised methodology of the Wetlands Prioritisation project has increased (tripled) the number of aquatic ecosystems with a high conservation value and low threats. This is most likely due to the changes to the input data resulting from the (interim) alterations to the methodology, as discussed in section 3.2. All of the aquatic ecosystems on the original list of wetlands ranked as high priority for protection also occur on the current list of aquatic ecosystems with a conservation-threat rank of CT1 (high conservation value and low threat).

While this review of AE classes has successfully recast understanding of ecosystem function throughout the floodplain from the DIWA view, it is issues of data collection and parameter definition that still require resolution for final outputs of the Wetland Prioritisation methodology to take hold. The WP project commenced with a slightly different focus on what it was informing – altered governance and funding models of river management have added new aspects to the use of its outcomes. Dropping the feasibility part has ensured the focus returns to the distinct outputs of conservation value and threats, while acknowledging usefulness of their combination as well.

Data management, of both recent historical baselines and current/future monitoring is critical to our ability to rerun this method and incrementally improve our understanding and prioritisation of aquatic ecosystem management through delivery of environmental water. Opportunities exist to draw on current developments of integrated information systems such as the Management Action database but smart money will need to be spent on properly collating data we already have to ensure this (and other) methods are fed by the best available source data, now and in the future.
7. References


Soil and Land Program (2009). Landscapes and soils of southern South Australia - spatial data and land resource information. [DVD ROM]. Department of Water Land and Biodiversity Conservation, South Australia.
## 8. Appendices

### 8.1. Appendix A: Metadata

<table>
<thead>
<tr>
<th>Spatial layer</th>
<th>scale / source</th>
<th>Capture Dates</th>
<th>Custodian</th>
</tr>
</thead>
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<td>1992-2001</td>
<td>DEH – Information, Science and Technology</td>
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<tr>
<td>South Australian Vegetation</td>
<td>Variable</td>
<td>2000-2008</td>
<td>DEH – Information, Science and Technology</td>
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<tr>
<td>Mapping</td>
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<td>Salinity Threat</td>
<td>30m pixels from groundwater</td>
<td>2006</td>
<td>DEH – Information, Science and Technology</td>
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<tr>
<td>Model outputs</td>
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<td>2006</td>
<td>CSIRO Land and Water</td>
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</tr>
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<td>SA MDB Board</td>
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## Appendix B: SAMDB relevant Aquatic Ecosystems Classification Version 7

### AE CLASSIFICATION ATTRIBUTES

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<th>Wetland type (INLAND &amp; NOT instream)</th>
<th>Climate* (Koppen)</th>
<th>Landscape setting</th>
<th>Instream type</th>
<th>Hydrological connectivity</th>
<th>Water source</th>
<th>Water regime: Inflows</th>
<th>Water regime: Persistence</th>
<th>Salinity</th>
<th>Vegetation presence</th>
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<tbody>
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<td>WC / Anab / Sp</td>
<td>Conn</td>
<td>All</td>
<td>P</td>
<td>P</td>
<td>Fresh / Brack</td>
<td>All</td>
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<td>T / G Hill / Fl B Micro / Macro / Micro / Lepto</td>
<td>WC / Anab / Sp</td>
<td>Semi</td>
<td>All</td>
<td>I</td>
<td>All</td>
<td>Saline / Hyper</td>
<td>Unveg</td>
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<td><strong>Permanent swamp - Terminal Branch</strong></td>
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<td>WC / Anab / Sp</td>
<td>Term</td>
<td>All</td>
<td>P</td>
<td>P</td>
<td>Fresh / Brack</td>
<td>All</td>
<td>Unveg</td>
</tr>
<tr>
<td><strong>Permanent swamp - Throughflow</strong></td>
<td>T / G Hill / Fl B Micro / Macro / Micro / Lepto</td>
<td>WC / Anab / Sp</td>
<td>Thru</td>
<td>All</td>
<td>P</td>
<td>P</td>
<td>Fresh / Brack</td>
<td>All</td>
<td>Unveg</td>
</tr>
</tbody>
</table>
| **Floodplain**                      | T / G / T Fl T B Micro / Macro / Micro / Lepto | Micro-S / Macro-C | Over | All | SW | SW | Fresh / Brack | All | Veg /
| **Saline Swamp**                    | G / T Fl B Micro / Macro / Micro / Lepto | M-S / M-C | Semi | All | I | All | Saline / Hyper | Unveg |
| **Temporary wetlands - Overbank Flow** | G / T Fl B Micro / Macro / Micro / Lepto | M-S / M-C | Over | All | SW | SW | Fresh / Brack | All | Veg /
| **Temporary wetlands - Terminal Branch** | G / T Fl B Micro / Macro / Micro / Lepto | M-S / M-C | Term | All | SW | SW | Fresh / Brack | All | Veg /
| **Temporary wetlands - Throughflow** | G / T Fl B Micro / Macro / Micro / Lepto | M-S / M-C | Thru | All | SW | SW | Fresh / Brack | All | Veg /

### Watercourse type (INSTREAM)

<table>
<thead>
<tr>
<th>Watercourse type</th>
<th>Climate* (Koppen)</th>
<th>Landscape setting</th>
<th>Insream type</th>
<th>Hydrological connectivity</th>
<th>Water source</th>
<th>Water regime: Inflows</th>
<th>Water regime: Persistence</th>
<th>Salinity</th>
<th>Vegetation presence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Permanent reach</strong></td>
<td>G / T All</td>
<td>WC / Anabr</td>
<td>Conn</td>
<td>All</td>
<td>P</td>
<td>P</td>
<td>Fresh / Brack</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td><strong>Seasonal reach</strong></td>
<td>G / T All</td>
<td>WC / Anabr</td>
<td>Semi</td>
<td>All</td>
<td>SW</td>
<td>E</td>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ephemeral reach</strong></td>
<td>G / All</td>
<td>WC / Anabr</td>
<td>Semi</td>
<td>All</td>
<td>SW</td>
<td>E</td>
<td>All</td>
<td></td>
<td></td>
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</tbody>
</table>
### Appendix C: South Australian Aquatic Ecosystems Classification Version 7

<table>
<thead>
<tr>
<th>Wetland type (RIVERS &amp; NOT instream)</th>
<th>Landscape setting</th>
<th>Landform</th>
<th>Size / scale</th>
<th>Substrate</th>
<th>Hydrology</th>
<th>Water source</th>
<th>Water regime</th>
<th>Persistence</th>
<th>Salinity</th>
<th>Vegetation presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lac: Inland lakes</td>
<td>L</td>
<td>D</td>
<td>Flat</td>
<td>0.01ha - 1ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Permanent</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Lac: Shore lakes</td>
<td>AL</td>
<td>D</td>
<td>Flat</td>
<td>5 - 10ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Lac: Salt lakes</td>
<td>SL</td>
<td>D</td>
<td>Flat</td>
<td>10 - 100ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Lac: Terminal lakes</td>
<td>LT</td>
<td>D</td>
<td>Flat</td>
<td>&gt;100ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Pal: Permanent rivers</td>
<td>PR</td>
<td>D</td>
<td>Flat</td>
<td>0.01ha - 1ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Pal: Seasonal rivers</td>
<td>SR</td>
<td>D</td>
<td>Flat</td>
<td>&lt;0.01ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Pal: Floodplains</td>
<td>FP</td>
<td>D</td>
<td>Flat</td>
<td>1 - 10ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
</tr>
<tr>
<td>Pal: Other wetlands</td>
<td>OW</td>
<td>D</td>
<td>Flat</td>
<td>0.01ha - 1ha</td>
<td>Meso</td>
<td>Semi</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Unveg</td>
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### Watercourse type (INSTREAM)

<table>
<thead>
<tr>
<th>Watercourse type (INSTREAM)</th>
<th>Climate* (Koppen)</th>
<th>Landscape setting</th>
<th>Isolom type</th>
<th>Hydrological connectivity</th>
<th>Water source</th>
<th>Water regime</th>
<th>Inflows</th>
<th>Persistence</th>
<th>Salinity</th>
<th>Vegetation presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riv: Permanent reach</td>
<td>PW</td>
<td>G</td>
<td>Flat</td>
<td>Semi</td>
<td>Always connected; Freshwater connected</td>
<td>Fresh</td>
<td>Permanent</td>
<td>Fresh</td>
<td>Fresh</td>
<td>Fresh</td>
</tr>
<tr>
<td>Riv: Seasonal reach</td>
<td>SW</td>
<td>G</td>
<td>Flat</td>
<td>Semi</td>
<td>Always connected; Freshwater connected</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Fresh</td>
<td>Fresh</td>
</tr>
<tr>
<td>Riv: Ephemeral reach</td>
<td>ER</td>
<td>G</td>
<td>Flat</td>
<td>Semi</td>
<td>Always connected; Freshwater connected</td>
<td>Fresh</td>
<td>Ephemeral</td>
<td>Fresh</td>
<td>Fresh</td>
<td>Fresh</td>
</tr>
<tr>
<td>Riv: Subterranean wetlands</td>
<td>SWT</td>
<td>G</td>
<td>Flat</td>
<td>Semi</td>
<td>Always connected; Freshwater connected</td>
<td>Fresh</td>
<td>Semi</td>
<td>Fresh</td>
<td>Fresh</td>
<td>Fresh</td>
</tr>
</tbody>
</table>

### Estuary type (INSTREAM/MARINE interface)

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<th>Climate* (Koppen)</th>
<th>Landscape setting</th>
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<th>Hydrological connectivity</th>
<th>Water source</th>
<th>Wave / tidal</th>
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<tr>
<td>Est: Wave-dominated systems</td>
<td>WDE</td>
<td>G</td>
<td>Flat</td>
<td>High efficiency; Sand</td>
<td>racks</td>
<td>Freshwater connected</td>
</tr>
<tr>
<td>Est: Tidal-dominated systems</td>
<td>TDE</td>
<td>G</td>
<td>Flat</td>
<td>High efficiency; Sand</td>
<td>racks</td>
<td>Freshwater connected</td>
</tr>
</tbody>
</table>

### Other

- Landscape
- Climate (Koppen)
8.4. Appendix D: Attribution of the wetland type using SQL queries

**Permanent Reach**

```
[(CLU_G) =1 OR (CLU_T) =1] AND
([LS_SL] =1 OR [LS_FL] =1) AND
([IST_WC] =1 OR [IST_ANAB] =1 OR [IST_SP] =1) AND
([HYC_CONN] =1) AND
([WRI_P] =1) AND
([WRP_P] =1) AND
([SAL_FRESH] =1 OR [SAL_BRACK] =1)
```

**Seasonal Reach**

```
[(CLU_G) =1 OR (CLU_T) =1] AND
([IST_WC] =1 OR [IST_ANAB] =1 OR [IST_SP] =1) AND
([HYC_SEMI] =1) AND
([WRI_S] =1) AND
([WRP_A] =1)
```

**Ephemeral Reach**

```
[(CLU_D) =1 OR (CLU_G) =1] AND
([IST_WC] =1 OR [IST_ANAB] =1) AND
([HYC_SEMI] =1) AND
([WS_SW] =1) AND
([WRI_E] =1) AND
([WRP_A] =1)
```

**Permanent Lake - Terminal Branch**

```
[(CLU_T) =1 OR (CLU_G) =1] AND
([LS_HILL] =1 OR [LS_FL] =1) AND
([LF_B] =1) AND
([SCL_MACRO] =1 OR [SCL_MESO] =1 OR [SCL_MICRO] =1 OR [SCL_LEPTO] =1) AND
([SUB_BED] =1 OR [SUB_MS] =1 OR [SUB_MC] =1) AND
([HYD_TERM] =1) AND
([WS_LR] =1 OR [WS_SW] =1 OR [WS_GW] =1) AND
([WRI_P] =1) AND
([WRP_P] =1) AND
([SAL_FRESH] =1) AND ([SAL_BRACK] =0 AND [SAL_SAL] =0) AND
([VEG_UNVEG]) =1)
```

**Permanent Lake - Throughflow**

```
[(CLU_T) =1 OR (CLU_G) =1] AND
([LS_HILL] =1 OR [LS_FL] =1) AND
([LF_B] =1) AND
([SCL_MACRO] =1 OR [SCL_MESO] =1 OR [SCL_MICRO] =1 OR [SCL_LEPTO] =1) AND
```
( [SUB_BED] =1 OR [SUB_MS] =1 OR [SUB_MC] =1) AND
( [HYD_THRU] =1) AND
( [WS_LR] =1 OR [WS_SW] =1 OR [WS_GW] =1) AND
( [WRI_P] =1) AND
( [WRP_P] =1) AND
( [SAL_FRESH] =1) AND ([SAL_BRACK] =0 AND [SAL_SAL] =0) AND
( [VEG_UNVEG] ) =1")

Permanent Swamp – Terminal Branch

"([CLI_T] =1 OR [CLI_G] =1) AND
( [LS_HILL]=1 OR [LS_FL] =1) AND
( [LF_B] =1) AND
( [SCL_MACRO]=1 OR [SCL_MESO] =1 OR [SCL_MICRO] =1 OR [SCL_LEPTO] = 1) AND
( [SUB_BED] =1 OR [SUB_MS] =1 OR [SUB_MC] =1) AND
( [HYD_TERM] =1) AND
( [WS_LR] =1 OR [WS_SW] =1 OR [WS_GW] =1) AND
( [WRI_P] =1) AND
( [WRP_P] =1) AND
( [SAL_FRESH] =1 AND [SAL_BRACK] =0 AND [SAL_SAL] =0) AND
[VEG_VEG] =1")

Permanent Swamp – Throughflow

"([CLI_T] =1 OR [CLI_G] =1) AND
( [LS_HILL]=1 OR [LS_FL] =1) AND
( [LF_B] =1) AND
( [SCL_MACRO]=1 OR [SCL_MESO] =1 OR [SCL_MICRO] =1 OR [SCL_LEPTO] = 1) AND
( [SUB_BED] =1 OR [SUB_MS] =1 OR [SUB_MC] =1) AND
( [HYD_THRU] =1) AND
( [WS_LR] =1 OR [WS_SW] =1 OR [WS_GW] =1) AND
( [WRI_P] =1) AND
( [WRP_P] =1) AND
( [SAL_FRESH] =1 AND [SAL_BRACK] =0 AND [SAL_SAL] =0) AND
[VEG_VEG] =1")

Floodplain

"([LS_FL] =1) AND
([LF_FL] =1) AND
( [SCL_MACRO] =1 OR [SCL_MESO] =1 OR [SCL_MICRO] =1 OR [SCL_LEPTO] =1) AND
( [SUB_MS] =1 OR [SUB_MC] =1) AND
( [HYD_OVER] =1) AND
([WS_SW] =1) AND
([WRI_P] =0) AND
([WRP_A] =1) AND
Saline Swamp

\[
\text{VEG\_UNVEG} = 1)\]

\[
(\text{CLI\_G} = 1 \text{ OR } \text{CLU\_T} = 1) \text{ AND } \\
(\text{LS\_FL} = 1) \text{ AND } \\
(\text{LF\_B} = 1) \text{ AND } \\
(\text{SCL\_MACRO} = 1 \text{ OR } \text{SCL\_Meso} = 1 \text{ OR } \text{SCL\_Meso\_Micro} = 1 \text{ OR } \text{SCL\_Lepto} = 1) \text{ AND } \\
(\text{SUB\_MS} = 1 \text{ OR } \text{SUB\_MC} = 1) \text{ AND } \\
(\text{HYD\_OVER} = 1) \text{ AND } \\
(\text{WS\_LR} = 1 \text{ OR } \text{WS\_GW} = 1) \text{ AND } \\
(\text{WRI\_P} = 0) \text{ AND } \\
(\text{WRP\_A} = 1) \text{ AND } \\
(\text{SAL\_SAL} = 1) \text{ AND } \\
(\text{VEG\_UNVEG} = 1)\]

Temporary Wetland - Overbank Flow

\[
(\text{CLI\_G} = 1 \text{ OR } \text{CLU\_T} = 1) \text{ AND } \\
(\text{LS\_FL} = 1) \text{ AND } \\
(\text{LF\_B} = 1) \text{ AND } \\
(\text{SCL\_MACRO} = 1 \text{ OR } \text{SCL\_Meso} = 1 \text{ OR } \text{SCL\_Meso\_Micro} = 1 \text{ OR } \text{SCL\_Lepto} = 1) \text{ AND } \\
(\text{SUB\_MS} = 1 \text{ OR } \text{SUB\_MC} = 1) \text{ AND } \\
(\text{HYD\_OVER} = 1) \text{ AND } \\
(\text{WS\_LR} = 1 \text{ OR } \text{WS\_SW} = 1) \text{ AND } \\
(\text{WRI\_P} = 0) \text{ AND } \\
(\text{WRP\_A} = 1) \text{ AND } \\
(\text{SAL\_FRESH} \text{ OR } \text{SAL\_BRACK} = 1) \]

Temporary Wetland - Terminal Branch

\[
(\text{CLI\_G} = 1 \text{ OR } \text{CLU\_T} = 1) \text{ AND } \\
(\text{LS\_FL} = 1) \text{ AND } \\
(\text{LF\_B} = 1) \text{ AND } \\
(\text{SCL\_MACRO} = 1 \text{ OR } \text{SCL\_Meso} = 1 \text{ OR } \text{SCL\_Meso\_Micro} = 1 \text{ OR } \text{SCL\_Lepto} = 1) \text{ AND } \\
(\text{SUB\_MS} = 1 \text{ OR } \text{SUB\_MC} = 1) \text{ AND } \\
(\text{HYD\_TERM} = 1) \text{ AND } \\
(\text{WS\_LR} = 1 \text{ OR } \text{WS\_SW} = 1) \text{ AND } \\
(\text{WRI\_P} = 0) \text{ AND } \\
(\text{WRP\_A} = 1) \text{ AND } \\
(\text{SAL\_FRESH} \text{ OR } \text{SAL\_BRACK} = 1) \]

Temporary Wetland - Throughflow

\[
(\text{CLI\_G} = 1 \text{ OR } \text{CLU\_T} = 1) \text{ AND } \\
(\text{LS\_FL} = 1) \text{ AND } \\
(\text{LF\_B} = 1) \text{ AND } \\
(\text{SCL\_MACRO} = 1 \text{ OR } \text{SCL\_Meso} = 1 \text{ OR } \text{SCL\_Meso\_Micro} = 1 \text{ OR } \text{SCL\_Lepto} = 1) \text{ AND } \\
(\text{SUB\_MS} = 1 \text{ OR } \text{SUB\_MC} = 1) \text{ AND } \"]
( [HYD_THRU] = 1) AND
((WS_L] = 1 OR [WS_SW] = 1) AND
([WRI_P] = 0) AND
([WRP_A] = 1) AND
( [SAL_FRESH] OR [SAL_BRACK] = 1) )
## Appendix E: Managed, Artificial and Regulated Aquatic Ecosystems

The following list has been generated from the mapped polygons and their managed status as captured through conversations with NRM and DEH staff.

<table>
<thead>
<tr>
<th>Name</th>
<th>Complex</th>
<th>AUS_WETNR</th>
<th>Managed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BANROCK SWAMP</td>
<td>BANROCK COMPLEX</td>
<td>S0001660</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>BELDORA WETLANDS</td>
<td>SPECTACLE LAKES COMPLEX</td>
<td>S0000926</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>BELDORA WETLANDS</td>
<td>SPECTACLE LAKES COMPLEX</td>
<td>S0000928</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>BREND A PARK</td>
<td>BREND A PARK AND MORPHETT FLAT</td>
<td>S0000547</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>BREND A PARK</td>
<td>BREND A PARK AND MORPHETT FLAT</td>
<td>S0001759</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>CAUSEWAY LAGOON</td>
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<td>HART LAGOON</td>
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<td>JAESCHKE LAGOON</td>
<td>ROSS AND JAESCHKE LAGOONS COMPLEX</td>
<td>S0001664</td>
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<tr>
<td>LAKE BONNEY COMPLEX</td>
<td>LAKE BONNEY COMPLEX</td>
<td>S0001058</td>
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</tr>
<tr>
<td>LAKE LIMBRA</td>
<td>CHOWILLA COMPLEX</td>
<td>S0001621</td>
<td>Managed wetland</td>
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<tr>
<td>LAKE LITTRA</td>
<td>CHOWILLA COMPLEX</td>
<td>S0001626</td>
<td>Managed wetland</td>
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<td>LAKE MERRETI</td>
<td>RAL RAL COMPLEX</td>
<td>S0000466</td>
<td>Managed wetland</td>
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<tr>
<td>LAKE WOOLPOOLOL</td>
<td>RAL RAL COMPLEX</td>
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<td>Managed wetland</td>
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<td>LITTLE DUCK LAGOON</td>
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<td>S0002020</td>
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<td>LOCK 6 DEPRESSION</td>
<td>PILBY COMPLEX</td>
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<td>MARTIN BEND COMPLEX</td>
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<td>MURBKO SOUTH</td>
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<td>MURBPOOK LAGOON COMPLEX</td>
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<td>KATARAPKO GAME RESERVE COMPLEX</td>
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<td>OLD LOXTON ROAD LAGOON</td>
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<td>PILBY CREEK</td>
<td>PILBY COMPLEX</td>
<td>S0001974</td>
<td>Managed wetland</td>
</tr>
<tr>
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</tr>
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<td>CHOWILLA COMPLEX</td>
<td>S0000366</td>
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<td>S0016023</td>
<td>Managed wetland</td>
</tr>
<tr>
<td>RIVERGLADES</td>
<td>SELF-CONTAINED HYDROLOGICAL UNIT</td>
<td>S0016022</td>
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</tr>
<tr>
<td>ROSS LAGOON</td>
<td>ROSS AND JAESCHKE LAGOONS COMPLEX</td>
<td>S0001682</td>
<td>Managed wetland</td>
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<td>SCHILLERS LAGOON</td>
<td>NIGRA CREEK COMPLEX</td>
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<tr>
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<td>-------</td>
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<tr>
<td>SLANEY WEIR BILLABONG</td>
<td>CHOWILLA COMPLEX</td>
<td>S0000098</td>
<td>Managed wetland</td>
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### Appendices

#### Appendices

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#### Appendix H: Maps of SA River Murray Aquatic Ecosystems

8.8 Appendix H: Maps of SA River Murray Aquatic Ecosystems
Map 10a: Goolwa - Aquatic Ecosystems

NOTE: Results below Lock 1 reflect pre-2007 conditions

Produced by: NRM Science Research Centre
Map Projection: EPSG 3855 - Australian Zoned UTM
Map Datum: Geodetic Datum of Australia 1994

WETLAND TYPES
- Flood plain
- Saline swamp
- Permanent lake
- Terminal branch
- Throughflow
- Permanent swamp
- Terminal branch
- Throughflow
- Temporary wetland
- Overbank flow
- Terminal branch
- Throughflow

WATERCOURSE TYPES
- Permanent reach
- Seasonal reach
- Ephemeral reach

GEOMORPHIC REACHES
- Border to Overland Corner
- Overland Corner to Mannum
- Mannum to Wellington
- Lower Lakes and Tributaries

Coorong and Lakes Alexandrina and Albert Ramsar Reserve
Managed/regulated wetland
Artificial wetland
Wetland not assessed
1956 flood level
Built up area
Irrigated crop 2003
Native vegetation
Property boundary

LOCALLITY

ADELAIDE