



All about the barrages

Key messages

- There are different opinions on whether the Lower Lakes were predominantly freshwater, estuarine or saline before European settlement; however, the weight of evidence shows that the Lakes were mainly fresh, with short periods where some flows from the sea entered the Lakes.
- The barrages are not the only cause of ecological change in the Lower Lakes; decreased flows from upstream usage has a big impact.
- Removing the barrages might have some limited environmental benefits, for example, preventing acid sulphate soils in the Lower Lakes area during severe droughts. At the same time though, this would allow sea water to flow in causing drastic changes to the ecology. It would not return the environment to a 'natural state' without significant reduction in upstream water usage. A natural estuarine environment – where substantial quantities of fresh and sea water mix – would only be returned if the natural end-of-system flows were returned.
- Removal of the barrages would not reduce the need for freshwater flows into the lakes, which are not simply 'lost' to evaporation, but rather flush salt from the entire system and also provide baseflows for water delivery and environmental benefits along the entire river.

From its headwaters in the Australian Alps, the River Murray travels over 2,500 km to the Southern Ocean. In the final 100 km before entering the ocean, the river passes through Lake Alexandrina, the Murray Estuary and the Murray Mouth. Connected to Lake Alexandrina by a narrow channel is Lake Albert. These are the Lower Lakes, together holding approximately 2,000 GL of water, nearly four times that of Sydney Harbour. Between Lake Alexandrina, the Coorong and Goolwa Channel are barrages separating the River Murray from the sea. These are designed and operated to ensure the lakes and lower reaches of the river remain fresh, not only for environmental reasons but as a water supply source.

There are five barrages that separate Lake Alexandrina from the Goolwa Channel and the Coorong — Goolwa, Mundoo, Boundary Creek, Ewe Island and Tauwichee (see Figure 1).

The barrages maintain the river level between the Lower Lakes and Lock 1 at Blanchetown, a distance of about 250 km. Adelaide, parts of the mid-north, Yorke Peninsula and south-east South Australia depend on water pumped from this weir pool.

The water in this reach is also directly drawn for towns and agriculture around the Lower Lakes and River Murray up to Lock 1.



Photo: Tauwichee Barrage, Murray Mouth. Image: Peter Solness.



Figure 1: The barrages

What were the Lower Lakes like before European settlement?

There are a variety of views on what the Lower Lakes were like before European settlement; however, evidence shows that the lakes were predominantly fresh. This is because most of the time, flows of freshwater down the River Murray would have been sufficient to fill the lakes and keep seawater from creeping in.

Historical material from the 1800s (including stories from the Ngarrindjeri people, explorers' diaries, information from sealers and herdsmen and parliamentary submissions by settlers) shows that the Lower Lakes were mainly fresh. It is likely that when river flows were very low, there would have been areas around the Murray Mouth and towards Point Sturt in Lake Alexandrina where sea water would have flowed back into the lakes.

Microscopic analysis of single-celled algae (Diatoms) also provides evidence that in the 7,000 years since they were formed, the Lower Lakes would have been mainly fresh with rare seawater inflows.

Charles Sturt observed elevated salinity levels in the Lower Lakes during his 1829–30 expedition, when entering what is today known as Lake Alexandrina near Pomanda Island:

'Thus far, the waters of the lake had continued sweet; but on filling a can when we were abreast of this point, it was found that they were quite unpalatable, to say the least of them. The transition from fresh to salt water was almost immediate, and it was fortunate we made the discovery in sufficient time to prevent our losing ground. But, as it was, we filled our casks, and stood on, without for a moment altering our course'. (Sturt 1833)

The Murray–Darling Basin Authority has used computer models to simulate what the Lower Lakes might have been like before European settlement. The models confirm that when evaporation from the Lower Lakes was higher than freshwater inflows, saltwater flowing in from the ocean and Coorong resulted in periods of elevated salinity in the lakes. This, however, would not have been a regular occurrence — in 17% of years, net flows from the ocean into the Lower Lakes were less than 30 GL. In 12% of years, they were 30–70 GL and in only 5% of years were net ‘backflows’ over 70 GL. These flows are small volumes compared to the total volume of the Lower Lakes (around 1,900 GL), indicating that the lakes were predominantly freshwater systems. Actual volumes flowing in from the sea would have been larger due to tidal effects.

Timeline of policy relating to Lower Lakes management

1880s	Changes in the quality and quantity of River Murray inflows to the Lower Lakes became evident with increasing extractions upstream in New South Wales, Victoria and South Australia.
1890	South Australia's engineer-in-chief, Alexander Moncrieff, first raised the idea of barrages to control outflows to the sea and prevent seawater entering the river at times of low flows (Sim & Muller 2004)
1909	The Victorian Royal Commission on Murray Waters concluded: 'With regard to the riparian rights of lakeside land owners near the mouth that if in time barrages are required South Australia should construct them at her own expense' (Eaton 1945)
1915	The Commonwealth, New South Wales, South Australian and Victorian governments signed the River Murray Waters Agreement
1930	The River Murray Commission agreed to establish an inquiry into salinity levels in the Lower Lakes and the construction of barrages
1934	After a favourable report from the South Australian Parliamentary Standing Cttee on Public Works 1933, the River Murray Waters Agreement was amended to provide for the construction of five barrages
1940	Barrages completed.

Why were the barrages built?

From the 1880s the South Australian Government was concerned about maintaining fresh water supplies for stock, irrigation and domestic purposes for settlements along the lower Murray and around the Lower Lakes. There was concern that due to increasing use of water all along the river, flows would not be sufficient to keep the lakes fresh.

The government also wanted to ensure there was enough water in the River Murray to allow navigation for river boats (and therefore trade) between New South Wales, Victoria and South Australia.

For many years, and throughout several inquiries and commissions, the barrages scheme was generally not supported by the other states.

The River Murray Waters Agreement (1915) established the River Murray Commission and water sharing arrangements between New South Wales, South Australia and Victoria. It also provided for the construction of the storages, weirs and locks that regulate the river for irrigation and allow navigation. South Australia was provided with flows to protect the settlements along the lower River Murray as far as Wellington from salinity, but Lakes Alexandrina and Albert were excluded.

The barrages were not included in the original scheme of works for the River Murray. South Australia continued to lobby for their construction on the basis of increasing salinity with general support from local landholders keen to secure fresh water. Salinity had increased from allowing the Lower Lakes to support a Murray Cod fishery in the 1800s, to supporting a salt water fishery in the 1930s.

Opposing concerns were raised that the barrages may impede navigation and cause the siltation of the Murray Mouth. Goolwa fishermen thought the barrages would prevent fish entering the river and lakes and reduce their catch. Some landholders were worried that during floods, more land and river townships would be inundated as a result of the barrages maintaining elevated levels in the Lower Lakes.

After construction of the barrages, South Australia finally had the confidence to connect Adelaide's water supply to the River Murray downstream of Lock 1.

How do the barrages work?

The barrages are a series of 593 independent gates or stoplog bays across five structures – creating a barrier 7.6 km long. The barrages isolate the estuarine area (including the Coorong) from the Lower Lakes and artificially hold the lakes at higher than natural levels (about 0.75m above sea level).

Gates and stoplogs are opened progressively to pass the target flow to the sea. This target is calculated taking account of river inflows, rainfall, local catchment run-off, evaporation, consumptive use and required lake level. In many summer and autumn months — when river flows are low and

There are fishways in the barrages that allow fish movement between the River Murray, Lower Lakes, Coorong and Southern Ocean. The fishways on the Goolwa and Tauwichee barrages were constructed between 2004 and 2010. Further fishways are planned as part of South Australia's long-term plan for the site.

For context, the World Health Organisation recommends that drinking water be no more than 800 mg/L Total Dissolved Solids (TDS) = 1250 EC.

According to the Australian Drinking Water Guidelines 2011 drinking water above 1400 EC becomes poorly palatable (but without known health effects). See (http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines.pdf).

Seawater is around 54,000 EC. Some groundwater in the Murray can be more than 62,000 EC because of salts leaching into the water table.

evaporation and demand are high — all barrage openings are fully closed and there is no release from the lakes to the sea. During such times there can be a rapid accumulation of sand inside the Murray Mouth.

Why do the lakes get so salty?

Flows to the lower reaches have been altered by significant changes in the annual flow, the distribution of flow through the year, and the duration of low flow periods. For example, under natural conditions, the median flow to the sea at the Murray Mouth was 11,880 GL per annum. By 1994, the level had declined to 21% of the flow that occurred under natural conditions. Consequently, the Lower Murray now experiences drought-like flows in over 60% of years, compared with 5% under natural conditions (South Australian Parliament Select Committee report on the River Murray).

When the weather is dry and flows are low, salt accumulates on floodplains and in wetlands and rivers across the Murray–Darling Basin. It comes mainly from eroding rocks and agricultural runoff. The only way to get rid of salt from the Basin is by high enough flows from the River Murray flowing out through the Murray Mouth. Without flushing flows through the barrages, salt accumulates in the Lower Lakes. Flows are needed to flush this salt from the Basin regardless of whether the barrages are in place.

As the lakes are large and shallow, there is a lot of evaporation. When inflows are less than evaporative losses (such as in a drought), water levels fall quickly and salt delivered via the Murray concentrates. Typical salinity in Lake Alexandrina fluctuates between 1,205 and 2,138 EC (units of electrical conductivity). In March 2010 at the height of the recent drought and when there had been no salt export from the Basin for years, it reached 6,200 EC. In Lake Albert it rose from a typical 415–1,300 EC to 19,000 EC.

Arguments for/against the barrages

There is enthusiastic debate throughout the community on whether the barrages should be removed. This is an extremely complex issue, and there is not a scientific consensus; however, there is also much misinformation on the barrages. It is a highly political and emotive issue, which further 'muddies the waters'.

One of the common arguments for removing the barrages is that it will reinstate and stabilise the natural tidal estuary, reducing the need for freshwater to maintain water levels in the Lower Lakes. A variation on this argument is that, particularly in times of drought, removing the barrages to allow sea water in could also stop the lake levels from dropping to environmentally disastrous lows.

It is true that the construction of the barrages has significantly changed the ecology of the Coorong, Lower Lakes and Murray Mouth; particularly in times of drought. However, simply removing the barrages would not reinstate these original ecosystems. Firstly, we must factor in the effect of the development that has already taken place in the Basin. Water used for irrigation, agriculture and drinking has significantly reduced flows from what would have been the natural situation, and it is not practical or desirable to stop these activities.

During the recent drought, MDBA and the South Australian government considered opening the barrages to allow sea water to raise the levels in the lakes, in the absence of fresh water inflows. However, the available scientific studies indicated that there were serious potential risks to the environment in so doing – introducing large quantities of sea water to the Lower Lakes may cause some species to be lost and others to decline, depending on their tolerances. In addition, the new ecosystems that have established over the last 75-odd years since the barrages were constructed are of significant environmental value, and are protected by the international Ramsar convention.

*Some examples
of infrastructure
initiatives to address
environmental and
drinking water quality.*

- Irrigation and stock/ domestic pipelines were built in 2008-09 to reduce pumping directly from the Lower Lakes.
- Irrigation-delivery infrastructure has been rehabilitated along the Murray, with water savings returned to the environment through The Living Murray.
- A \$100m Riverine Recovery project investing in environmental infrastructure and relocation of pumps to the main river channel. This will reinstate wetting and drying cycles to the floodplain, rather than the permanent inundation currently caused by weir construction — reducing evaporative losses.

On the other hand, there are strong arguments for retaining the barrages. When inflows to the Lower Lakes are less than evaporation and consumption, releases to the sea are stopped and the lake levels fall. In such circumstances, such as in the recent prolonged drought from 2006 to 2009, the level in the Lower Lakes fell to -1.1m. At such times the barrages play an important role in preventing further salt entering the Lower Lakes from the ocean. Salt concentrations in the lakes could rise quite quickly to levels even higher than the ocean — which already occurs in the Coorong. At such high salinity levels, there is a risk of salty water moving up the River Murray (particularly if it is also windy), compromising the river environment and risking the potability of water supplies for much of South Australia.

In response to this argument, a weir directly above Lake Alexandrina near Wellington is sometimes proposed. Such a weir would be technically challenging because there is a lack of suitable foundations; meaning any permanent weir would be very expensive and its long-term integrity difficult to ensure. A temporary weir has been considered as an extreme drought measure only; designed to fail at relatively low river flows.

A healthy river system needs good flows all the way to the sea. The Murray–Darling Basin Authority’s modelling indicates that in most years, if flows are sufficient to meet environmental needs all along the River Murray, the same water would also be sufficient to export salt through the Murray Mouth with the barrages retained. That is, sufficient flows will occur to replace evaporative losses in the Lower Lakes, therefore maintaining water levels and healthy ecosystems, whether or not the barrages are in place.

In any case, there are many ways to help the ecosystems and environments of the Lower Lakes, Coorong and Murray Mouth that do not relate to removing the barrages or increasing flows. These are being explored by the Murray–Darling Basin Authority, the Basin state governments and a variety of other groups and people interested in improving the health of the region.

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