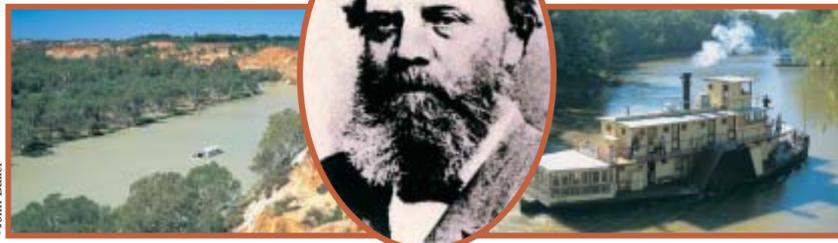
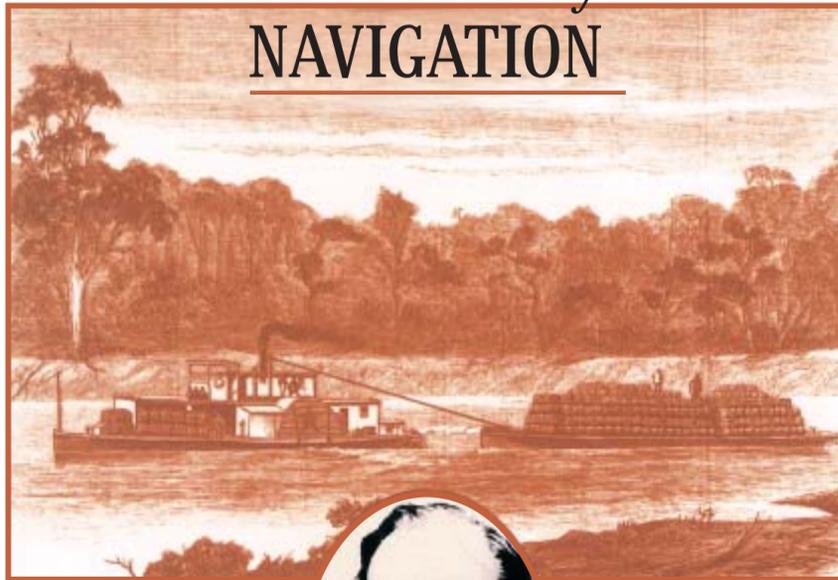
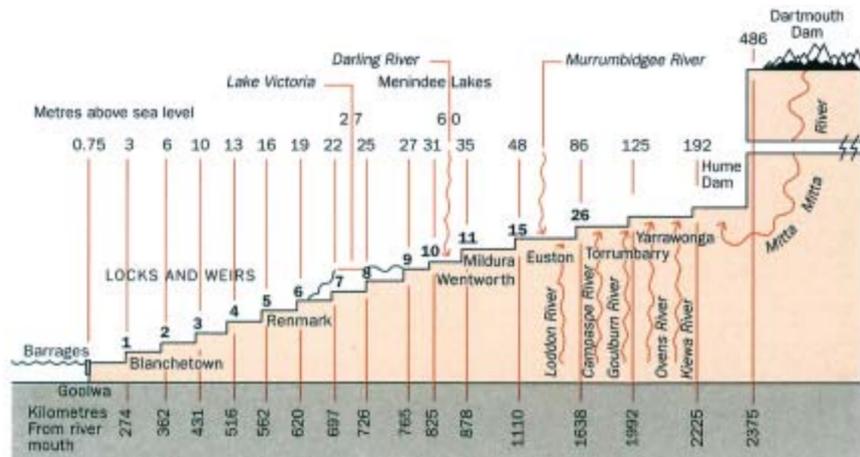


River Murray NAVIGATION



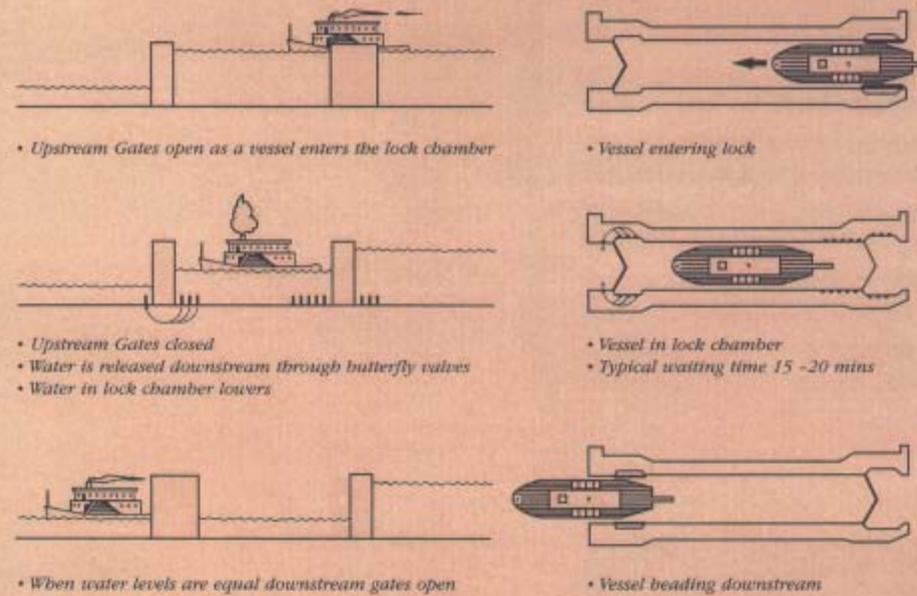
TOP: P.V. 'Hero' and barge; CENTRE: William Randell the first man to use a steam-powered boat on the River Murray; BOTTOM LEFT: The River Murray above Renmark, SA; BOTTOM RIGHT: P.V. 'Emmy Lou' cruises near Echuca.



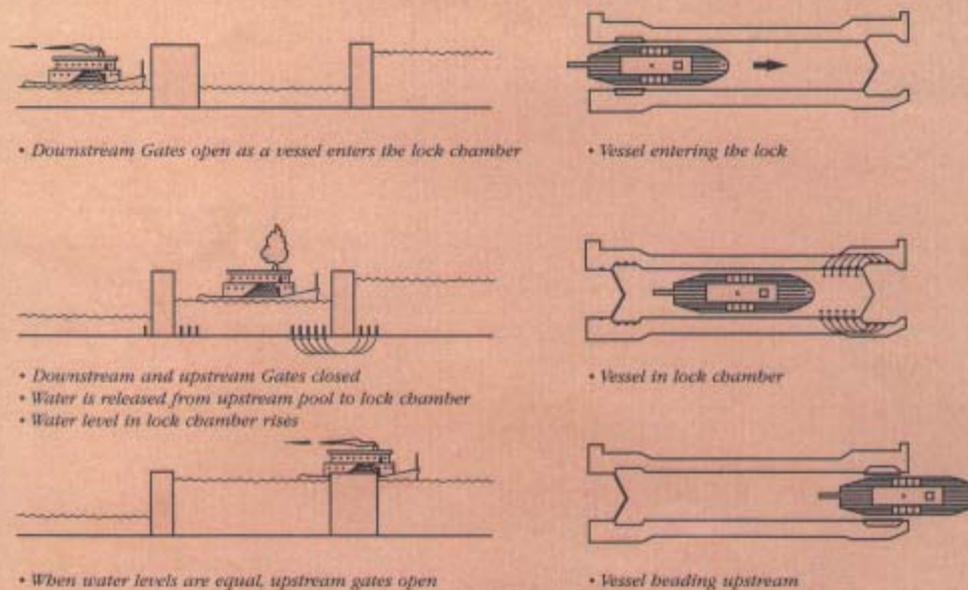
The River Murray System - Longitudinal Section

Passing through a lock

GOING DOWNSTREAM



GOING UPSTREAM



River Murray NAVIGATION



'Murray Princess' passes through Lock 1 at Blanchetown



The first navigation lock on the River Murray was completed at Blanchetown in South Australia in 1922.

The first navigation lock on the Murray-Darling system was constructed near Bourke on the Darling River in 1897. This lock served as the prototype for locks later constructed on the River Murray.

River Murray Navigation

The weirs and locks were originally constructed on the River Murray in the 1920s and 1930s to provide year-round navigation for commercial cargo and passenger paddle steamers. They were generally built too late to be of benefit to the river trade, as the development of railways and the growth of motorised road haulage had overtaken river transport. Today there are 13 navigation locks on River Murray weirs and two locks on the barrages at the Murray mouth.

They are maintained and operated for the Murray-Darling Basin Commission by the New South Wales, Victorian and South Australian Constructing Authorities to serve an increasing number of houseboats, tourist cruise boats and other recreational craft. The locks and weirs on the River Murray make an enormous contribution to the tourist industry in South Australia and Sunraysia.

The River Murray is permanently navigable from the Barrages to the top of the Mildura Weir pool, near Nangiloc, a distance of 970 kilometres from the mouth. The River Murray was permanently navigable in its natural state to Blanchetown in South Australia. Eleven weirs with locks, each raising the water level behind it by an average of 3.1 metres, create a continuous series of stepped pools from Blanchetown to Mildura. The River Murray upstream of Nangiloc, at the top of the Mildura weir pool, is only navigable during periods of high flow.

The first lock and weir on the River Murray was completed in 1922 at Blanchetown in South Australia, and the last was completed at Euston, near Robinvale, in 1937. The small locks on the barrages at the Murray mouth were completed in 1940. The original Torrumbarry weir, downstream of Echuca, was replaced with a new structure in 1966. However, the original lock chamber has been retained.

The decline in the river trade led to the abandonment, in 1934, of the construction of further weirs and locks purely for navigation purposes. Weirs at Maude and Redbank on the Murrumbidgee River and Yarrawonga on the River Murray were built during the 1930s for irrigation purposes, but did not include locks.

Passing Through a Lock

For a boat to pass downstream through the lock, the water inside the chamber must be at the same level as the top weir pool, to allow the gates to open. The top gates are opened by hydraulic powered arms to allow the boat to enter. The gates are closed behind the boat and the water in the lock chamber is released by opening large hydraulically operated butterfly valves just above lock gates. The butterfly valves are only slightly smaller than an average house door. Water

flows from the lock chamber, via tunnels, to the weir pool below. As the water level in the chamber drops, the boat is lowered with it, until equal to the level of the lower weir pool. The bottom gates are then opened and the boat continues on its way. The water levels in the locks are raised and lowered entirely by gravity; no pumps are used.

To travel upstream the reverse occurs. After the boat enters the lock chamber and the gates are closed behind it, valves are opened above the upstream gates to fill the chamber, via tunnels from the top weir pool. Water enters the chamber from the tunnels through ports spaced along the bottom of each wall. This is to distribute the inflowing water to minimise turbulence in the lock chamber as it fills. When the water level in the lock chamber is equal to the weir pool, the gates can be opened and the boat can proceed. It takes only 7 minutes to empty or fill the lock chamber but it normally takes 15 to 20 minutes to pass a boat through the lock. Six to eight medium houseboats can be accommodated in one lockage.

Lock Design

A lock is a simple design: a rectangular chamber of concrete with gates at each end. Locks have made permanent inland water transport possible, as they enable boats to move from one level to another without danger or loss of large quantities of water.

Locks similar to those of today were first used on the Grand Canal in China during the Eighth Century. In the Fifteenth Century, Leonardo da Vinci is reputed to have designed the first lock with the familiar pair of mitred swing gates at each end. This is the type of lock which is used on the River Murray. The gates close to form a 'V' against the current and upstream water pressure helps to keep them closed and make a watertight seal. The pressure of water within the lock chamber keeps the downstream gates closed.

The designs for the locks, and associated weirs on the River Murray, except Mildura and Torrumbarry, were developed by Captain E.N. Johnston of the United States Corps Engineers. Mildura weir and the first Torrumbarry weir were designed by John Dethridge of Dethridge wheel fame.

South Australia benefited considerably from river transport and wished to establish permanent navigation on the River Murray. In 1912, the South Australian Government engaged Captain Johnston to prepare a report on a scheme for the improvement of the River Murray by locks and weirs. In addition to his experience with the various types of locks and weirs on the navigable rivers in the United States, Captain Johnston was also familiar with the engineering aspects of European inland waterways.

The standard structure recommended by Captain

Johnston to assist in the navigation of the River Murray consisted of three parts:

- a lock chamber, for use by boats during normal flow periods
- a navigable pass consisting of steel collapsible trestles supporting Boulé shutters. This section is used by boats during periods of high flow, after the Boulé panels are withdrawn and the hinged trestles collapsed onto the floor of the channel
- a sluice selection consisting of openings between concrete piers which are normally closed by stop logs. The stop logs are removed during floods to minimise the interference to flow.

Lock Sizes

There are two sizes in the locks on the River Murray (not including the small locks on the barrages). Those upstream of the Darling junction are shorter than those between Blanchetown and Wentworth. The River Murray Commission adopted the larger lock below the Darling junction because of the greater traffic along that section of the river in the early 1920s. To reduce construction cost and because there was less traffic above the Darling junction, the smaller lock was adopted for Mildura, Euston and Torrumbarry weirs.

Following discussions and correspondence with people involved in navigation on the River Murray in 1912, the Engineer-in-Chief of South Australia, Mr Graham Stewart, instructed Captain Johnston on the approximate size requirements for the locks on the River Murray. The locks were to be

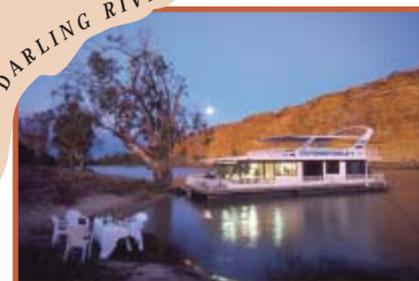
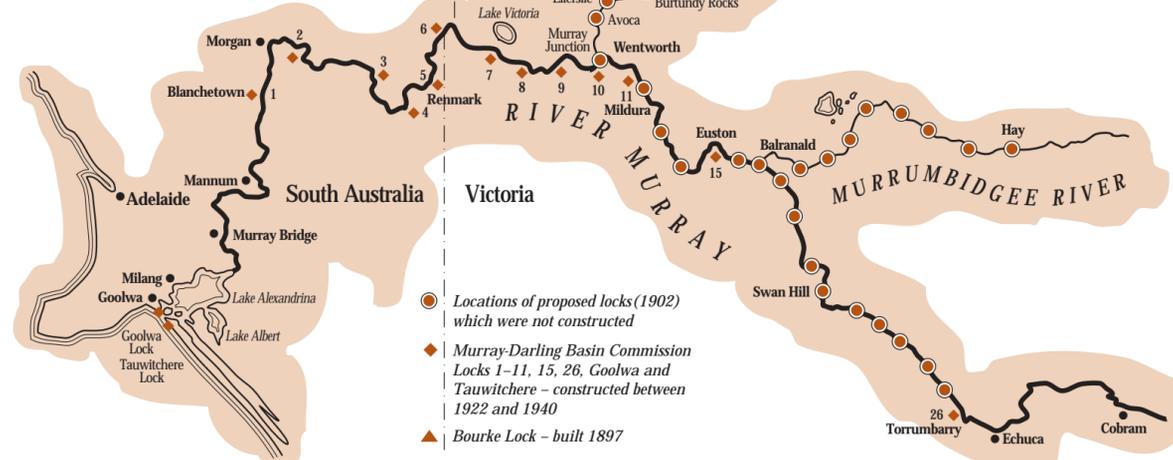
sufficient 'to accommodate one of the large steamers now in use and two of the large barges, probably abreast, at one lockage'. Alternatively if that size proved too costly 'a lock to pass vessels singly, but capable of being enlarged in the future, if necessary'.

With these instructions, Captain Johnston calculated the most suitable sizes for the lock, after a detailed study of the dimensions of the boats and barges operating on the River Murray at the time. The two sizes he recommended were:

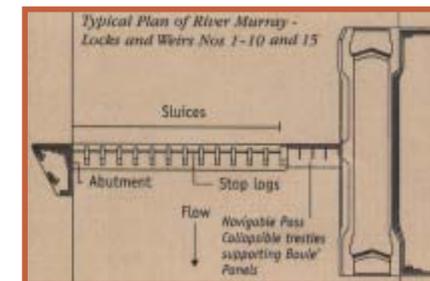
- a large lock, 56 feet by 275 feet (17 x 83 metres) which was 'large enough to contain two standard barges and one steamboat at one lockage ... with allowances for rudders and clearances at each end'.

This size was arrived at by using the dimensions of the steamer 'Ruby' (now being restored at Wentworth) which were 130.9 ft x 18.8 ft x 6 ft (39.7 x 5.7 x 1.8 metres), towing barges such as the 'Ukeek' and 'Emerald' 130 ft x 26 ft x 6.5 ft (39.4 x 7.9 x 2.0 metres).

The first lock and weir on the Murray was completed in 1922 at Blanchetown in South Australia and the last was completed at Euston, near Robinvale, in 1937.



Houseboat cruising is popular on the River Murray, especially in the Riverland and Sunraysia regions. Photo: courtesy of Unforgettable Houseboats, South Australia.



These were considered as the most suitable sized vessels for the Murray and Darling rivers.

- the smaller lock, 56 feet by 170 feet (17 x 51.5 metres); 'would pass at one lockage two suitable barges, or the largest barge, 'Crowie', alone. It would also pass any steamboat on the river alone at one lockage. Ordinarily, steamboats towing one or more barges would be locked through separately from the barges'.

The largest steamer on the river at the time was the 'Gem' (now at the Swan Hill Pioneer Settlement), which was 133.6 ft x 20.7 ft x 6.6 ft (40.5 x 6.3 x 2.0 metres), with a beam across the paddle-boxes of 35.6 ft (10.8 metres). The largest barge was the 'Crowie', which was 151 ft x 30 ft x 8 ft (45.8 x 9.1 x 2.4 metres), with the rudder an extra 8 ft (2.4 metres).

The overall dimensions of the lock chambers on the River Murray are slightly larger than those quoted by Johnston.

The largest boat operating on the River Murray today is

the tourist cruise boat PV 'Murray Princess' which is 67 metres long and 15 metres wide.

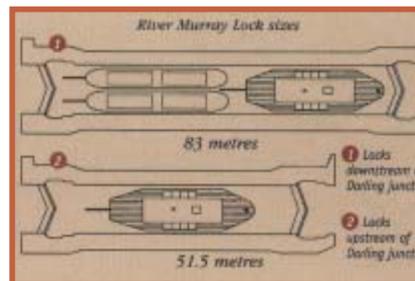
In addition to navigation, advantage is taken of the deep water stored in the weir pools for fishing, water skiing, power boating, canoeing and sailboard riding.

Upgrading Locks and Weirs

Over the years a number of components of the locks and weirs have been replaced to maintain them as contemporary assets, including concrete stoplogs, crane, lock gates and hydraulics and controls for lock gates.

In January 2003, construction works commenced at Locks 7 and 8 to upgrade the navigable pass sections of Weirs 1 to 10 and 15. Concurrent with these works, fishways will be constructed as part of a program to enable fish passage from 'the sea to the Hume Dam' (a distance of 2225 km).

When originally constructed, the navigable pass section complied with safety standards of the day. However, with the passage of years, community expectations have increased. In particular, the use of divers to assist



with re-establishment of the navigable pass following a flood has raised long-term safety concerns.

The upgrade of the navigable pass will eliminate the need for divers and enable the navigable pass to be removed and replaced using the existing lock crane. It has significant occupational health and safety benefits for lock operators as well as improving the structural integrity of the weir.

Fishways will be installed to make it possible for native fish species to migrate upstream past each weir at any time. The fishways consist of a series of interconnected pools. Fish from small juveniles to large adults will be able to swim from pool to pool as part of their upstream travel.

The fishway program is an important step in the long-term ecological recovery of the River Murray.

The upgrading program will be undertaken over the period 2003 to 2008, with work at any one lock and weir taking about 8 to 12 months.