The Institution of Engineers, Australia

# The ENGINEERING WORKS of the RIVER MURRAY

**Nomination for a**

**NATIONAL ENGINEERING LANDMARK**

**on the Centenary of Federation 2001**

**Institution of Engineers, Australia**

# September 2001

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## 1. INTRODUCTION

The River Murray is one of Australia's major rivers. It rises in the Snowy Mountains and flows westwards along the border between New South Wales and Victoria into South Australia. There it turns southward and eventually flows into the Great Australian Bight, a total distance of 2500km.

This great river provided an important water transport route and had the potential to "make the deserts bloom". However in its natural state the flow was much diminished during recurrent droughts, and the calls for some control over its vagaries grew persisted.

After decades of fruitless debate in colonial times, the newly-created Federal Government brokered an agreement with the three States in 1914 to construct a series of locks and weirs. These structures would facilitate navigation up to Echuca in Victoria and to Hay on the Murrumbidgee River in New South Wales. The weirs would create ponds of water from which pumps would deliver water for irrigation. In addition the flow in the river was to be made more reliable by the construction of two large storages, one in the headwaters (Hume Dam) and one near the South Australian border (Lake Victoria).

The decline in river traffic meant that not all the weirs and locks were built. Instead a series of barrages was constructed across the Murray mouth to exclude salt water from the lower reaches of the river. In 1961 and 1979 the storage capacity was greatly increased to expand the irrigation areas and improve long term reliability. All the works are included in this nomination.

## 2. NOMINATION FORM

To: Commemorative Plaque Sub-Committee
From: Sydney Division
Date: October 2001

The following work is nominated for an **National Engineering Landmark**

Name of work..... **RIVER MURRAY WORKS**

Location, including address and map grid reference if a fixed work.....**In south-eastern Australia, extending from the Snowy Mountains to the Great Australian Bight.**

Owner..... **Murray-Darling Basin Commission**

The owner has been advised of the nomination of the work and has given approval

..... **Copy of letter attached**

Access to site..... **By road in three States**

Future care and maintenance of the work.... **Will be maintained by three State authorities for the Murray Darling Basin Commission.**

Name of sponsor..... **Engineering Heritage Committee, Sydney Division**

……
Chairperson of Nominating Committee

……
Chairperson of Division Heritage Committee

## ADDITIONAL SUPPORTING INFORMATION

Name of work.....**RIVER MURRAY WORKS**

Year of construction or manufacture…**1914-1979**

Period of operation.....**Progressively since 1922**

Physical condition .....**Very good**

**Engineering Heritage Significance:**

Technological/scientific value.....**Yes**

Historical value .....**Yes**

Social value .....**Yes**

Landscape or townscape value.....**Yes**

Rarity.....**Yes**

Representativeness .....**NA**

Contribution to the nation or region....**Yes**

Contribution to engineering .....**Yes**

Persons associated with the work.....**Yes**

Integrity .....**Sound**

Authenticity.....**Yes**

Comparable works (a) in Australia....**None**

(b) overseas .....**Yes**

Statement of significance .....**Page 17**

Citation (70 words is optimum)…..

**RIVER MURRAY WORKS**

*See page 18 for draft citation*

**Dedicated by the Institution of Engineers, Australia**
**and the Murray-Darling Basin Commission**
**2001 – the Centenary of Federation**

Attachments to submission (if any).....

Proposed location of plaque (if not a site)....

# 3. HISTORY

## 3.1 Background

For many thousands of years Aboriginal people have inhabited the Murray Valley. European influence only commenced in the mid-1800s, but its impact over the next 150 years has been dramatic.

In 1853 the first paddle steamers commenced operation on the River Murray from Goolwa at the Murray mouth in South Australia, developing trade links up the Murray to Echuca, the Darling to Walgett and the Murrumbidgee to Hay.

From the 1860s the three colonies of NSW, South Australia and Victoria had attempted, without success, to reach agreement of the utilisation of the waters of the Murray River and its tributaries. The colonies were serious competitors and each was concerned about the potential effects on their own trade.

The trading pattern on the river was affected by the construction of railways. In 1864 a rail link from Melbourne to Echuca was completed, stimulating "top end" river trade and establishing Echuca as a major inland port. Goolwa's role as the main "bottom end" port was replaced by Morgan in 1878, following completion of the Port Adelaide to Morgan rail link.

In 1881 and 1882 the South Australian Government attempted to obtain the cooperation of NSW and Victoria to improve navigability, but without success. While the initial focus was on maintaining navigability, from the mid-1880s there was increasing interest in irrigation. The early 1880s had been a period of severe drought and, particularly in Victoria, the advantages of irrigation were eagerly sought. In its natural state the River Murray was too unreliable to allow intensive development of irrigation.

In 1885 the Premier of Victoria tried to arrange an interstate conference to deal with questions of improving navigation and utilising the waters of the Murray for irrigation. It was a time of mistrust between South Australia and the other two states, not assisted by a joint declaration by NSW and Victoria that all the waters upstream of the South Australian border were "the common property of NSW and Victoria". Over the next decade and a half, numerous attempts were made to bring the three states together, to resolve issues relating to navigation and irrigation. A succession of droughts from 1895 to 1902 renewed interest in the development of this important resource.

A landmark event occurred in May 1902 when the Corowa Water Conference was held. The purpose was to discuss the establishment of an irrigation scheme for the southern Riverina (in NSW) and in northern Victoria. The conference was attended by the Prime Minister and the Premiers of NSW, South Australia and Victoria, and it resulted in the establishment of an Interstate Royal Commission on the River Murray. That same year the Commission produced a very valuable and comprehensive report whose recommendations included:

- Construction of a storage on the upper Murray.
- The utilisation of Lake Victoria as a storage.
- The provision of a series of weirs and locks in the Murray from Blanchetown to Wentworth.
- Proposed minimum flows for South Australia.
- Proposed diversions for NSW and Victoria.

The proposals were seen as a grand scheme to allow for the significant future development of the River Murray. However the conclusions and recommendations were not unanimous, with the South Australian member submitting his dissent on the grounds that navigation had not been given due prominence. Indeed the report did not fully satisfy any of the states concerned.

Negotiations progressed without any agreement being reached until, in 1911, the Premiers made significant progress. NSW and Victoria agreed to give South Australia permission to construct works at Lake Victoria, to assist in regulation of flows to South Australia. In addition the Premiers agreed to instruct the engineers of their three States to jointly report on the question of the River Murray and its tributaries. The three engineers of note were E M de Burgh (NSW), J J Dethridge (Victoria) and G Stewart (SA).

The Conference of Engineers Report was completed in July 1913 and subsequently formed the basis of the River Murray Agreement of 9 September 1914. The agreement forms part of the River Murray Waters Act of 1915 which was passed by The Commonwealth, NSW, South Australian and Victorian Parliaments.

### 3.2 River Murray Water Act 1915

The Act provided for:

1) the ratification of the Agreement by the Commonwealth and three State Parliaments;
2) the appointment of the River Murray Commission;
3) the powers and duties of the Commission;
4) the construction of works by State constructing authorities;
5) the acquisition of lands;
6) the prescription of tolls;
7) the provision of all moneys required for the purposes of the act;
8) the submission of an annual report, and other machinery clauses.

The Agreement, which is a schedule to the Act, provided for the construction of the following works:

1) a storage on the Upper Murray.
2) a storage at Lake Victoria.
3) the construction of 26 weirs and locks on the Murray from Blanchetown in South Australia to Echuca in Victoria.
4) the construction of nine weirs and locks on the Murrumbidgee from its junction with the Murray to Hay, or alternatively on the Darling, from its junction with the Murray. (New South Wales decided to place the weirs and locks on the Murrumbidgee.)

The Agreement also prescribed:

- the River Murray Commission to have a Commonwealth representative as president and one representative from each of the three States;
- a unanimous vote on all matters other than prescribed formal business with certain provisions for arbitration;
- a constructing authority to be constituted in each of the three States to be responsible for the design and construction of the works under its control, subject to the general approval and direction of the River Murray Commission.
- the cost of the works to be borne in equal shares by the three States and the Commonwealth, the latter contribution at first being limited to £1,000,000. (This sum was

later increased to one-quarter share of the total cost, making the contribution of each contracting Government equal.)

### 3.3 Initial Construction

Even before finalising the Agreement, South Australia had (in 1912) commenced design of the series of locks and weirs. Captain E N Johnston of the United States Army Corps of Engineers was engaged for this task. By 1913 construction of Lock 1 at Blanchetown had commenced. Delayed by World War 1, this lock was not completed until 1922.

Thirteen of the locks and weirs were completed in the period 1922 to 1937. These structures were designed to provide passage for vessels drawing 1.5m of water, and a reserve storage or water for irrigation by pumping from the river. Each weir included a demountable section which allowed ships and logs to pass through unimpeded during periods of high flow.

Construction of Hume Dam commenced in 1919. It consisted of a concrete gravity spillway across the river and a long earthen embankment on the Victorian side. It was not until 1926 that the required storage capacity was confirmed at 2.0 million acre feet (2460 gigalitres). Financial problems of the Great Depression resulted in the governments instructing the builders to limit the initial work to store 1.25 million acre feet (1542 gigalitres), without jeopardising achievement of the full design capacity later. Construction of this stage was completed in 1936.

### 3.4 Changes to the Agreement in 1934

As railways replaced rivers as main transport arteries, the use of the river as a major transport route had progressively declined, and by the 1930s river transport had virtually ceased. In 1934 the Agreement was amended as follows:

- The number of weirs and locks on the Murray was reduced from 26 to 13;
- A diversion weir with no lock (Yarrawonga) was added on the Murray above Echuca.
- The nine locks and weirs on the Murrumbidgee were replaced by two diversion weirs.
- Five barrages were added to exclude salt water from the Murray mouth.

Yarrawonga Weir, completed in 1939, is the largest weir on the Murray and enables gravity diversion of water to the Finley-Deniliquin region in NSW and the area between the lower Goulburn and Murray Valley in northern Victoria.

By 1940 the Murray mouth barrages and two weirs on the lower Murrumbidgee had been completed.

### 3.5 Post War Developments

Following the Second World War various “soldier settlements” areas were developed for irrigation in South Australia, Victoria and NSW, placing increasing demand on the River Murray water resource.

In 1950 work began at Hume Dam to increase the storage to the original design capacity of 2,000,000 acre feet (2460 gigalitres). In 1954, with the Snowy Mountains Scheme due to

deliver additional flows into Hume reservoir, the required capacity was raised to 2,500,000 acre feet (3038 gigalitres).

The additional capacity was achieved mainly by installing 29 gates on a raised spillway crest. Whilst the crest level of the main embankment was not increased, a concrete parapet wall was added to protect the embankment from overtopping wave action. In addition, the town of Tallangatta was relocated to a new flood free site, and the Bethanga Bridge was raised. (see Reference 3).

By 1960 it had become apparent that an additional major storage was needed to provide more operational flexibility. The Chowilla Dam site had been chosen near Renmark in South Australia, but this location was abandoned in 1967 due to concerns about the construction cost, evaporation and salinity. Instead a site on the Mitta Mitta River in north-eastern Victoria was chosen for the construction of Dartmouth Dam. The dam has a storage capacity of 4000 gigalitres and provides drought protection for the irrigation in the Murray Valley. Dartmouth Dam is 180m high (the highest in Australia) and was completed in 1979.

### 3.6 The future

The River Murray Works continue to provide the basic functions of flow regulation, diversion, salinity control and navigation that they were originally intended to provide when first conceived 100 years ago. In relation to navigation there is no longer any freight transport on the river, but a significant tourist and recreational use of the river has built up so that the locks remain in regular use.

Extensive asset management programs are ongoing and are designed to ensure that the various works are maintained and upgraded as appropriate to satisfy contemporary requirements for:

- floods, earthquakes and other loads;
- occupational health and safety;
- environmental management.

## 4. RIVER MURRAY COMMISSION

The River Murray Commission was not a constructing authority in its own right. Rather the respective States were responsible for appointing a constructing authority for the works in their state. At Hume Dam this approach saw one half constructed by NSW and the other half by Victoria. For each structure, the Commission approved the general arrangement, detailed design and specifications before work proceeded.

The River Murray Commission had to deal with the competing interests of the States in relation to navigation and irrigation. The creation of the River Murray Commission has allowed the Commonwealth and the relevant state governments to do collectively what they had found difficult to achieve individually.

During its early years the River Murray Commission had a relatively stable membership with the main Commissioners being:

| | | |
|---|---|---|
| Commonwealth | Deputy President<br>T Hill, OBE, MIE Aust | <br>1918 to 1944 |
| NSW - | H H Dare, MinstCE | 1917 to 1934 |
| Victoria - | J S Dethridge, MinstCE<br>R H Horsfield, MInstCE, MIE Aust | 1917 to 1926<br>1926 to 1936 |
| South Australia - | J H O Eaton, ISO, MInstCE, MIE Aust | 1918 to 1947 |

In 1988 the River Murray Commission was succeeded by the Murray Darling Basin Commission. The new Commission provided advice to Ministerial Council on land and environmental matters in the whole Murray Darling Basin, in addition to the traditional role of managing and distributing the waters of the Murray to the States of NSW, South Australia and Victoria.

## 5. STATE CONSTRUCTING AUTHORITIES

Although conceived as a single scheme, the works have been designed, constructed, operated and maintained by separate authorities, one in each of the three states.

South Australia was responsible for design, construction, operation and maintenance of all Locks and Weirs 1 to 9, Lake Victoria and the five Murray mouth barrages.

New South Wales and Victoria were jointly responsible for all works on the Murray above its junction with the Darling. In fact Victoria built Locks & Weirs 11 and 26, and Yarrawonga Weir. NSW built Locks & Weirs 10 and 15, and the two weirs on the Murrumbidgee.

Hume Dam was constructed as a joint asset by NSW and Victoria, although since 1985 it has been operated and maintained solely by NSW, by mutual agreement.

The original State Constructing Authorities were:

*New South Wales*

Minister of Works and Local Government, The Hon J J Cahill, MLA.

Department of Public Works: The design and construction was under the Principal Engineer, Water Supply and Sewerage and Chief Engineer, River Murray Works, Mr S W Jones, BE, MInst CE, MIE Aust

*Victoria*

Minister for Water Supply and Electrical Undertakings, The Hon JGB McDonald, MLA.

State Rivers and Water Supply Commission: The design and construction was under the Chairman, Mr L R East, MCE, MInstCE, MIE Aust.

*South Australia*

The Hon M McIntosh, MP, Minister of Works.

Engineering & Water Supply Department: The design and construction was under the Engineer-in-Chief, Mr H T M Angwin, CMG, BE, MInstCE, MIE Aust.

## 6. THE RIVER MURRAY WORKS

The various works, which today comprise the River Murray Works, are set out in Table 6.1 to 6.4 below, together with the responsible Constructing Authority by state. The current Constructing Authorities are:

| | |
|---|---|
| NSW | Department of Land and Water Conservation |
| South Australia | SA Water Corporation |
| Victoria | Goulburn Murray Water |

**Table 6.1 – MAJOR STORAGES**

| Storage | Capacity GL | Top Water Level (m) | Year Completed | State Operator |
|---|---|---|---|---|
| Lake Dartmouth | 4000 | 486 | 1979 | Vic |
| Hume Reservoir | 3038 | 192 | 1936 & 1961 | NSW |
| Menindee Lakes | 1682 | 60.5 av | 1968 | NSW |
| Lake Victoria | 680 | 27 | 1928 | SA |
| Total | 9400 | | | |
| Active | 8710 | | | |

Dartmouth Dam has a catchment area of 3,600 km$^2$. The embankment has a central earth core and rockfill shoulders, and the height of 180m is the highest in Australia. The spillway is unusual in that a short concrete-lined chute discharges onto a series of quarry benches from which the rockfill for the dam was won. The high-level outlet supplies both the irrigation outlet and a 150MW power station. The diversion tunnel has been modified for use as a low-level outlet. A serious accident destroyed the power station in 1991?? but it has been rebuilt.

Below Dartmouth Dam there is a 25m high concrete gravity dam which created a regulating pond to smooth out the variable discharges from the power station, thereby avoiding erosion of the river banks downstream.

Hume Dam has a catchment area of 15,275 km$^2$. The main dam is 1.6km long; this length includes a 1.2km long earthfill embankment to the south and a concrete gravity spillway and outlets section 318m long. The height above lowest foundation is 51m. There are four irrigation outlets, and a hydro-electric power station with two 25MW machines.

The Menindee Lakes on the Darling River, east of Broken Hill in NSW were constructed by NSW in the early 1960s and have been leased by the Commission since 1963 to supplement flows in the lower Murray.

Lake Victoria is a natural lake in NSW near the SA border. It serves as an off-stream storage in that any surplus water is diverted into the lake via a channel from Weir 9.

**Table 6.2 - MURRAY LOCKS & WEIRS**

| Lock | Location | River km from mouth | Upper Pool Level (m) | Type of Weir | Year Completed | State Operator |
|---|---|---|---|---|---|---|
| 1 | Blanchetown | 274 | 3.30 | Boule | 1922 | SA |
| 2 | Waikerie | 362 | 6.10 | Boule | 1928 | SA |
| 3 | Overland Corner | 431 | 9.80 | Boule | 1925 | SA |
| 4 | Bookpurnong | 516 | 13.20 | Boule | 1929 | SA |
| 5 | Renmark | 562 | 16.30 | Boule | 1927 | SA |
| 6 | Murtho | 620 | 19.25 | Boule | 1930 | SA |
| 7 | Rufus River | 697 | 22.10 | Boule | 1934 | SA |
| 8 | Wangumma | 726 | 24.60 | Boule | 1935 | SA |
| 9 | Kulnine | 765 | 27.40 | Boule | 1926 | SA |
| 10 | Wentworth | 825 | 30.80 | Boule | 1929 | NSW |
| 11 | Mildura | 878 | 34.50 | Dethridge | 1927 | Vic |
| 15 | Euston | 1110 | 47.60 | Boule | 1937 | NSW |
| 26 | Torrumbarry[1] | 1638 | 86.20 | Dethridge | 1924 | Vic |
| - | Yarrawonga[2] | 1992 | 124.90 | Concrete | 1939 | Vic |

[1] Original Dethridge weir replaced by gated weir in 1995

[2] 22m high concrete gravity dam with eight spillway gates plus a subsidiary channel with two gates.

**6.3 – MURRUMBIDGEE WEIRS**

| Location | River km from Murray | Upper Pool Level (m) | Type of Weir | Year Completed | State Operator |
|---|---|---|---|---|---|
| Redbank | 193 | 68.12 | Concrete | 1940 | NSW |
| Maude | 290 | 74.43 | Concrete | 1940 | NSW |

Note: These structures have three lifting steel gates

**6.4 – MURRAY MOUTH BARRAGES**

| Barrage | Upper Pool Level (m) | Total Length (m) | Type of Opening | Lock Dimensions (m) | Year Completed | State Operator |
|---|---|---|---|---|---|---|
| Goolwa | 0.75 | 632 | Stop logs | 30.48 x 6.10 | 1940 | SA |
| Mundoo | 0.75 | 792 | Stop logs | - | 1940 | SA |
| Boundary Ck | 0.75 | 244 | Stop logs | - | 1940 | SA |
| Ewe Island | 0.75 | 2271 | Radial gates | - | 1940 | SA |
| Tauwitchere | 0.75 | 3658 | Radial gates | 13.72 x 3.81 | 1940 | SA |

Further details of most of River Murray Works are available in the references.

# 7. UPGRADING THE ORIGINAL WORKS

## 7.1 Raising Hume Dam

As mentioned in the history section, various works were carried out between 1950 and 1961 to double the storage volume. The Full Supply Level of the reservoir was raised 9m by adding 1.8m of concrete to the spillway crest and installing 29 spillway gates 7.2m high above that. The gates were raised and lowered by hoists mounted on an overhead bridge running the full length of the spillway. This striking feature gave the spillway a new look.

To combat the higher reservoir level, the spillway structure was stabilised by anchoring it to its foundations with steel prestressing tendons. This was one of the first dams in Australia to be stabilised using this new technique.

It was not necessary to raise the adjoining earthfill embankments, but a parapet wall was added to the crest to prevent erosion by waves. A third saddle dam was built on the reservoir rim. The town of Tallangatta was relocated to a flood-free site, and the Bethanga Bridge was raised.

## 7.2 Repairing Hume

After the first filling in 1939-40, the effect of reservoir drawdown caused substantial slumping of the upstream face of the two embankments and the displacement of many facing slabs. Rockfill was dumped from barges to stabilise these faces, and further rockfill was dumped in the late 1950s.

In 1987, due to doubts about the condition of the prestressing tendons in the spillway, a set of load-monitorable tendons was installed. The southern retaining wall of the main embankment was strengthened to resist seismic loading. To improve the discharge capacity the main outlet valves were replaced with larger valves.

Since 1995 a $75 million remedial works program has been underway. It includes major stabilisations of the embankments, spillway rehabilitation and the replacement of six penstock closure gates. Concerns about the continuing downstream movement of the embankment core wall adjacent to the spillway resulted in the emergency lowering of the storage by 5m in 1996, causing an existing flood discharge to be extended by several weeks. Remedial works specific to this incident were completed in 1997 and refilling was allowed.

## 7.3 Replacing Torrumbarry

The original steel trestle structure, a Dethridge Weir near Echuca, was mounted on wheels and could be winched up a ramp onto the river bank when high flows were expected. In 1992 the weir suffered a foundation failure and was condemned. A new concrete weir with radial gates was constructed in 1995/96, but the original lock was retained. The steel trestles are on display as heritage relics at the site. The only other Dethridge weir, at Mildura, remains in service.

### 7.4 The future

Notwithstanding all these works, studies are continuing into the question of what spillway capacity is required at Hume Dam to satisfy contemporary design standards, and further upgrades of spillway capacity may be implemented in the future.

## 8. ILLUSTRATIONS

*Suggestions:* *Typical lock and weir – Johnson type*
*Mildura weir – Dethridge type (Bruce Cole can supply)*
*Lake Victoria*
*Hume Dam from the air (embankment and spillway)*
*GG opening Hume Dam in 1936*
*A Murray mouth barrage*
*Dartmouth Dam*
*Luxurious crop in irrigated area (oranges?)*
*Paddle steamer*

## 9. KEY PERSONNEL

Over the past 90 years there have been many hundreds of professional engineers associated with the investigation, design, construction, operation and maintenance of the River Murray Works. Periods of design and construction inevitably involved more intense engineering contributions. Without wishing to detract from the contributions of each and every one of the professional, technical and administrative staff who have served the River Murray Works, the following records some of the engineers who warrant special mention.

### 9.1 The early days

| | |
|---|---|
| NSW | E M de Burgh, Chief Engineer, DPW |
| | H H Dare, Chief Engineer, DPW |
| | R H Brewster |
| Victoria | J S Dethridge, Chief Engineer, State Rivers & Water Supply Commission |
| | E D Shaw, Chief Engineer, State Rivers & Water Supply Commission |
| SA | G Stewart, Engineer-in-Chief |
| | J H O Eaton, Engineer-in-Chief, Engineering & Water Supply Dept |
| | H T M Angwin, Engineer-in-Chief, Engineering & Water Supply Dept |
| | Capt E N Johnston, US Army Corps of Engineers |
| Commonwealth | T Hill, Chief Engineer, Commonwealth Works & Railways |

### 9.2 The 50s and 60s

| | |
|---|---|
| Victoria | L R East, Chairman, State Rivers & Water Supply Commission |
| | M G Speedie, Chief Designing Engineer, State Rivers |
| | G L Harrison |

### 9.3 The 1970s

Dartmouth Dam

| | | |
|---|---|---|
| - | design | I L Pinkerton, Chief Civil Engineer, Snowy Mountains Engrg Corp |
| | | V Michels, Chief Designing Engineer, State Rivers |
| - | construction | J Maver, Chief Engineer Major works, State Rivers |
| | | K Johnson, River Murray Commission |

### 9.4 The 1980s and 90s

| | |
|---|---|
| MDBC | K Johnson |
| | D Blackmore, CEO |
| | D Dole, General Manager, River Murray Water |
| | B Haisman, Manager Assets, River Murray Water |
| NSW | J Bate, Water Conservation & Irrigation Commission |
| | M Verrender, Director, Dept Lands & Water Conservation |
| | R H Foster, Water Conservation & Irrigation Commission |
| | B Cooper, Dept Public Works & Services |
| Victoria | I Howley, Project Manager, Goulburn-Murray Water |
| | D Jeffrey, Goulburn-Murray Water |
| South Australia | W Dare, Engineering & Water supply Dept |

A special mention should be made to the technical personnel who have operated and maintained the assets with dedication and pride over the past 80 years. The lockmasters, lock-keepers, OICs of dams and other technical staff have, in many cases, served the River Murray Works for most, if not all, of their working lives. In quite a number of cases it has been a family affair involving more than one generation.

## 10. CHANGING ROLES OF THE WORKS

The River Murray works were originally designed to provide certainty in paddle steamer navigation from Goolwa to Echuca and to promote irrigation development and closer settlement in the Murray Valley.

By the time the works were completed in the 1930s river trade had demised and emphasis turned to providing water for irrigation.

Since 1944, when water was first piped from the Murray to Whyalla, regulation has had to ensure that urban and industrial water requirements are met. The city of Adelaide is particularly reliant on water from the Murray, receiving on average 55% of its water from this source. However during severe droughts this dependance has increased to more than 90%. In effect without the River Murray Works, the development of Adelaide and the towns of Whyalla, Port Pirie and Port Augusta in South Australia would not have been possible, due to lack of water.

By the year 2000, the River Murray Works are capable of providing an assured water supply for 700,000 hectares of irrigation development and the urban and industrial needs of Adelaide and the Iron Triangle.

In the 1980s and early 90s there was increasing recognition that, as more and more water was extracted from the rivers of the Murray Darling Basin, the rivers were showing increasing signs of stress. There was growing concern that the riverine environment would not be able to survive in the longer term without action. Increasing salinity was also proving a threat to sustainable irrigation. In 1997 a Cap was introduced which varied the sharing of water between NSW, Victoria and South Australia and limited future diversions to those applicable in 1993/94.

In late 2000 the first regulated release for the environment was made, with a specific allocation of water for release into the Barmah-Millewa Forrest. Further downstream, near Renmark, regulated discharges were made from Lake Victoria, in conjunction with the passage of a minor flood, to increase the extent of flood plain inundation and thereby stimulating the environment.

In future years there will be increasing emphasis on regulation to give greater emphasis to water quality and environmental issues, and to gradually redress some of the environmental problems caused by river regulation whilst maintaining the significant benefits.

The River Murray Works will continue to play an important role in a sustainable future for the River Murray region. They will remain a credit to those who conceived and built them and those who have operated, maintained and refurbished them for the past eighty years.

## 11. ASSESSMENT OF SIGNIFICANCE

### 11.1 Technical value

Many of the weirs and locks were founded on poor sandy foundations through which piping could easily occur. Counter measures included keeping the difference in pond level small, and providing sheet pile cut-offs and long leakage paths. Timber piles support the concrete slabs beneath the weirs. These decisions have stood the test of time.

The construction of Hume Dam was the largest civil engineering undertaking in Australia between the two world wars. The earthfill embankment was easily the longest and had the highest concrete core wall inside it. The concrete spillway was stabilised in 1961 by anchoring it to its foundations with steel tendons, one of the first uses of this technique in Australia.

The Murray Mouth is the only place in Australia where barrages have been built on such a scale, the total length being 7.6km. These concrete structures were built on soft foundations with extensive use of timber piles for support.

Dartmouth Dam is the highest dam in Australia. It is a rockfill dam with a central earth core. This type of dam was only developed after 1950, when graded filters placed between the earth core and the rockfill shoulders ensured that piping could not occur. The three highest dams in Australia are of this type.

## 11.2 Historical value

The construction of the River Murray Works was the outcome of an historic agreement between three States and the Commonwealth. Such an agreement had been wanted for many decades, but it only became possible after Federation when the federal government could act as an independent broker and contribute to the cost. The original agreement of 1914 has been altered on several occasions as circumstances have changed, but the four governments working together have achieved what could not be done separately.

## 11.3 Social value

The River Murray Works have made a huge contribution to the settlement of inland Australia through the greatly improved reliability of water supplies for irrigation, stock water, towns and industries. Lake Hume is popular for holidays and water activities. River boats and house boats carrying happy tourists ply up and down the river using the locks originally built for the conveyance of goods.

## 11.4 Landscape or townscape value

Many parts of the river are very scenic with tree-lined banks and prolific bird life. There are many ferry crossings yet to be replaced by bridges, and these sites as well as the locks are attractively landscaped and well maintained. Hume Dam, particularly with the high structure across the spillway, is a truly impressive sight.

## 11.5 Rarity

While weirs and locks are common in many other countries, there are very few if any examples in Australia other than those on the Murray and Murrumbidgee Rivers. The Murray Mouth barrages are certainly the only ones on this scale in Australia.

## 11.6 Representativeness

In relation to irrigation the first major scheme in Australia was Burrinjuck Dam on the Murrumbidgee River, constructed between 1907 and 1927. Hume Dam was the next. Since then there have been many more large dams constructed for irrigation in Australia. The importance of irrigation for increased and economic production has remained high in Australia. Hume Dam itself has been enlarged and serves as an example of what can be achieved when water supplies can be relied upon.

## 11.7 Contribution to the nation or region

The Murray River Works have enabled inland towns to be established, irrigated areas to be expanded in three States and the water supply needs of South Australian towns to be met. Produce from the irrigated areas is exported all over Australia and overseas. The contribution to employment in south-eastern Australia is highly significant.

## 11.8 Contribution to engineering

The scale of the River Murray Works, constructed by engineering organisations in three States, showed that Australian engineering had matured to the point where large projects could be tackled with confidence and that the outcomes would be highly satisfactory.

## 11.9 Persons associated with the work

Many eminent politicians and engineers have been associated with the River Murray Works. Some of these are listed earlier in this nomination. They come from the Commonwealth and the three States. Some were influential in achieving the landmark River Murray Agreement in 1914; others had vital inputs at the design and construction stage. More still have been closely involved in operating the scheme for the benefit of all stakeholders in the face of sometimes conflicting requirements.

## 11.10 Integrity

While extensive remedial works have been carried out on Hume Dam, only the stabilising berms on the embankments are visible to the casual observer, and such berms are commonplace on earthfill structures. One of the weirs has been replaced, but another of the same type is still in service. The majority of the River Murray Works are essentially as originally built and the overall integrity has a high rating.

## 11.11 Authenticity

Like most civil engineering works, the final designs are tailored to the particular site conditions, so that none of the structures are absolutely identical. It follows that every structure is authentic.

## 11.12 Comparable works in Australia

There are many large irrigation storages and schemes in Australia. Those storing over one million megalitres are listed below:

| YEAR | DAM | STATE | STORAGE ML |
|---|---|---|---|
| 1927 | Burrinjuck | NSW | 1 026 000 |
| 1936/61 | Hume | Vic/NSW | 3 038 000 |
| 1953 | Eildon | Vic | 3 390 000 |
| 1960 | Menindee | NSW | 1 794 000 |
| 1967 | Burrendong | NSW | 1 188 000 |
| 1968 | Blowering | NSW | 1 628 000 |
| 1971 | Wyangala | NSW | 1 220 000 |
| 1972 | Fairbairn | Qld | 1 400 000 |
| 1972 | Ord River | WA | 10 760 000 |
| 1976 | Copeton | NSW | 1 364 000 |
| 1979 | Dartmouth | Vic | 4 000 000 |
| 1987 | Burdekin Falls | Qld | 1 900 000 |

### 11.13 Comparable works overseas

As there are many large river systems in other countries, it is to be expected that some of these will have works comparable to the River Murray Works. It is noted that the conceptual design for most of the River Murray locks and weirs is attributed to Captain Johnston of the US Corps of Engineers who presumably had previous experience with these structures, possibly on the Mississippi River in the USA.

## 12. CURRENT HERITAGE LISTINGS

Nominations have been submitted to the Australian Heritage Commission for the listing of the following works on the Register of the National Estate (RNE). These nominations have not been assessed (2001) but they can be accessed on the RNE Database at www.ea.gov.au/heritage .

Hume Dam
River Murray Locks & Weirs 1 to 9, 15 and 26.
River Murray Barrages.

These nominations are also listed in the references.

*State listings?*

## 13. STATEMENT OF SIGNIFICANCE

The River Murray works have been substantially responsible for enabling:

- the development of large areas of NSW, Victoria and SA and the Nation as a whole;
- the development and growth of Adelaide;
- the development of the iron triangle towns of Whyalla, Port Pirie and Port Augusta and their associated industries;
- substantial agricultural and food production for both domestic and export purposes.

The works are:

- a tribute to the robustness of the original designs and to the engineers who conceived, designed, built and maintained them, and to their successors who have adapted and upgraded them;
- tangible evidence of the ability of four sovereign governments to work together, of their ability to make decisions by consensus and to resolve issues, over more than 85 years; and
- by and large not only of national engineering significance, but have an important place in the history of Australian engineering and the development of Australian engineering skills.

The works are part of a research effort of great importance to both Australia and the world, in the need to address and solve some of the great environmental and ecological problems of regulated and irrigated river basins, problems that were not understood when the works were constructed. The effort is providing a greater understanding of the interdependence of population growth, agriculture and engineering in the development of large land areas, particularly those that have poor and fragile soils and sparse and unreliable rainfall.

Locks and Weirs

The thirteen locks and weirs were deliberately limited to low structures to minimise the risk of undermining by seepage through the sandy foundations. The locks allowed river traffic

with less than 1.5m draft to travel with certainty from the mouth to Mildura, and from Mildura to Echuca except at low flows. The storages above each weir provided pumping ponds for adjacent irrigation areas. Eleven of the weirs could be disassembled in situ and the piers laid flat when high flows were expected. Two of the weirs, designed by Australian engineer John Dethridge were mounted on wheels and could be winched up a ramp onto the river bank to let floods pass unimpeded. The Mildura Weir of this type remains in service, while the original Torrumbarry Weir is on display at the site as a heritage exhibit.

Barrages

The five barrages at the Murray mouth serve to keep sea water out of Lakes Alexandrina and Albert. Their importance cannot be overstated as, before they were constructed, salt water travelled 150km up the Murray River to Morgan during the 1914-15 drought. The salt content prevented farmers from using the river water for irrigation. The level of Lake Alexandrina is only 0.75m above sea level and is carefully controlled to allow diversion by gravity to adjacent irrigable land.

Hume Dam

The construction of Hume Dam was the largest engineering project between the two world wars. As the border between NSW and Victoria runs along the southern bank of the river, the concrete gravity spillway across the river lies in NSW and the long southern embankment lies in Victoria. Each State was responsible for building its part of the dam.

When the decision was made, after World War 2, to double the storage volume, it was necessary to move the town of Tallangatta to higher ground, perhaps the first example in Australia of a displaced community. Adaminaby and Jindabyne were similarly affected by the Snowy Mountains Scheme.

Hume Dam was one of the first examples in Australia of a gravity dam being anchored to its foundations with steel prestressing cables to maintain its stability when the storage level was raised.

Dartmouth Dam

The initial plan to provide another large storage on the River Murray System was to build a dam at Chowilla in South Australia. This structure would have given South Australia much more control over its share of the Murray water. The abandonment of the Chowilla Dam site mainly for technical reasons was partly responsible for the South Australian government losing the next election.

The 180m high Dartmouth Dam is the highest dam in Australia. It is an earth core rockfill dam, a dam type which was unknown before 1950. Such is their versatility and economy that over 65 of these dams have now been built in Australia, and the three highest dams are of this type.

## 14. DRAFT CITATION

*Note: This may not be the latest version.*

**RIVER MURRAY WORKS**

The creation of the River Murray Commission in 1915 by the governments of the Commonwealth, New South Wales, South Australia and Victoria established the framework under which the four governments would work together for the equitable efficient and sustainable use of the waters of the River Murray and lower Darling River.

A comprehensive scheme of works, comprising Hume and Dartmouth Dams, Lake Victoria, Menindee Lakes and a series of locks, weirs and barrages from Yarrawonga to the Murray mouth, have been constructed to support irrigation, urban water supply, hydro-electric generation, navigation, recreation and flood mitigation throughout the Murray Valley.

Their purpose continues to be to contribute to human welfare.

The challenge remains for current and future generations to ensure that continuing operations sustain the health of the river's ecological community.

Dedicated by
The Institution of Engineers, Australia and
Murray-Darling Basin Commission
2001 – the Centenary of Federation

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