Key Issue:
5- Water Quality


Crotty Dam

Climate Zone:
Cfb: Marine West Coast - Mild

Subjects:
- Heavy metal pollution from ongoing mining activity
- Sulphidic rock
- Old tailing dumps
- Low level of oxygen caused by thermal stratification

Effects:
- Prevention of the heavy metal polluted inflow into the reservoir
- Sealing and revegetation of old tailing dumps
- Aeration of water discharged downstream

Project Name: King River Power Development
Country: State of Tasmania, Australia

Implementing Party & Period
- Project: Hydro Tasmania
1983 - 1993
- Good Practice: Hydro Tasmania
1983 – 1993

Key Words:
Water Quality in Reservoir, Heavy Metal Polluted Inflow, Water Aeration, Timber Salvage prior to Impoundment

1. Outline of the Project

The King River Power Development is located in the southwest of Tasmania shown on Fig. 1. The Project, with an installed capacity of 143 MW, contains two dams, one 83 m high and the other 20 m high, a 7 km long headrace tunnel, power station with a single generator remotely controlled, 50 km of 220 kV transmission line, and some 36 km of road works. The lake created by the scheme has been developed to support both recreation and fishing and is of benefit to the whole west coast community of Tasmania. The construction works commenced in 1983 and was completed in 1993.

The main dam, Crotty Dam is a concrete-faced gravel and rock fill embankment. The fill is local river gravels from the King River floodplain' upstream of the dam. Their use avoided the need for quarrying and thus reduced costs and visual impacts, but required special techniques to avoid saturation in a high rainfall area.

The power station is of circular slip formed construction. It is located at the downstream end of the narrow King River gorge and is tucked into a left bank excavation, clear of any flows which might deposit gravels in the tailrace. With an effective head of 184 m on the

turbine, the rated output is 143 MW for a flow of about 85 m^3/s. The station is designed for unmanned operation and is controlled remotely from the System Control Centre in Hobart.

Table 1: Outline of the King River Power Development

River System	King River
Crotty Dam	Gravel & Rock Fill with Concrete Faced 83 m high
Darwin Dam	Gravel Fill 20 m high
Reservoir	Lake Burbury 53 km^2
Power Plant	The John Butters PP 143 MW x 1 no.
Headrace Tunnel	D= 7.2 m, L= 7 km
Transmission Line	220 kV, L= 50 km

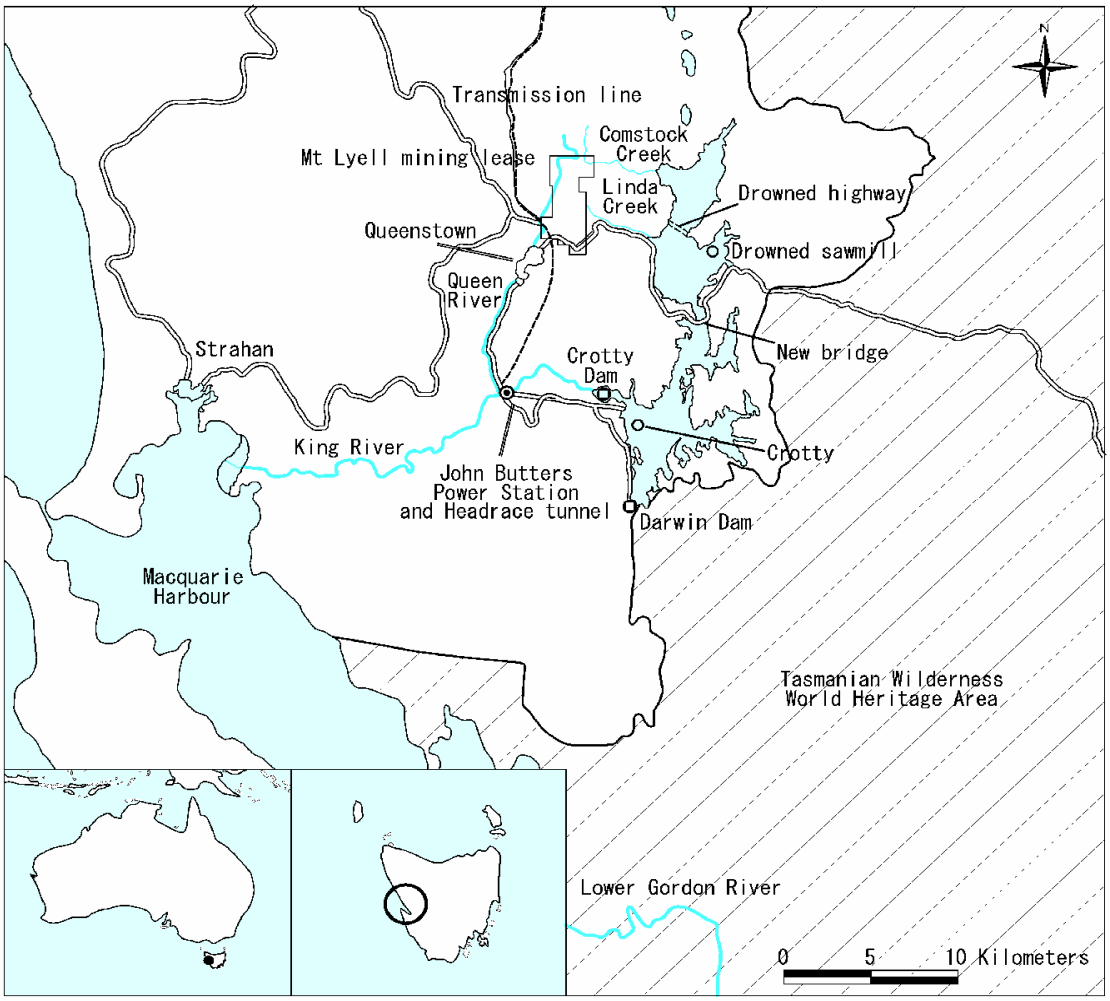

Fig.1 Location of King River Power Development
in Australia and the State of Tasmania

2. Features of the Project Area

The King River Power Development was constructed in a climate of intense public disquiet about the environmental effects of Tasmania's future power schemes. This disquiet arose from events relating to the Gordon River Power Development (GRPD) Stage 2 in Tasmania's southwest.

Opposition to hydro schemes in Tasmania began in 1967 with the flooding of Lake Pedder, as part of Stage 1 of the GRPD. The emerging conservation movement ran a strong "Save Lake Pedder" campaign with a high national profile. This anti-dam campaign sparked major public unrest at both state and national levels, and was the catalyst for the information of the Tasmanian Wilderness Society and the Greens, groups, which grew to become major community and political influences. Following an official inquiry into the flooding of Lake Pedder, the commonwealth Government ratified the World Heritage Convention in 1974, thus giving it extra powers over State government.

Fig. Gordon Dam

Fig. Lake Pedder

Flooding of the Lower Gordon River was proposed in 1981, as part of Stage 2 of the GRPD (the "Lower Gordon scheme"). This proposal was strongly opposed by the Tasmanian Wilderness Society and green groups from around Australia. Significantly, in 1982, the then South West National Park Franklin-Lower Gordon Wild Rivers National Park and Cradle Mountain – Lake St. Clair National Park were designated as the "Tasmanian Wilderness World Heritage Area". The lower GRPD proposal would have led to inundation of parts of this area, including significant Huon pine habitat and caves containing Aboriginal artifacts.

Demonstration continued after Stage 2 of the GRPD received State parliamentary approval. When the national Labour Party came to power in 1983, it used the external powers under the World Heritage Convention to override the State Government, and construction of the Lower Gordon power scheme was permanently halted.

After swift but careful consideration, two smaller hydro schemes were proposed that were both outside the Tasmanian Wilderness World Heritage Area – the "King" and the "Anthony". Together these schemes would have an average annual output of 120 MW, somewhat less than the 180 MW planned for the Lower Gordon scheme. The King and Anthony schemes were also less economic than the Lower Gordon scheme. The Commonwealth Government agreed to fund part of the capital cost so that the unit price of power from the two alternative schemes would be the same as that forecast for the Lower Gordon scheme.

These events set the stage for the King River Power Development. Both Tasmanian houses of parliament gave their approval promptly, as did the wider Tasmanian community, and Hydro Tasmania

embarked on the engineering investigation, design and construction activities concurrently instead of in the normal planned sequence. While there was no legal requirement for Hydro Tasmania to produce an envir9nmental management plan, the decision to do so reflected business recognition of the need to demonstrate more socially and environmentally responsible development.

3. Major Impacts

The King River Power Development presented some very unique site investigation and design challenges, primarily arising from a suite of environmental issue~ associated with a large copper mine which had been operating in the catchment over the past 100 years.

The Mount Lyell Copper Mine in Queenstown, at the time of site investigations, still continued to practice direct discharge of its tailings (fine-grained waste sediments) directly into the Queen River. Substantial accumulations of tailings and smelter slag could be found stored in the bed banks and delta of the lower King River. Additionally, considerable sulphidic rock is found exposed to air and rainfall on the mining lease. Heavy metals associated with this sulphidic rock, notably copper, aluminum and zinc, are liberated due to the creation of acid drainage and are present in high concentrations in the run-off from the lease site.

At the time the Lower Gordon scheme was halted, significant studies had already been carried out on the King River catchment as part of Hydro Tasmania's considerations into alternative power development options. These studies were released for public scrutiny in 1980, and included:

- identification of the main heavy metal pollution sources arising from the historical and ongoing mining activities in the catchment;
- estimates of the amounts of heavy metals that would enter a proposed storage;
- modeling of the heavy metals within a proposed storage;
- the status of the biota in the river systems and assessment of the effect of heavy metals on the biota; and
- proposed methods of reducing pollution off the lease site to acceptable levels.

Based on these studies, the dam and power station are located upstream of the Queen River tributary that delivers tailings to the lower King River, but acid drainage off the lease site into the proposed storage would occur. Diversion Works were undertaken on the lease site to address this occurrence and are described in Section 4.

Although in 1983 Hydro Tasmania was not required to prepare environmental impact statements the business voluntarily prepared an Environmental Management Plan for the construction of the･King scheme This was the first hydro-power scheme built in Australia to have a formal Environmental Management Plan, and this plan influenced the design and construction activities for the development An Environmental Committee was formed for the construction period to ensure that unnecessary impacts were avoided and unavoidable ones were minimized and treated.

4. Mitigation Measures

Some particular notable environmental measures were implemented at the construction stage of this scheme, relating to water quality diversion works as well as timber salvage and land rehabilitation.

Water quality in the new lake was a concern due to acid drainage and heavy metal runoff from old mine workings and spoil dumps in the catchment. High copper concentrations in particular were identified as

having potential to interfare with the development of a recreational trout fishery in the lake.
Following intensive studies into the relative contribution of the various sources of pollutant in the catchment, remediation works were designed and implemented to reduce a significant amount of the copper flux entering the new storage. The work involved passive diversion of some flows to the already heavily polluted Queen River, and the sealing and revegetation of old tailings dumps to reduce leaching by rainwater. The Queen River joins the King River downstream of the power station.
In addition, 48,900 m^3 of timber was salvaged from Mt Jukes Road and the storage area in conjunction with the Tasmania Forestry Commission.
The storage area was cleared from full supply level to two meters below the minimum operating level, to avoid unsightly dead trees and remove water hazards for boats using the lake. By maximizing timber salvage, Hydro Tasmania generated favorable publicity, created jobs, provided the state government with revenue and minimized the areas that remained for storage clearing.

5. Results of the Mitigation Measures

The most important considerations in commissioning of the King River Power Development were environmental. There were, in particular, concerns with;

- heavy metals and water quality associated with the filling of the storage, Lake Burbury,
- oxygen levels in the power station discharge.

Hydro Tasmania, working with the Inland Fisheries Commission Biological Consultancy (IFCBC), began a Lake Burbury water quality-monitoring program with the commencement of filling of the lake in August 1991. The program was implemented in response to concerns about heavy metal contamination via polluted Linda and Comstock Creeks, which drained into the new storage, and as a means to monitor the effectiveness of ameliorative measures such as diversion works which had been put in place.
The main objectives of the program included:

- monitoring the development of the physico-chemical environment of the new storage, including changes associated with thermal stratification and decay of flooding vegetation;
- assessing the spatial and temporal distribution of metal contamination in the water and sediments of lake Burbury;
- assessing the affect of any contamination on the productivity of the lake;
- monitoring the fish populations and development of the trout fishery in the lake; and
- assessing the effect of releases from the lake on water quality in the King River and Macquarie Harbour.

The monitoring program included ongoing water, soil and sediment sampling; lake productivity measurements; and investigations into aspects of the fishery such as heavy metal levels in trout, distribution of fish in the lake, growth rates, physiological condition and reproductive success of the fish.
By 1996 ongoing monitoring had established there were no major problems with either copper toxicity or the development of the Lake Burbury fishery. Testing by the Tasmanian IFCBC found that even though mean soluble copper concentrations were 2-3 times higher than recommended ANZECC levels, the toxicological response in fish was much less than predicted. This was attributed to the presence of high levels of naturally occurring dissolved organic matter in the water (creating the ‘tea’ colour associated with river systems on Tasmania’s west coast). Dissolved organic matter binds with copper, rendering it biologically unavailable, and so protects organisms from any toxic effect of this heavy metal.

Based on these results, the remediation works described earlier were found to be adequate for the protection of a recreational trout fishery in Lake Burbury. Lake Burbury presently supports a successful recreational trout fishery, and Hydro Tasmania now conducts its own copper surveys on a routine basis to ensure these conditions don't deteriorate.

Soon after commissioning of the power station in 1992, water containing very low levels of oxygen accompanied by hydrogen sulphide was noted in the tailrace, a common problem in the early life of a reservoir. The low level oxygen was caused by thermal stratification in the reservoir. After investigation and consideration of ameliorative measures, water discharged downstream from the power station was aerated by operation of a jet pump installed on the turbine. This is now utilised to increase dissolved oxygen concentrations at appropriate times. Ongoing and continuous monitoring of the water quality leaving the tailrace ensured adequate notice of low dissolved oxygen levels, and timely utilization of the air injection facilities in the turbine.

6. Reasons for Success

During design and construction, significant community consultation took place with interested stakeholders including the people of Queenstown, those seeking access to the proposed lake, the local councils, the Mount Lyell mine, recreational fisherman interested in the potential for a trout fishery in Lake Burbury, and aquaculture interests in Macquarie Harbour.

The power scheme provided a very welcome boost to local employment opportunities during construction, as the copper mining industry was winding down. With Queenstown so close to the scheme, Hydro Tasmania made increasing use of local labour and contractors.

The building of new transmission line also provided the opportunity to upgrade the power supply to Queenstown and to prepare for the future line from Anthony Power Station. When construction of the King scheme was completed, the local workforce was utilised to build the nearby Ansony Power scheme.

A number of public amenities were built into the scheme, including picnic areas, boat ramps, and public viewing points.

The power scheme has provided some additional tourism opportunities for existing and potential businesses in Queenstown. Comprehensive and early revegetation of disturbed areas has enabled many areas to recovery by the time tourist visits began.

The intended future of the lake as a major recreational trout fishery was a consideration guiding numerous design and construction activities affecting the lake. The local community has greatly appreciated Hydro Tasmania's efforts to establish a recreational fishery in the lake by the diversion works to reduce the inflow of heavy metals. Several construction roads have been converted into convenient boat ramps for public use, and the clearing of timber from the lake has made it safer for boating.

Fig. Lake Burbury

7. Further Information

7.1 References

1) King River Power Development in Australia, "Submission for the IHA BLUE Planet Award (version 2)", July 2001, Hydro Tasmania
2) IHA White Paper, "The Role of Hydropower in Sustainable Development", February 2003, International Hydropower Association

7.2 Inquiries

Hydro Tasmania,
GPO Box 355, Hobart, Tasmania,
7001, Australia
Tel. +61 3 6230 5522
Fax. +61 3 6230 5933
http://www.hydro.com.au/