CROTTY DAM

Tasmania

Submission for an

HISTORIC ENGINEERING MARKER

from

The Engineering Heritage Committee
Tasmania Division
The Institution of Engineers, Australia

September 2000

CROTTY DAM

CONTENTS

INTRODUCTION

Located in western Tasmania, Crotty Dam is an 80m high rockfill dam with a reinforced concrete face. The dam is sited at the entrance to a narrow gorge where the King River passes through the West Coast Range on its way to Macquarie Harbour.

The purpose of the dam is to provide a substantial storage on the King River and to divert its flow through a 7km long tunnel to the 143MW John Butters Power Station for the generation of hydro-electric power. Named Lake Burbury the storage is also retained at its southern end by Darwin Dam, located on the reservoir rim at the Andrew Divide.

The area has a rich history. Crotty Dam takes its name from James Crotty, a mining entrepreneur whose company (North Mt Lyell Copper Mining Co) spent a fortune around 1900 developing a mine at Mt Lyell. To support the mine, a township and smelter were built at Crotty (near the present dam site), a port on Macquarie Harbour and a railway line from the port via Crotty to the mine. The township had a population of 800 in 1901 but virtually died overnight when the smelting process failed to produce copper metal in 1903. The railway continued to transport firewood and timber props to the mine until 1926.

A hydro-electric power scheme was proposed for the Crotty damsite in 1917. The layout was similar to the present scheme except that the dam was to be a concrete arch dam and the water was to be conveyed by aqueduct instead of a tunnel. The excavation of a rock cut to divert the river at the dam site was completed and is still visible. The energy was required for the refining of zinc at Rosebery. However, when a decision was made to establish the smelter at Hobart, using power from the Waddamana Power Station, the King River scheme was abandoned.

Apart from Bradshaws sawmill, further habitation did not return to the King River valley until 1982. Then HEC road construction to the Lower Gordon dam site required the setting up of a construction camp near the remains of the old Crotty township. Soon after the Lower Gordon Power Development was stopped by the High Court in 1983, the King River Power Development took its place and a larger camp was built for the work force engaged on the construction of the Crotty Dam and the headrace tunnel to the power station.

Lake Burbury has an area of 54km^2. It is surrounded by a backdrop of mountains and well-forested hills and valleys, and in calm weather forms a peaceful scene when viewed from the Lyell Highway to the east or the Mt Jukes Road to the west. From the east the whole King River valley is overlooked by the prominent west coast mountain peak, the Frenchmans Cap (1443m).

The high scenic values of the area required the construction works to be carried out with great sensitivity. Most of the construction scars are hidden beneath the lake. This required the evacuation and dismantling of the camp and workshops to enable reservoir filling to commence before the works were complete. Scars above water level were carefully restored with peat and revegetated. All the visible timber was removed from the storage.

Main dimensions:	Dam type	Concrete-faced gravel & rockfill
	Height	80m
	Length	245m
	Face thickness	300mm
	Volume	800,000m^3
	Spillway capacity	245m^3/s chute on dam face, plus 190m^3/s valve in tunnel
	Storage volume	1,065,000ML
	Storage area	52km^2

Commemorative Plaque Nomination Form

Date.....***September 2000***

To:

Commemorative Plaque Sub-Committee
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2000

From…***Tasmania Division***
Nominating Body

The following work is nominated for an ***Historic Engineering Marker***

Name of work.....***CROTTY DAM***

Location, including address and map grid reference if a fixed work.....***On the King River, 10km southeast of Queenstown. Grid ref***: ***E 385600 N 331400 Tas Map Sheet 8013.***

Owner.....***Hydro-Electric Corporation***

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

Copy of letter attached

Access to site.....***by road from Queenstown***

Future care and maintenance of the work.... ***Will be maintained by the Hydro-Electric Corporation as part of the King River Power Development.***

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

……
Chairperson of Nominating Committee

……
Chairperson of Division Heritage Committee

ADDITIONAL SUPPORTING INFORMATION

Name of work..... ***CROTTY DAM***

Year of construction or manufacture..... ***Completed 1991***

Period of operation..... ***Continuous since 1991***

Physical condition ..... ***Excellent***

Engineering Heritage Significance:

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

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

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

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

Rarity..... ***Yes***

Representativeness ..... ***Yes***

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

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

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

Integrity..... ***Yes***

Authenticity..... ***Yes***

Comparable works (a) in Australia..... ***No***

(b) overseas ..... ***Possibly***

Statement of significance, its location in the supporting doco… ***Next page***

Citation (70 words is optimum)…..

HISTORIC ENGINEERING MARKER

CROTTY DAM

COMPLETED IN 1991, THIS 80M HIGH CONCRETE FACED ROCKFILL DAM IMPOUNDING LAKE BURBURY IS NOTABLE FOR HAVING A SPILLWAY CHUTE ON ITS DOWNSTREAM FACE. VERY FEW EMBANKMENT DAMS HAVE THIS FEATURE. FLEXIBLE JOINTS IN THE CHUTE ALLOW IT TO ADJUST TO THE LONG TERM MOVEMENTS OF THE UNDERLYING FILL WITHOUT CRACKING. THE SPILLWAY IS CAPABLE OF PASSING FLOODS UP TO 240M^3/S, THEREBY ALLOWING TIME FOR THE LARGE VALVE IN THE DIVERSION TUNNEL TO BE OPENED. (75 words)

Dedicated by the Institution of Engineers, Australia 2001

Attachments to submission (if any)..... ***See contents***

Proposed location of plaque (if not a site)..... ***Not applicable***

CROTTY DAM

STATEMENT OF SIGNIFICANCE

GENERAL

Crotty Dam has been nominated for listing on the Register of the National Estate. For that purpose a comprehensive Nomination was prepared in accordance with Australian Heritage Commission requirements. In that document the heritage significance of the dam was tested against nine National Estate criteria. Much of the material for this submission has been extracted from that document.

TECHNOLOGICAL/SCIENTIFIC VALUE

Both the dam and the spillway have technical features worthy of note.

The rockfill embankment in fact consists mainly of river gravels which are plentiful in the area whereas rock quarries were not. However some rockfill was available from the excavation of the 7 km long headrace tunnel. This material was used in the upstream zone of the embankment to enable the upstream face slope to be constructed at the rockfill angle of repose (1 on 1.3) rather than the gravel slope of 1 on 1.5. This procedure reduced the volume of the embankment considerably.

In building the embankment, current practice is to place the gravels in horizontal layers about 600mm thick and to compact each layer with several passes of a 10 tonne vibrating roller. This process reduces the subsequent settlement of the embankment under water loading when the reservoir is filled. Compacted gravel is in fact a more rigid material than compacted rockfill. However the dam was to be built in a high rainfall area and the King River gravels were so well-graded that, when wet, compaction would develop pore pressures and the job would have to be delayed until the pore pressure dissipated. To avoid these delays a gravel washing plant was built to remove the fines and create a stockpile of clean gravel which could be placed and compacted in wet weather. In some cases layers of tunnel rock were placed to aid drainage. The construction engineers managed to make big savings on the dam cost by using as much gravel straight from the borrow pits as possible and minimising the use of the much more expensive processed gravels.

While some embankment dams have emergency spillways (for rare use) on their downstream faces, very few have service spillways. The designers are concerned that a rigid concrete spillway chute resting on the dam fill may develop cracks as the embankment gradually settles over time. When the spillway is discharging floodwater at high velocity, it is possible that a cracked chute could be damaged and, if it allowed water to escape, the dam itself could be damaged or destroyed.

At Crotty Dam there were several favourable factors. One was that a relatively small chute (12m wide) would be sufficient to discharge substantial floods. Another was that a large outlet was provided in the diversion tunnel to supplement the chute capacity, so that floods of all sizes could be handled. However during severe storms it could be some days before personnel could reach the outlet to open it. The chute spillway is designed to discharge the rising flood for that period. A third factor was that the use of gravels in the embankment would minimise the long-term settlements of the fill supporting the concrete chute.

In the detailed design of the chute, the structure was firmly anchored into the rockfill outer zone, and flexible joints were provided across the chute at regular intervals. These joints enabled the chute to adjust to movements of the underlying embankment without cracking. In addition an aeration slot was installed at each joint and, in jumping over the slot, the water entrained air which reduced the risk of damaging the concrete by cavitation. We are not aware of another spillway being designed in this location with all these attributes.

HISTORICAL VALUE

The historical value of Crotty Dam arises mainly from its perpetuation of the name of the mining entrepreneur James Crotty whose smelters and village were established near the present dam site around 1900.

The new bridge which carries the Lyell Highway across Lake Burbury is called Bradshaws Bridge after the owner of the sawmill displaced by the rising waters of the lake.

SOCIAL VALUE

The new lake is popular with people living on the west coast. An angling club has built premises on the western shore, and a HEC constructed a picnic area on the eastern shore, with a magnificent view of the West Coast Range. Boats can be launched at several locations.

LANDSCAPE VALUE

Lake Burbury has enhanced the already attractive scenery in the valley. On still sunny days, the reflections in the lake of the surrounding mountains are delightful.

RARITY

While there are many concrete-faced rockfill (gravel) dams in Australia, we are not aware of another dam with a concrete chute spillway on its downstream face.

REPRESENTATIVENESS

The dam itself is a good example of a modern concrete-faced rockfill dam.

CONTRIBUTION TO NATION OR REGION

The dam created a large lake which is used for power generation and for additional security for Tasmania's hydro-electric system.

CONTRIBUTION TO ENGINEERING

Several technical papers on the dam and the spillway have been presented at international forums, as listed in the references.

While no large floods have yet occurred, the behaviour of the spillway to date has been as expected and regular measurements of movements are carried out.

PERSONS ASSOCIATED WITH THE WORK

The following HEC engineers were associated with the work:

Mike Fitzpatrick	Asst Chief Civil Engineer Design (later Chief Civil Engineer and Asst General Manager Engineering)
Frank Kinstler	Engineer Design Group 3
Bill Tindall	Section Engineer Dams
Steven Li	Section Engineer Dams
Rick Boyle	Project Manager King & Anthony

INTEGRITY

The dam remains in its as-constructed condition. Its behaviour is monitored and is satisfactory.

AUTHENTICITY

The dam was designed and constructed by the Hydro-Electric Commission (now Corporation) Tasmania in accordance with current practice and to suit the particular conditions at the site.

COMPARABLE WORKS

(a) There are many dams of this type in Australia. The highest concrete-faced rockfill dams in Australia are:

NAME	HEIGHT	YEAR	STATE
Reece	122m	1986	Tas
Cethana	110m	1971	Tas
Sugarloaf	89m	1980	Vic
Murchison	89m	1982	Tas
Pindari	85m	1995	NSW
Mangrove Creek	80m	1982	NSW
Crotty	80m	1991	Tas

(b) There are many dams of this type in other countries. In 1996 the highest concrete-faced rockfill dam was 187m high.

REFERENCES

1. ANCOLD 1990. *Register of Large Dams in Australia*, Australian National Committee on Large Dams, Hobart.

2. Fitzpatrick, M D 1988. "Crotty Dam Spillway Over Dam and Bottom Outlet", *Trans 16th ICOLD Congress*, San Francisco, Session on Q63 Speaker 20 in Vol 5 p.582-585.

3. ICOLD 1988. *World Register of Dams*, International commission on Large Dams, Paris.

4. Li, S.Y. et al 1993. "Design of Crotty Dam and Spillway", *Proc International Symposium on High Earth-Rockfill Dams*, October, Beijing, China, Vol.1, pp 263-271.

5. Li, S.Y. et al 1994. "Design and Monitoring of Crotty Dam Spillway", *ANCOLD Bulletin* Issue No 98, December.

6. Li, S.Y. et al 1997. "Five Years Monitoring of Crotty Dam Spillway", *Trans 19th ICOLD Congress*, Florence, Vol 1, C.21, p.789-806.

7. Geoffrey Blainey 1993. *The Peaks of Lyell*, 5th Edition, St. David's Park Publishing, Hobart.

8. "Hydro Development in Tasmania", *Water Power & Dam Construction*, December 1987.

Hydro

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Our Ref.
Your Ref.
Ask for

24 February 2000

Mr K C Drewitt
Chairman
Engineering Heritage Committee
The Institute of Engineers
2 Davey Street
Hobart Tas 7000

Dear Mr. Drewitt,

Thank you for your correspondence of 14 February 2000, advising of the eight dams which have recently been nominated for national heritage listing on the National Estate Register.

The Hydro is very pleased to approve the nominations and we look forward to hearing the outcome of the proposed public recognition awards.

With kind regards,

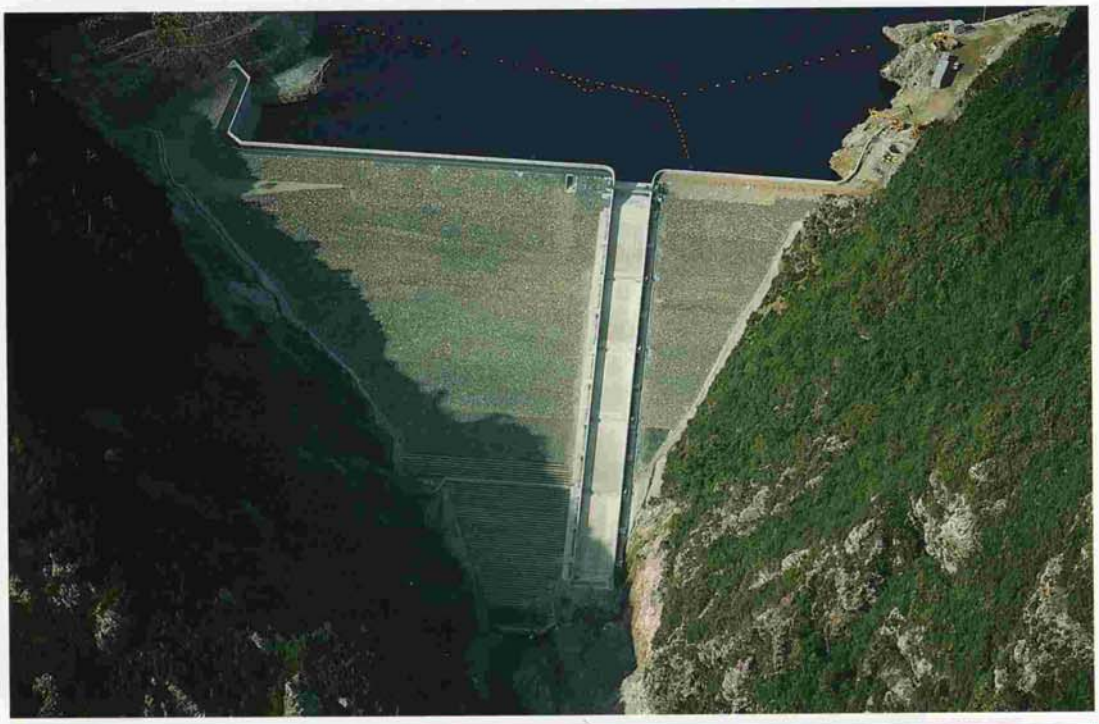
Yours sincerely,

Roger Gill
Generation Manager Generation

c.c. Andrew Pattle, Dam Safety Manager
Peter Grierson, Manager Power Schemes

CROTTY DAM

AUSTRALIA



TYPE: Concrete faced rockfill
HEIGHT: 82 m **CREST LENGTH:** 280 m
EMBANKMENT VOLUME: 800 000 m^3
STORAGE VOLUME: 1065 million m^3
SPILLWAY CAPACITY: Jet flow valve 200 m^3/s, Crest spillway 240 m^3/s
COMPLETED: 1991
OWNER: Hydro-Electric Commission of Tasmania

Crotty Dam is the main dam of the King River Power Development near Queenstown in western Tasmania. It is located at the entrance to a steep and narrow gorge. Upstream of the dam, however, the terrain is flatter and Lake Burbury, the storage created by Crotty Dam (along with a saddle dam, Darwin Dam), is quite large at 50 km^2.

Crotty Dam is a concrete faced rockfill dam with several distinguishing features. The main embankment consists of river gravels of high density and low permeability; this fill material is supplemented by zones of free-draining rockfill obtained from the excavation of the headrace tunnel. The concrete face is unusual in that it lies in three planes due to the need to turn the crest through ninety degrees in plan to avoid founding the plinth over a fault in the right abutment.

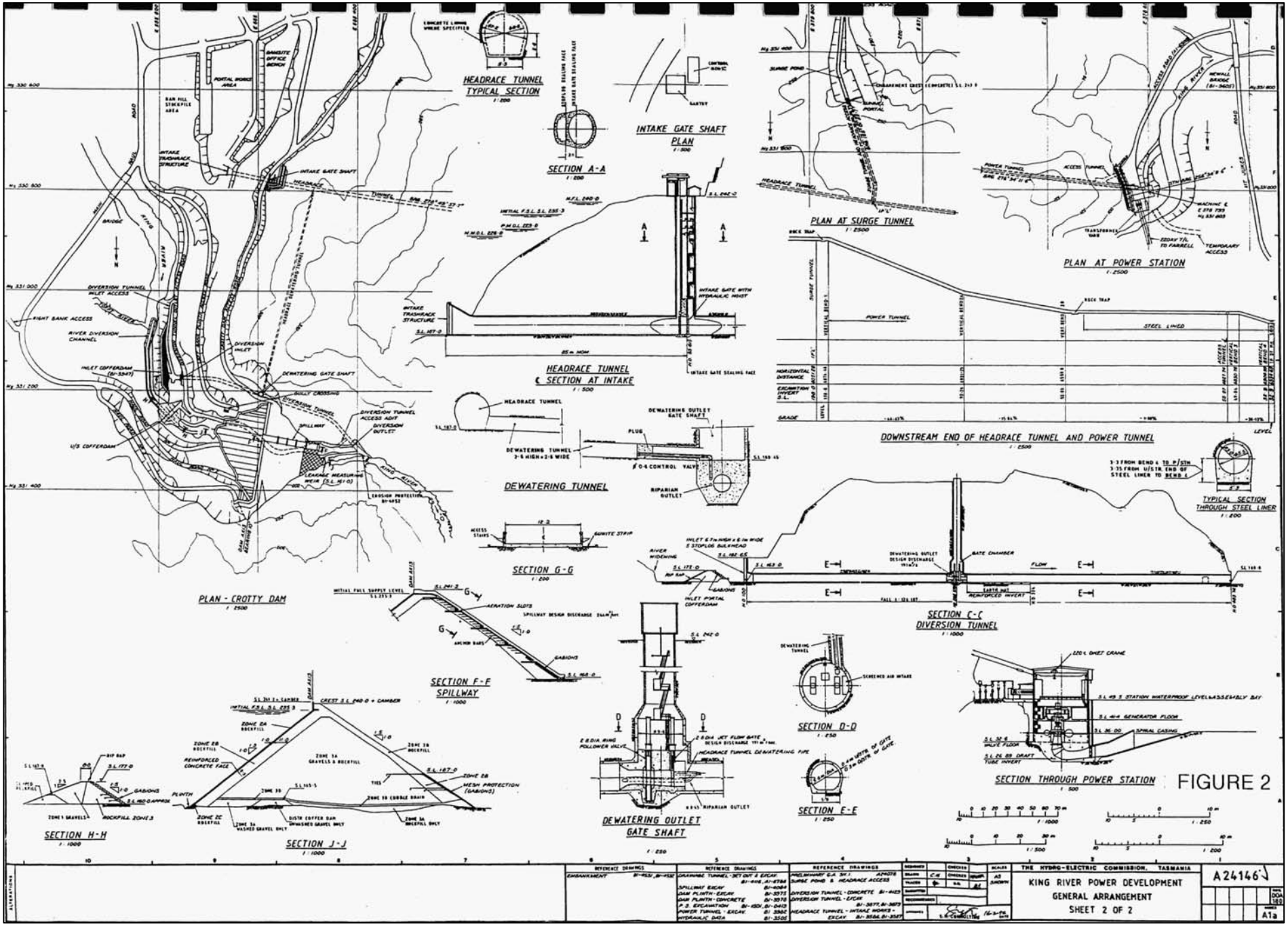
Because the steep-sided valley posed difficulties in the siting of a conventional open spillway beside the dam, the spillway has been placed on the downstream face at its deepest point. This is a world first for a dam of this size and type. The 12 m wide spillway is divided into structurally independent lengths with aeration slots at 23 m intervals. The spillway capacity is augmented by an operable outlet (a 2.8 m diameter jet flow valve) in the diversion tunnel.

Services Provided

Feasibility study, investigations, detailed design, documentation, supervision of construction, operation and maintenance.

HEC


Savage River
Corinna
TOLL PUNT CRUISE
REECE DAM
Mt Livingstone
Mt Meredith
MERIDITH RANGE
Yellow Cr
Mt Ramsay
Que R
Mt Charter
Mt Remus
Cradle Valley
WALDHEIM
VISITOR CENTRE
Middlesex Plains
Mt Cattley
CRADLE MTN
MACKINTOSH DAM
Mt Romulus
WOOD CRAFTS LIGHT RAILWAY
Tullah
Mt Farrell
Granite Tor
BASTYAN DAM
Rosebery
Mt Black
MURCHISON DAM
Victoria Peak
MT MURCHISON
Renison Bell
MINE
Williamsford
TRIBUTE
MONTEZUMA FALLS
Mt Read
Mt Heemskirk
Trial Harbour
MINE MUSEUM
Zeehan
Mt Agnew
Mt Zeehan
Mt Tyndall
Lake Rolleston
Eldon Peak
1439
Eldon Bluff
CRADLE MOUNTAIN
LAKE ST CLAIR
NATIONAL PARK
PART OF TASMANIAN WILDERNESS WORLD HERITAGE AREA
MT OSSA
HENTY GLACIAL MORAINE
HISTORIC POWER STATION
Mt Sedgewick
Mt Lyell
Lake Burbury
COPPER MINE
Gormanston
Queenstown
MUSEUM
CHAIRLIFT
Mt Owen
NELSON FALLS NATURE TRAIL
Victoria Pass
Lynchford
Strahan
WHARF CENTRE
Regatta Point
JOHN BUTTERS
CROTTY DAM
Mt Jukes
Crotty Dam
DONAGHYS HILL LOOKOUT
Mt Alma
C Sorell
Macquarie Hds
SCENIC FLIGHTS CRUISES
Swan Basin
KING RIVER FOREST DRIVE
Teepookana Forest Reserve
DARWIN DAM
Mt Darwin
Mt Sorell
1144
Mt Flinders
FRANKLIN RIVER NATURE TRAIL
FRENCHMANS CAP
1443
Sophia Pt
Liberty Pt
Table Hd
Sloop Rocks
Sloop Pt
Phillips I
Gorge Pt
Gould Pt
CONVICT RUINS
Sarah I
Rum Pt
Mt McCall
FRANKLIN - GORDON WILD RIVERS NATIONAL PARK
PART OF TASMANIAN WILDERNESS WORLD HERITAGE AREA
Goodwins Peak
Mt Humboldt
Western Plains
ERS
t Helens


HEADRACE TUNNEL TYPICAL SECTION
1:200
INTAKE GATE SHAFT PLAN
1:500
SECTION A-A
1:200
PLAN AT SURGE TUNNEL
1:2500
PLAN AT POWER STATION
1:2500
HEADRACE TUNNEL & SECTION AT INTAKE
1:500
DOWNSTREAM END OF HEADRACE TUNNEL AND POWER TUNNEL
1:2500
DEWATERING TUNNEL
TYPICAL SECTION THROUGH STEEL LINER
1:200
PLAN - CROTTY DAM
1:2500
SECTION G-G
1:200
SECTION C-C DIVERSION TUNNEL
1:1000
SECTION F-F SPILLWAY
1:1000
SECTION D-D
1:50
SECTION E-E
1:50
SECTION H-H
1:1000
SECTION J-J
1:1000
DEWATERING OUTLET GATE SHAFT
1:250
SECTION THROUGH POWER STATION
1:500
FIGURE 2
THE HYDRO-ELECTRIC COMMISSION, TASMANIA
KING RIVER POWER DEVELOPMENT
GENERAL ARRANGEMENT
SHEET 2 OF 2
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A1a