Trips: Trips - 13

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Dag Hammarskjölds saml.

D. H. trips 1956 Feb. 15-16

Trip to Snowy Mountains (Australia)

YOUR ITINERARY

SNOWY MOUNTAINS HYDRO-ELECTRIC AUTHORITY

VISIT TO AREA BY MR. DAG HAMMARSKJOLD, SECRETARY-GENERAL, OF UNITED NATIONS.

15/16th. February, 1956.

Wednesday, 15th. February, 1956.

10.00a.m.	-	11.00a.m.	Description of Scheme. Film. Morning Tea.
11.00a.m.	-	11.45a.m.	Scientific Services Laboratories.
11.45a.m.	-	2.00p.m.	Travel to Eucumbene Lookout. Picnic lunch.
2.00p.m.	-	3.00p.m.	Travel to Junction Shaft. Inspect works.
3.00p.m.	-	5.15p.m.	Travel to Tumut Pond. Inspect works.
5.15p.m.	-	6.15p.m.	Travel to T.1. Inspect underground workings.
6.15p.m.	-	6.45p.m.	Travel to Pete Jarman Cottage, Cabramurra.
7.p.m.			Dinner and stay night at the Pete Jarman Cottage, Cabramurra.

Thursday, 16th. February, 1956.

7.00a.m.	-	7.30a.m.	Breakfast at the Pete Jarman Cottage, Cabramurra.
7.35a.m.	-	9.45a.m.	Travel to and inspect Adaminaby Dam.
9.45a.m.	-	10.45a.m.	Travel to Cooma Airport via Rocky Plains Road.
			End of Tour.

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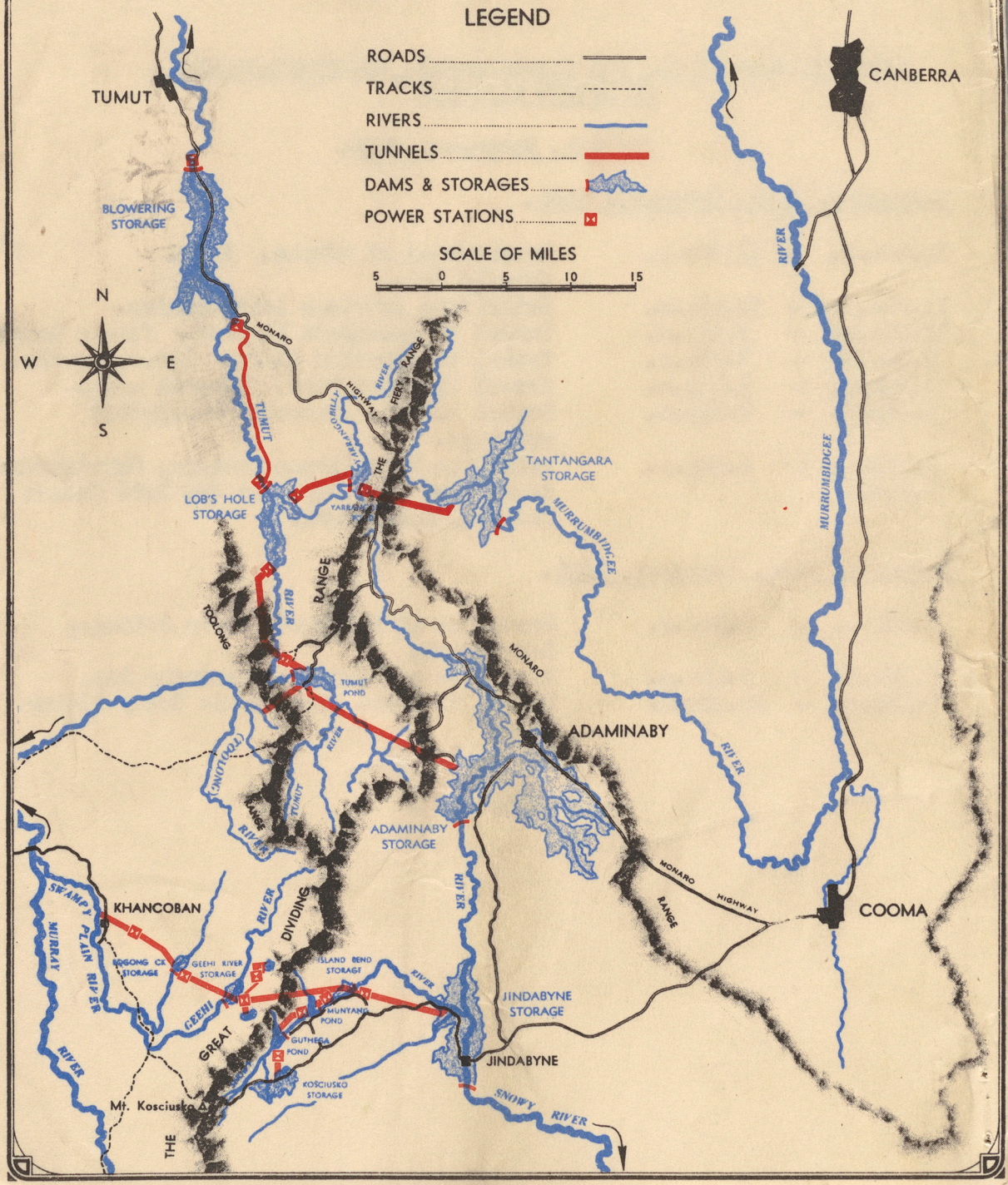
SNOWY MOUNTAINS HYDRO-ELECTRIC SCHEME



THE SNOWY MOUNTAINS SCHEME

PRICE 2/6

SNOWY MOUNTAINS HYDRO-ELECTRIC AUTHORITY

APRIL 1955

AUSTRALIA'S FUTURE SECURITY DEPENDS ON ITS ABILITY TO SUPPORT ITS PROPER SHARE OF THE PEOPLES OF THIS OVERCROWDED WORLD. TO DO THIS IT MUST EXPAND ITS INDUSTRIES AND INCREASE FOOD PRODUCTION, WHICH IN TURN MEANS MORE POWER AND MORE WATER — MORE POWER FOR INDUSTRY, MORE WATER FOR IRRIGATION.

THE SNOWY SCHEME CAN CONTRIBUTE MORE TO THE PROVISION OF THESE TWO ESSENTIALS — POWER AND WATER — THAN ANY OTHER DEVELOPMENT WORK EVER CONTEMPLATED IN AUSTRALIA.

THE SNOWY MOUNTAINS SCHEME

WATER AND POWER

FOR

THE DEVELOPMENT OF AUSTRALIA

THE SCHEME

The rugged ranges in the south-east of Australia, known as the Australian Alps, form the highest land mass of the continent. They include the Snowy Mountains, which extend north to south for a distance of approximately 100 miles and rise to an elevation of 7313 feet at Kosciusko, the highest peak in Australia.

The Snowy Mountains are snow-capped for five or six months every year. This extensive area of land of high elevation with its rapid fall to low levels, together with the high annual snowfall and rainfall, provides conditions which are particularly favourable for the generation of hydro-electric power.

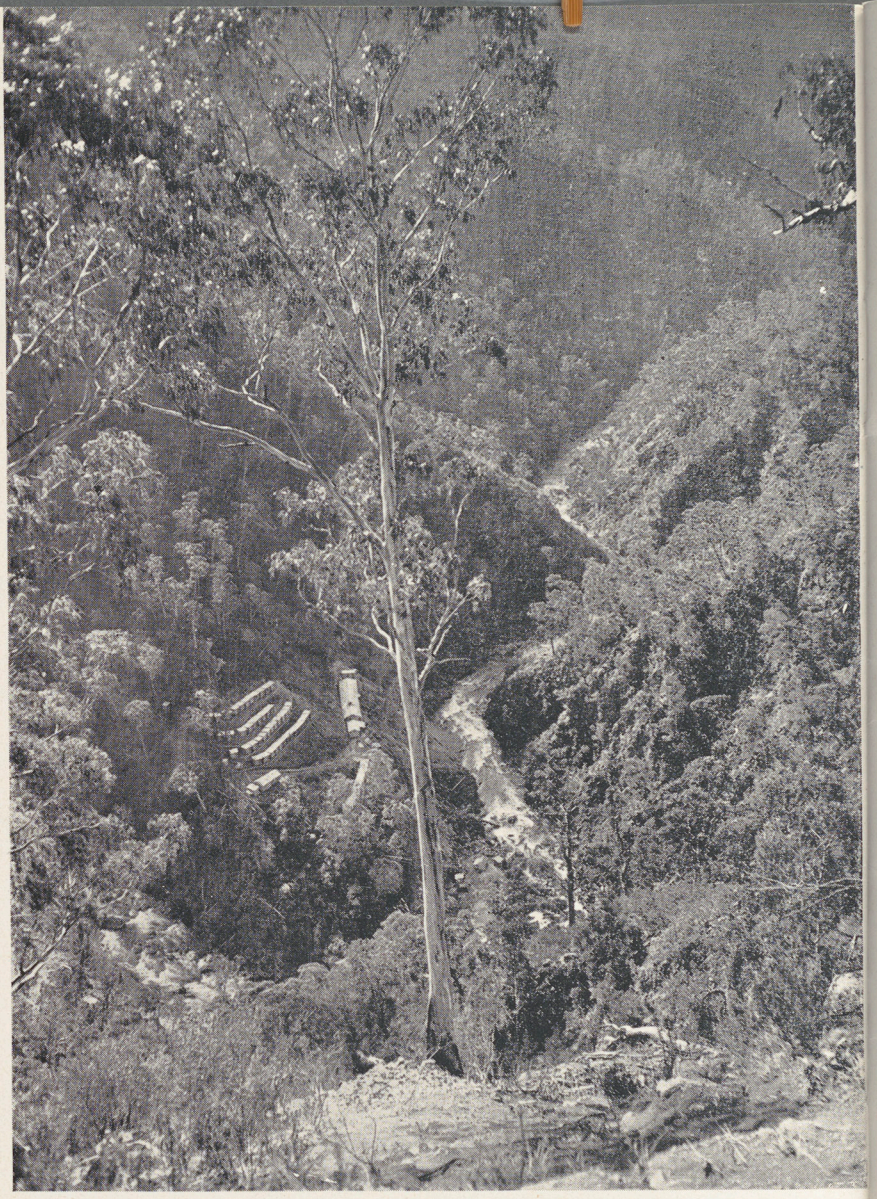
Several rivers rise in the Snowy Mountains. After leaving the mountains, the waters of three of the most important of these, namely the Murray, the Murrumbidgee and its tributary the Tumut, flow generally westward to traverse the dry but otherwise fertile plains which stretch for several hundred miles to the coast of South Australia. Irrigation farming on these plains is already a well-established and prosperous industry, with food and other primary production greater than in any other irrigation region in Australia. Further substantial expansion of production is dependent on augmenting the flow of the Murray and Murrumbidgee Rivers.

The fourth river, the Snowy, rises in the highest part of the Snowy Mountains and receives the largest share of the run-off. It flows in the opposite direction, to the south-east coast, traversing eastern Victoria, a region which, owing to its adequate and regular rainfall, does not require water for irrigation.

The realization that the well-watered lands of eastern Victoria could afford to share the Snowy with the dry lands on the western side of the mountains led to various proposals to divert the upper reaches of the Snowy to the west. The higher elevation of the upper Snowy in relation to the other rivers makes such diversions practicable and offers opportunities for developing very large amounts of hydro-electric power.

The Scheme, as finally adopted, provides for the diversion of part of the upper Snowy and its tributaries to the Murray and the remainder to the Tumut. It involves the construction of 7 major dams; 17 power stations, most of which will be underground; 83½ miles of tunnels varying in size to over 30 feet in diameter; over 330 miles of racelines or aqueducts along the mountain sides to pick up streams and lead their waters to reservoirs and tunnels; shafts ranging up to 1100 feet deep; and some hundreds of miles of mountain roads.

Ultimately, the Scheme will make available nearly two million acre-feet of water each year for irrigation in the Murray and Murrumbidgee valleys, and will provide approximately three million kilowatts of power.



Tumut River Gorge at Happy Valley

By undertaking one of the largest water development schemes in the world, Australia is demonstrating recognition of her responsibilities—her responsibility to increase primary production and her responsibility to provide large quantities of electric power for the expansion of industry and to help in raising further our standard of living and defence preparedness.

THE SNOWY MOUNTAINS POTENTIAL

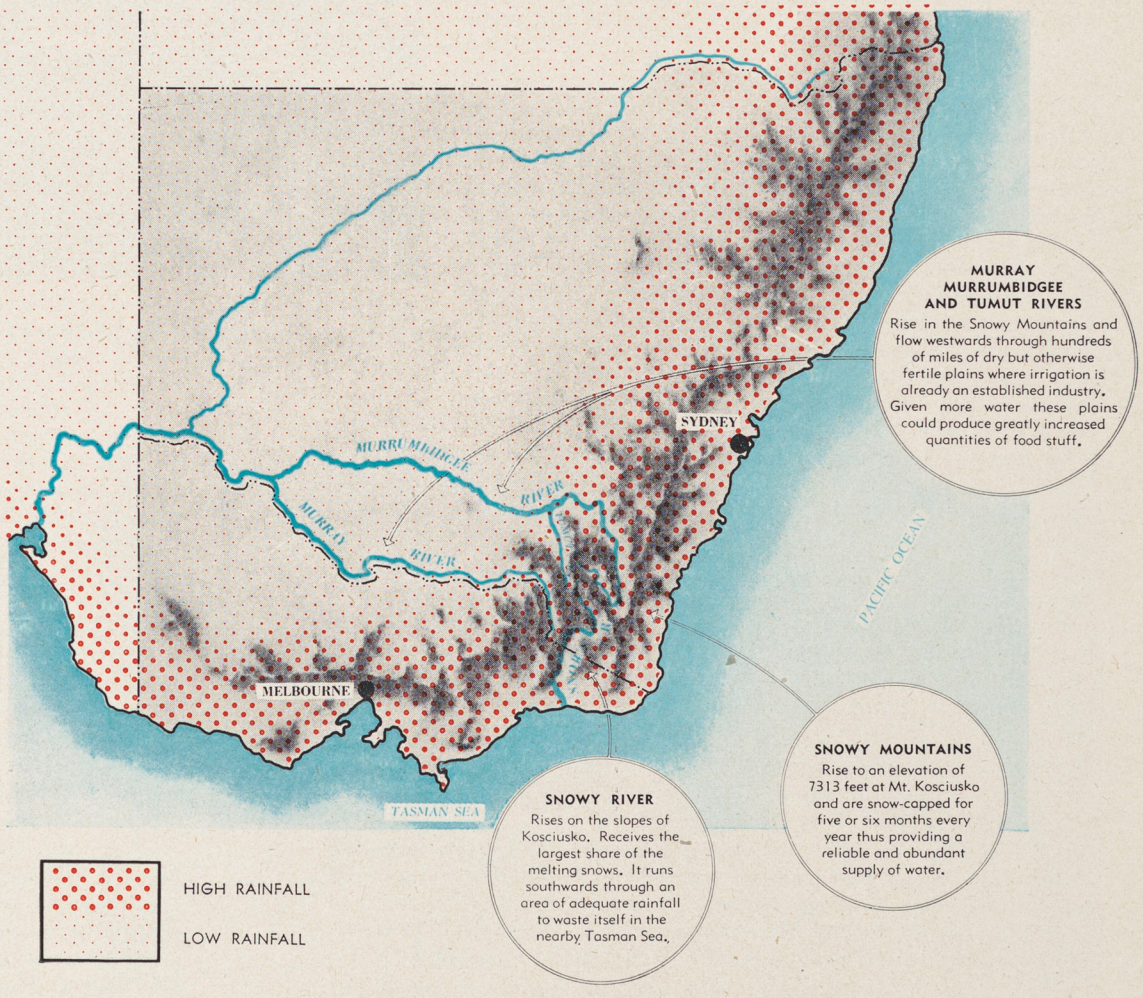
THE SCHEME:

WATER

By means of dams and tunnels the waters of the Snowy will be diverted to the Murray and Murrumbidgee River Systems for irrigating the dry lands of the West.

POWER

The fall of the diverted waters as they pass through the tunnels and shafts will be utilised for producing huge quantities of power.



BACKGROUND OF THE SCHEME

Road constructed by the Authority in the Tumut River Gorge between Cabramurra and T.1 Power Station site.

From time to time over the last 70 years various proposals have been put forward for making use of the waters of the Snowy Mountains Area. Most of the early schemes centred around water for irrigation, but between 1915 and 1918 the New South Wales Department of Public Works carried out surveys with a view to using the Snowy River for the generation of electricity for Sydney and the south-east region of the State. This project did not contemplate the use of water for irrigation and was considered solely from the aspect of production of power, the total amount of which was estimated at 150,000 kilowatts.

In the early and middle twenties other proposals were considered, including one for the supply of water to Sydney and some country towns. In 1937, the former hydro-electric scheme of 1918 was revived and elaborated by two Swedish Engineers engaged by a firm of British Consulting Engineers acting for the New South Wales Government. The estimated capacity of their proposal was approximately 250,000 kilowatts, that is, 100,000 kilowatts greater than the 1918 proposal, but less than one-tenth that of the present Snowy Mountains Scheme.

All these proposals arose from regional interests rather than the full utilization of the water resources of the Area in the interests of the Nation as a whole.

Later, in 1944, a Special Committee appointed by the New South Wales Government carried out further investigations on the possible use of the Snowy River and stressed the need to divert the water to the Murrumbidgee for irrigation. However, the Commonwealth and Victoria were both concerned.

The Commonwealth had certain rights conferred by the Seat of Government Acts of 1909. Victoria had some claim on the waters because the lower Snowy traversed the eastern portion of that State. A Victorian Engineer drew attention to the fact that by diverting the Snowy into the Murray, not only would its waters be available for irrigation but also the power output would be considerably greater than from any of the earlier schemes considered by New South Wales.

The commencement of effective action came for the first time in June 1946 when Ministers of the Commonwealth, New South Wales, and Victoria, with their technical advisers, met to discuss the future of the Snowy waters. Thus for the first time the use of this river was considered from the National viewpoint, and, in addition, due attention was given to its complete usage for both power and irrigation. New South Wales representatives at the Conference strongly advocated the diversion of the Snowy to the Murrumbidgee for irrigation. Victorian representatives, however, pressed for diversion to the Murray.

The important conference ended with an agreement that an investigation into the two alternative proposals, namely, diversion to the Murrumbidgee and diversion to the Murray, should be carried out by the Commonwealth. The engineering aspects were made the responsibility of the Department of Works and Housing and the agricultural and economic aspects were handled by the Department of Postwar Reconstruction. Both Departments were assisted in their investigations by the

New South Wales and Victorian State Government Services and by experts from other Commonwealth Departments.

The result of this Commonwealth examination showed that the proposed diversion from the Snowy to the Murray was not only practicable but was also extremely attractive from the viewpoint of production of power. The agricultural and economic investigation, however, indicated that from the viewpoint of irrigation the proposal to divert the waters to the Murrumbidgee Valley possessed advantages.

A Premiers' Conference in August 1947 considered the power and irrigation reports and recommended further investigation. For this purpose, a Technical Committee was set up under the Chairmanship of Dr. L. F. Loder, Director General of the Commonwealth Department of Works and Housing, with representatives from the Commonwealth, New South Wales, and Victoria. The main function of this Technical Committee was to obtain the necessary information so that a decision could be made on which of the rival schemes should be adopted.

In its first report of November 1948, the Committee showed that the potential value of the waters of the Snowy Mountains was very much greater than previously appreciated. It recommended that neither of the alternatives previously considered be adopted, but that another proposal providing for the diversion of a substantial quantity of water from the Snowy, the Murray, and the Murrumbidgee catchments to the Tumut River should be proceeded with as soon as possible, and that further investigations should be carried out before a decision was made on the use of the remainder of the Snowy flow. This recommendation was approved by Ministers representing the Commonwealth and the States of New South Wales and Victoria in February 1949.

The Technical Committee's second report, recommending that the balance of the Snowy River waters should be diverted to the Murray, was presented in June 1949. This report covered the full range of the Committee's investigations, which extended far beyond a specific comparison of the two alternative proposals and included an examination of the water resources of the whole Snowy Mountains Area. The examination brought out the great significance of the Scheme and lifted it to the level of one of major importance, from the viewpoint of both irrigation and power development. It was established that in addition to the water diverted from the Snowy and Tooma Rivers, "storages . . . . . will be used to regulate the Tumut and Murrumbidgee Rivers so that a considerable amount of the flow of those streams, which is at present not used because of lack of regulation, will become available for irrigation in the Murrumbidgee."

Ministers of the Governments of the Commonwealth, New South Wales, and Victoria met in Canberra in July 1949 and approved the Committee's recommendations. To give effect to the proposals, and so enable the extensive water resources nature has provided in the Snowy Mountains Area to be fully developed for the use of the Nation, the Commonwealth Parliament passed the Snowy Mountains Hydro-Electric Power Act, 1949, establishing the Snowy Mountains Hydro-Electric Authority, which came into being on 1st August, 1949. Activities commenced immediately .

The Technical Committee presented its final report in May 1950, setting out the scheme as finally recommended. This report included much more detailed information than the earlier ones and stressed the fact that the newly constituted Snowy Mountains Authority would need to extend and amplify the investigational work done before detailed designs could be prepared.

Sledging supplies to camps in winter. A vital feature of the Scheme is the full utilization of the largest snowfields in Australia.

DESCRIPTION OF THE SCHEME

The basis of the Scheme is the impounding of the Snowy River and its tributary the Eucumbene where they leave the high country on the eastern side of the mountains, and the diversion of their waters through long tunnels under the main dividing range into the western rivers.

In this way, enough water to cover 1500 square miles one foot deep will be supplied annually to the farms in the Murray and Murrumbidgee Irrigation Areas, in drought years and in good years alike. The fall of the diverted waters will be utilized for generating very large amounts of water.

The diversion of the Snowy to the Murray is known as the *SNOWY-MURRAY DEVELOPMENT* and the diversion of the Eucumbene to the Tumut, a tributary of the Murrumbidgee, is known as the *SNOWY-TUMUT DEVELOPMENT*. In addition to the main diversions, each of these developments includes subsidiary projects for the generation of additional power. Although it is convenient to consider the Scheme in two sections, it is emphasized that it will develop as one integrated whole for purposes of power generation and distribution, and for the supply of water for irrigation.

The Snowy - Murray Development

This development consists of three main parts:

(1) The main diversion of the Snowy River at Jindabyne to the Swampy Plains River in the upper Murray Valley.

(2) A group of power stations in the upper Snowy Valley.

(3) Another group of power projects in the Geehi Valley on the western side of the main dividing range.

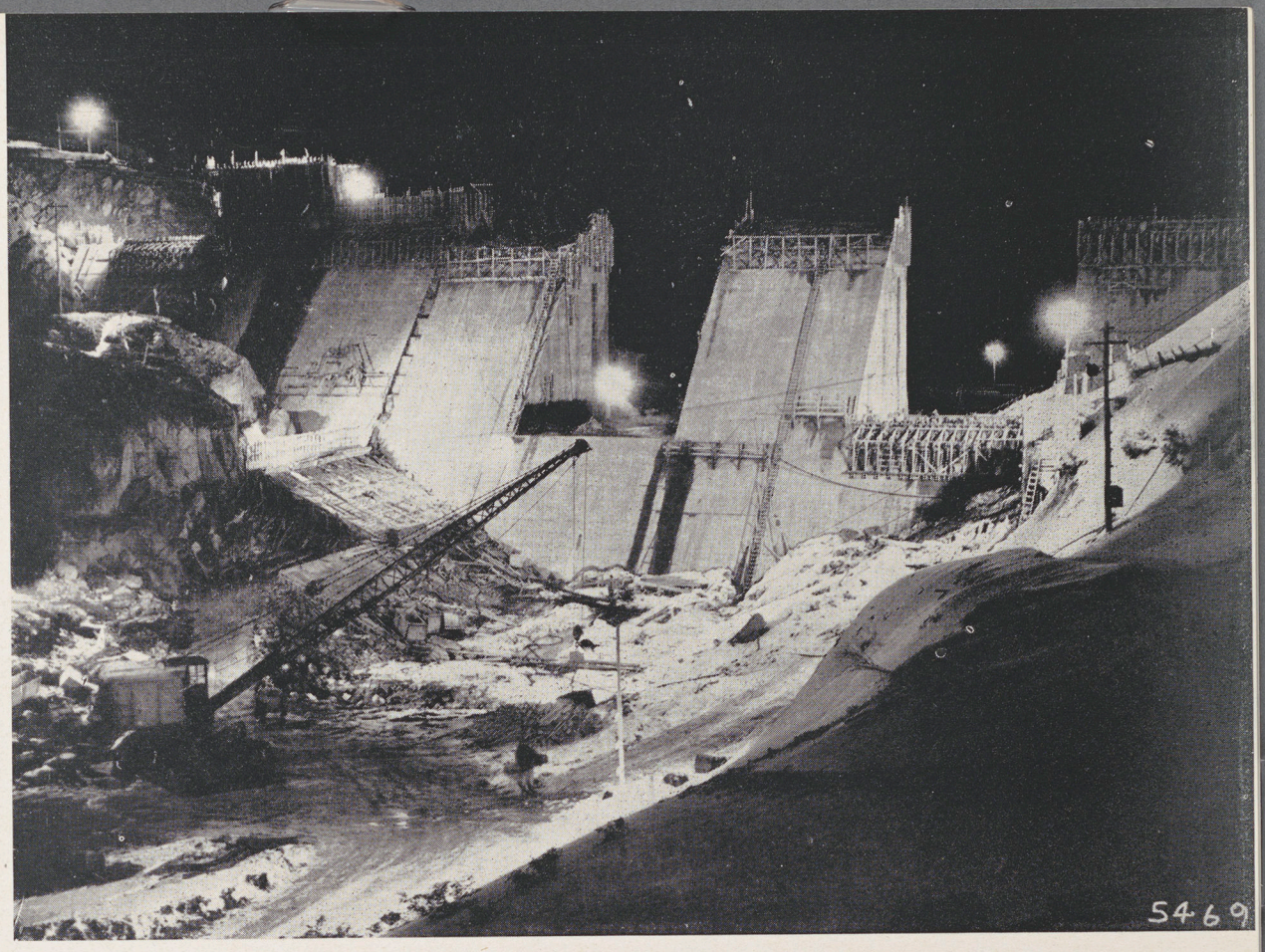
(1) *The Snowy-Murray Diversion Works.*—The main works for this diversion are the dam at Jindabyne on the Snowy River, the tunnel through the mountains, and the large Power Stations M.6 and M.7 to utilize the 2000 feet fall between Jindabyne and the Swampy Plains River. The dam at Jindabyne on the Snowy River will be some 260 feet high and will store 1,200,000 acre-feet of water, enough to cover an area 2000 square miles about one foot deep. The Snowy-Murray tunnel will have a diameter of approximately 15 feet at Jindabyne and over 30 feet at the western end. It will total 30 miles in length, and in places the rock cover will be greater than 3000 feet.

GUTHEGA TUNNEL. Part of this tunnel is concrete-lined where the rock is not self-supporting, but most of it is unlined, as in the foreground. This tunnel takes water from Guthega Dam on the upper reaches of the Snowy River to the penstocks feeding the Guthega Power Station. The Guthega Project, in operation at the beginning of 1955, is the first of the power stations of the Snowy Mountains Scheme to generate electricity.

The combined capacity of the two underground Power Stations M.6 and M.7 will be over 1,000,000 kW, more than the total capacity installed in the whole of New South Wales at the present time. The first power station, M.6, will discharge into a small storage on Bogong Creek, 22 miles west of Jindabyne. From this pondage, the tunnel will carry the water to Power Station M.7, discharging finally into the Swampy Plain River near Khancoban.

At two points on the tunnel line, shafts will connect with reservoirs on the rivers above, one where the tunnel passes under the upper Snowy River at Island Bend and the other where it passes under the Geehi River. Power Stations M.3 and M.5.L will be built at the base of these shafts to develop power from the falling waters before they flow into the tunnel. The shaft at Island Bend will be 1000 feet deep.

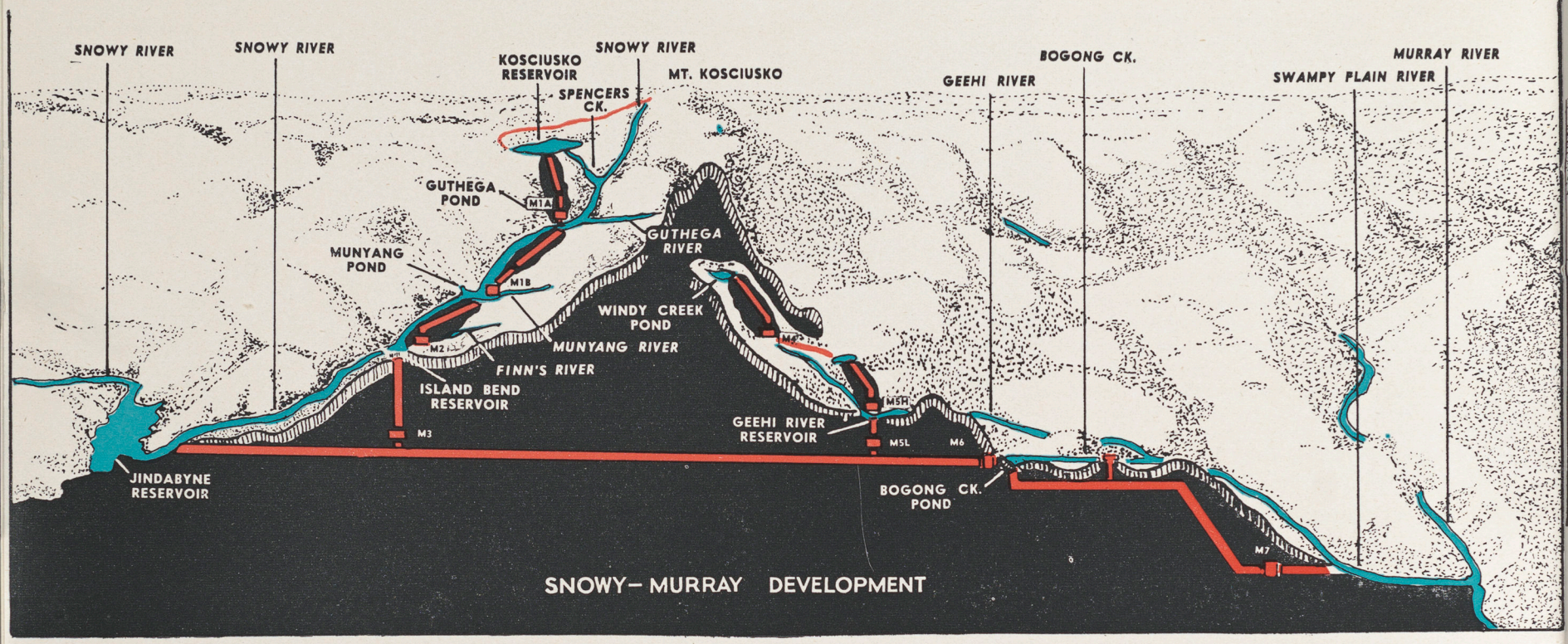
(2) *The Upper Snowy Projects.*—By means of a system of racelines, dams, tunnels, and power stations, the waters of the upper Snowy will produce power at four stations, including M.3 at the base of the Island Bend shaft mentioned above, before entering the main Snowy-Murray diversion tunnel. The main storage for this series of power stations will be on Spencer's Creek, a tributary of the Snowy near Charlotte Pass. This storage, known as Kosciusko Reservoir, will be at an altitude of nearly 6000 feet. Because of the very great power potential of water at this altitude, many miles of racelines can be justified economically, to collect mountain streams from the surrounding areas and lead them into the reservoir.



Work on the major projects of the Scheme continues day and night. This is a night scene during the building of Guthega Dam, at the junction of the Snowy and Guthega Rivers.

The water will then pass through three projects, viz., M.1.A., M.1.B (Guthega), and M.2. Each of these three projects will consist of a dam to provide a small pondage, several miles of tunnel and racelines, as well as the power station works. From M.2 Power Station on the third project the water will discharge to Island Bend Reservoir, where, as mentioned above, it will be dropped through a shaft over 1000 feet deep into the main Snowy-Murray diversion tunnel, passing through Power Station M.3 at the base of the shaft. Concentration on the second of these projects, known as the M.1.B or Guthega Project, has enabled the Authority to make a significant contribution already to the power available to the New South Wales system. The Guthega Power Station, with two of the projected three generators now producing 60,000 kW, is the first of the Authority's power stations to be built. Pending the completion of the Kosciusko Reservoir, it will operate as a "run-of-the-river" station with a variable output.

(3) *Geehi Valley Projects.*—High up on the western slopes above the Geehi River, under the peaks of the main range at an elevation of 5200 feet, a small dam will be built on Windy Creek. Racelines will collect and lead additional water into this reservoir. The water will then pass through a tunnel and shaft to Power Station M.4, 1700 feet below, thence through another tunnel and shaft to Power Station M.5.H, a further fall of 300 feet. The water will then enter a shaft on the Geehi River and so into the main diversion tunnel through Power Station M.5.L.



The Snowy - Tumut Development

This development consists of three main parts:

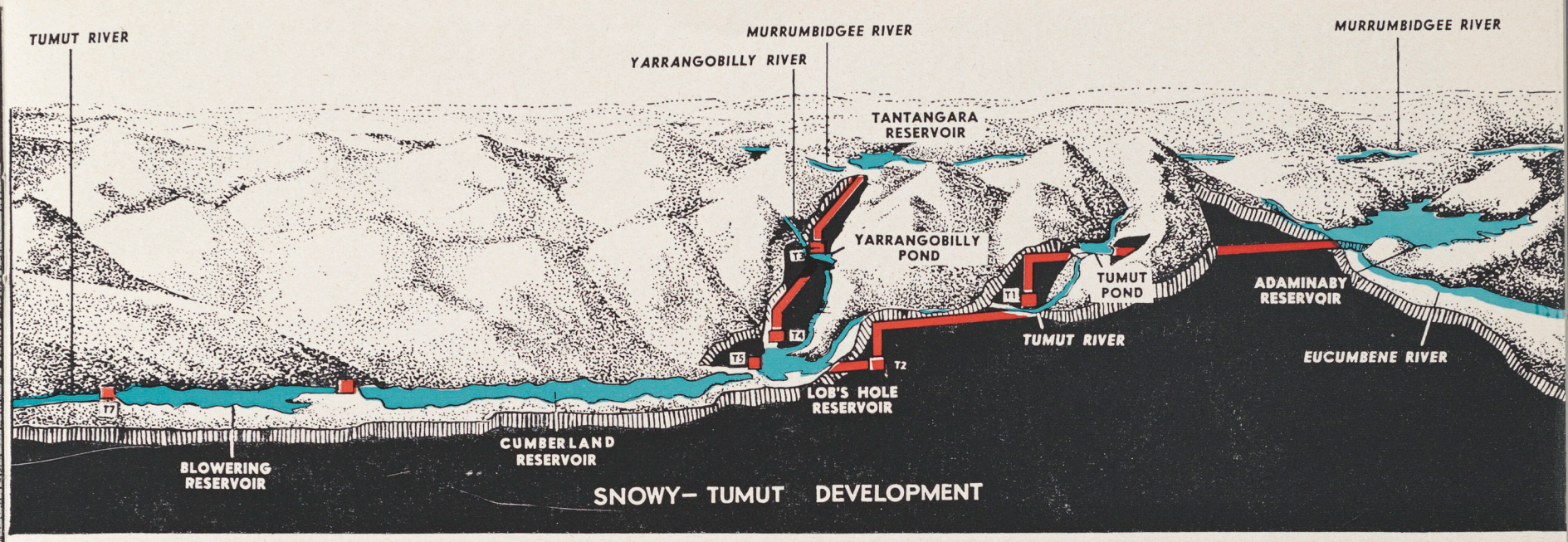
(1) The main diversion of the Eucumbene in the Snowy catchment and the supplementary diversion of the Tooma River in the Murray catchment to Tumut Pond on the Tumut River.

(2) The use of the Eucumbene, Tooma, and Tumut waters to produce power as they flow from Tumut Pond down the Tumut Valley.

(3) Two power projects involving the diversion of the upper Murrumbidgee to the Tumut River, or alternatively the diversion of the upper Murrumbidgee River to Adaminaby Reservoir, whichever is found to be the sounder on economic grounds.

(1) *The Diversion of the Eucumbene and Tooma to Tumut Pond.*—A dam known as Adaminaby Dam is being built on the Eucumbene River near Adaminaby. This dam will rank among the largest earth and rock fill dams of the world. It will be almost 400 feet high and will provide an effective storage of 3,500,000 acre-feet of water, over eight times the quantity in Sydney Harbour and enough to cover 5500 square miles one foot deep. From this storage the waters of the Eucumbene—almost one-third of the total Snowy River flow at Jindabyne—will be diverted through the main 14-mile tunnel to Tumut Pond. In addition, the water of the upper Tooma River in the Murray catchment will be diverted through another tunnel to Tumut Pond. A high dam will be constructed at Tumut Pond to form a collecting and balancing reservoir for the waters of the upper Tumut and the diverted waters from the Eucumbene and Tooma. The works are so designed that in periods of flood the surplus water from the Tooma and Tumut Rivers may be fed back to Adaminaby Reservoir through the main diversion tunnel, to be held in storage for future use.

(2) *Tumut Valley Projects.*—Five power projects described below will be constructed along the Tumut River to make use of the 2600 feet fall between Tumut Pond and Blowering, near the town of Tumut. From Tumut Pond the waters of the three rivers will be carried in a tunnel downstream to T.1 Power Station. They will then flow through another tunnel to T.2 Power Station five miles further downstream. The total fall utilized in these two projects will be about 2000 feet.



From T.2 Power Station the water will be discharged into a large reservoir to be formed by a dam at Lob's Hole just below the junction of the Yarrangobilly and Tumut Rivers. At the foot of this dam there will be another power station, T.5. It will discharge into the Cumberland Reservoir formed by a high dam located some distance above Talbingo. An underground power station, T.6, will be located just below the dam and a tail-race tunnel will lead the water from this power station to Blowering Storage.

Blowering Reservoir, which is to be built by the Water Conservation and Irrigation Commission of New South Wales, will hold water discharged from the power stations on the Tumut River so that it can be released as and when required for irrigation in the Murrumbidgee Valley. Power Station T.7 will be built at the base of Blowering Dam for the production of power from the water discharged from the reservoir.

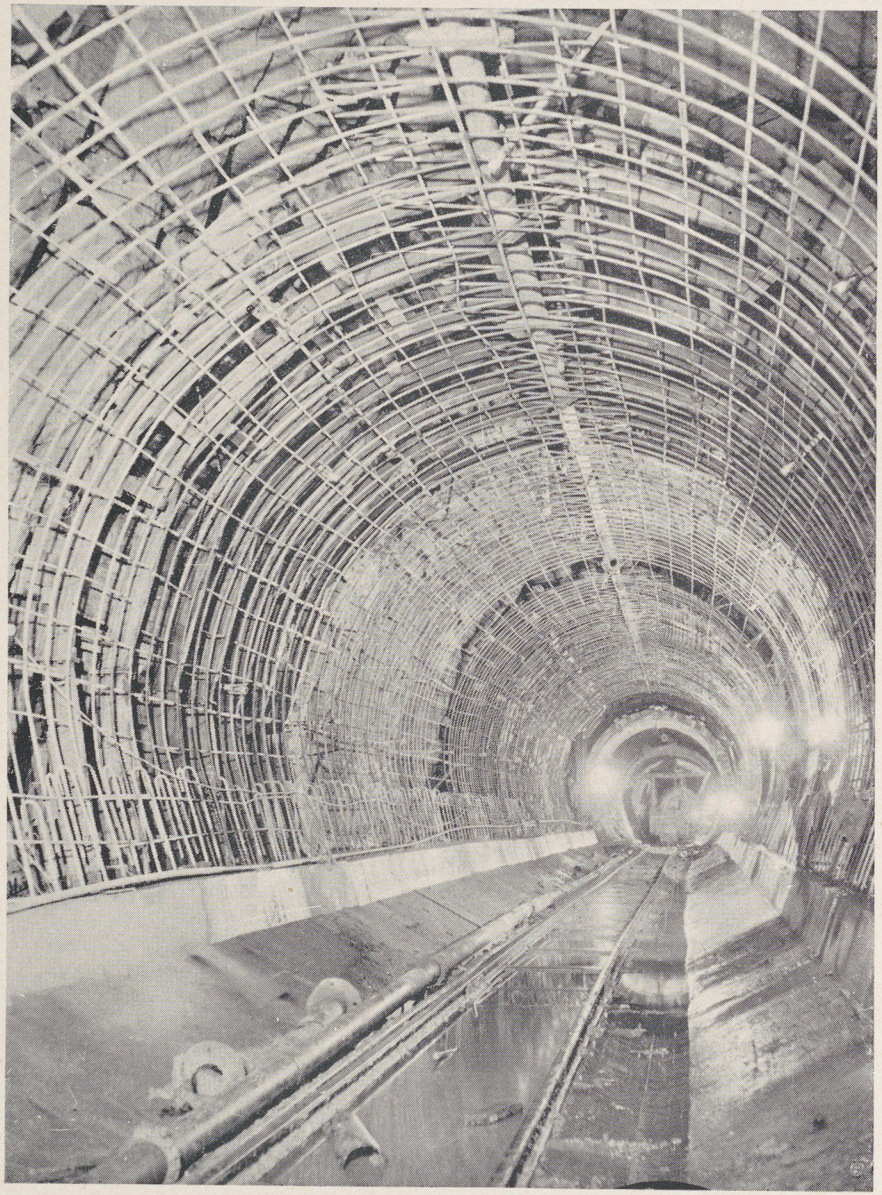
(3) (a) *Tantangara-Tumut Project.*—At Tantangara, the upper reaches of the Murrumbidgee River flow through a high mountain valley about 2500 feet above the nearby Tumut River at Lob's Hole. One proposal provides for the diversion of the Murrumbidgee through a tunnel to Power Station T.3 in the Yarrangobilly Valley and through a second tunnel into Power Station T.4 near Lob's Hole, where it would join the flow from the Tumut Valley Projects T.1 and T.2.

(b) *Tantangara-Adaminaby Project.*—An alternative proposal of more recent origin is being examined, and this provides for the diversion of the upper Murrumbidgee River into the Adaminaby Reservoir. This proposal has the merit of increasing the volume of water available to Power Stations T.1 and T.2.

An outstanding feature of the Scheme is the vast quantity of water which will be reserved for use in years of drought. This reserve will be held in the major reservoirs at Adaminaby and Jindabyne, and to a lesser extent at Tantangara. The total effective capacity of these storages will be over 5,600,000 acre-feet, or more than five times the average annual discharge from the Snowy River at Jindabyne.

As already mentioned, the above works involve the construction of seven major dams, over 80 miles of large-diameter tunnels, 17 power stations, more than 330 miles of racelines along the mountain sides to pick up streams at high elevation and lead their water to reservoirs and tunnels, and a number of subsidiary works. Generating plant of a total capacity of over three million kilowatts will be installed and additional water for irrigation to the extent of nearly two million acre-feet per year will flow down the western rivers for irrigation in the Murrumbidgee and Murray Valleys.

THE AUTHORITY'S OBJECTIVES AND PROGRAMME



Reinforcing steel in position for concrete lining the Guthega Tunnel.

The Joint Commonwealth-States Technical Committee drew up between 1946 and 1949 a general plan for the development of the resources of the Snowy Mountains Area; it showed the proposed development to be practicable and economical; and it prepared broad estimates of the potential quantities of power and water and of the cost of the works. The committee recognized, however, that its studies required to be extended and amplified, that many of the proposals may have to be amended.

When the Authority was constituted on 1st August, 1949, it therefore had to face the immense task of carrying out detailed and comprehensive investigations for one of the world's largest and most intricate developments. Rather than await the completion of investigations, the Authority decided that the construction of preliminary field works would be put in hand immediately so that full-scale operations would commence as soon as designs became available. Experience has already shown that much time has been saved in the overall progress of the Scheme by the decision to follow that course.

Two basic objectives have influenced the Authority in the planning of the work, namely:

(a) The early production of electricity, and

(b) The early diversion of water inland.

With a view to the achievement of these objectives the Authority has followed the policy of making full use of all the construction resources available to it, its own, those of State construction authorities able and willing to assist, and those of private contractors, both local and overseas.

The work being carried out by the Authority's forces comprises in the main, general planning and the co-ordination of the works as a whole, surveys, investigations, and designs; also work in the field such as the provision of accommodation, stores, workshops and other works buildings, diamond drilling, river gauging, and other field investigations, construction of access roads, installation of power plants and transmission lines for construction purposes, and other preliminary works necessary to enable contractors to proceed with the constuction of major works. In addition the Authority supervises the work of contractors.

State Departments and Public Bodies are playing an important part in the Scheme. The Department of Public Works, New South Wales is undertaking the construction of Adaminaby Dam which will be one of the world's largest earth and rock fill dams. The Department of Main Roads, New South Wales is carrying out on the Authority's behalf the reconstruction of over 100 miles of public roads. The Water Conservation and Irrigation Commission, New South Wales, the Soil Conservation Service of New South Wales, the Snowy River Shire, the Forestry Commissions of New South Wales and Victoria, and several other State Bodies are also giving assistance, each in its own particular sphere.

Wherever work can be conveniently and economically allotted to Contractors, this is being done. Except in remote areas where access presents a special problem, most of the building work is carried out by contract. Contractors will undertake the constuction of all major works with the exception of Adaminaby Dam. The first major work to be completed, the Guthega Hydro-electric Project, was built by Selmer Engineering Pty. Ltd., an Australian company formed by the original Contractor for this Project, Ingenior F. Selmer, A/S, of Oslo, Norway. Very large contracts in the Upper Tumut Area to a total value of approximately £30,000,000 have been placed with a group of Contractors from the U.S.A. and with a group of French Contractors. These are described later in this brochure.

Special mention should be made of the very valuable assistance the Authority is receiving from the Bureau of Reclamation, U.S.A. This great engineering organization undertook for the Authority the preparation of designs for the 14-mile Eucumbene-Tumut Tunnel, a large concrete dam at Tumut Pond, and the T.1 Pressure Tunnel. In addition it has prepared the designs for the Adaminaby Dam. It is now proceeding with the designs of the greater part of the T.2 Project. It is

Guthega Power Station during construction in winter of 1954

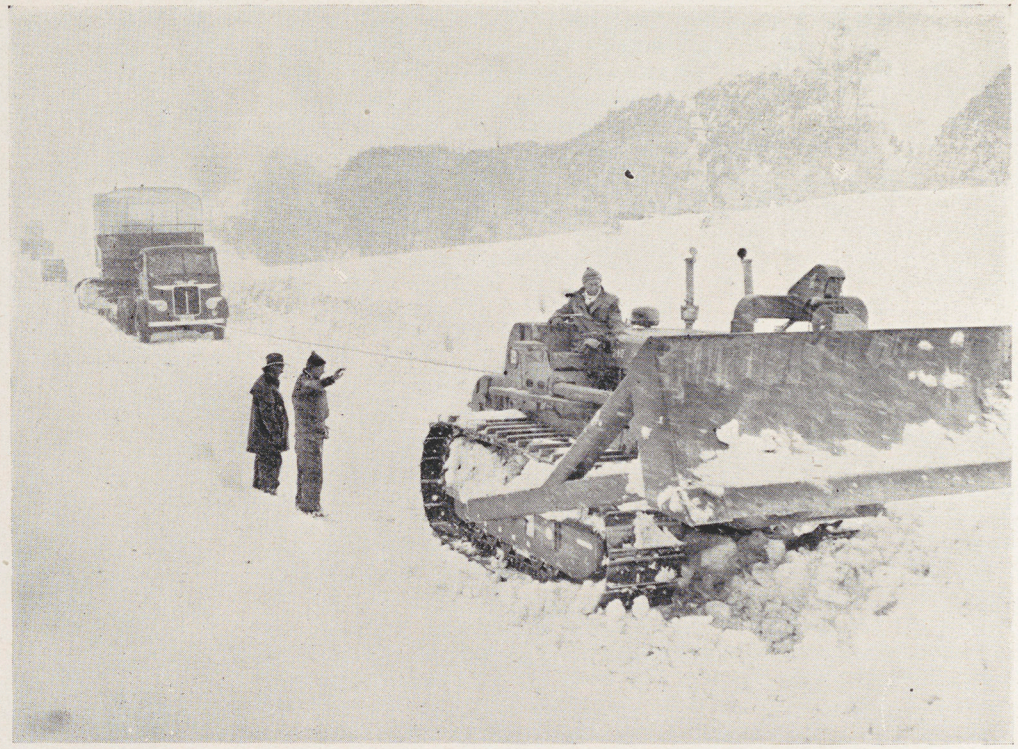
also training a number of the Authority's Engineers at Denver and on large projects in the U.S.A. At any one time approximately twelve engineers are receiving training and as each trainee completes his course another engineer is sent to the United States

to take his place. Additional and most valuable help is available on the spot by the action of the Bureau in providing on loan to the Authority six experienced staff engineers as Engineering Advisers. The presence of these men has been of great assistance in anticipating and solving problems arising from day to day in the early stages of the large Upper Tumut contracts.

It is by the combined efforts of these organizations, the Authority, State Departments, Private Enterprise, and the Bureau of Reclamation, U.S.A., that the Authority plans the expeditious completion of the assignment given to it by the Commonwealth Government.

The Authority's immediate programme is aimed at the early production of power and the early diversion of water inland to supplement the flow of the Murrumbidgee River, which is now fully absorbed for irrigation. The first objective is already yielding tangible results from Guthega Power Station, and the second is well in hand with the major works now in progress.

Further progress towards these objectives will be achieved stage by stage as follows:



Winter transport in difficult conditions on the road to Cabramurra.

POWER

Project	Estimated Completion	Power Available
UPPER SNOWY WORKS:		
Guthega	Complete as a "run-of-the-river" station	60,000 kW
UPPER TUMUT WORKS:		
T.1	1959	320,000 kW
T.2	1963	280,000 kW
Total annual amount of power available by 1961-62		660,000 kW

WATER

Project	Estimated Completion	Water Available
UPPER TUMUT WORKS:		
From Eucumbene River	1959	300,000 ac.-ft. p.a.
From Tooma River	1961	200,000 ac.-ft. p.a.
Annual amount of water available by 1962		500,000 ac.-ft. p.a

The rate at which subsequent projects are brought into operation will depend on the rate of growth of the demand for power.

Work in Hand

In undertaking the design and construction of the Scheme, the Authority's first task was the collection of a large staff of professional, technical, administrative, and other officers. This occurred at a time when Australia was suffering from an acute shortage of engineers, and had to be done in such a way as to avoid having any appreciable effect on the activities of other construction organizations. Accordingly, the appointment of Australians, particularly professional men, was carefully controlled and an intensive recruitment programme was undertaken in New Zealand, Great Britain, and Europe. As a result of efforts in Australia and abroad, a staff of over 1100 professional, technical, and administrative officers is now at work in the office and the field.

The shortage of skilled and unskilled workmen also presented a problem, particularly as regards tradesmen. The situation was met by recruiting over 600 tradesmen in Western Germany and engaging a large number of New Australians. These men comprise a large proportion of the total day labour force, which now stands at about 1500 men. The Authority's contractors also employ large numbers of New Australians.

One of the Authority's staff houses in the Headquarters Township, Cooma North, built by an Italian contractor.

The provision of plant, equipment, and engineering stores for the working force, during a period of general shortage and without causing serious impact on resources available to other Australian construction organizations, has been no small task. This involved large overseas purchases at considerably increased costs. With the recent improvement in the local market, however, overseas purchases have been reduced to a minimum.

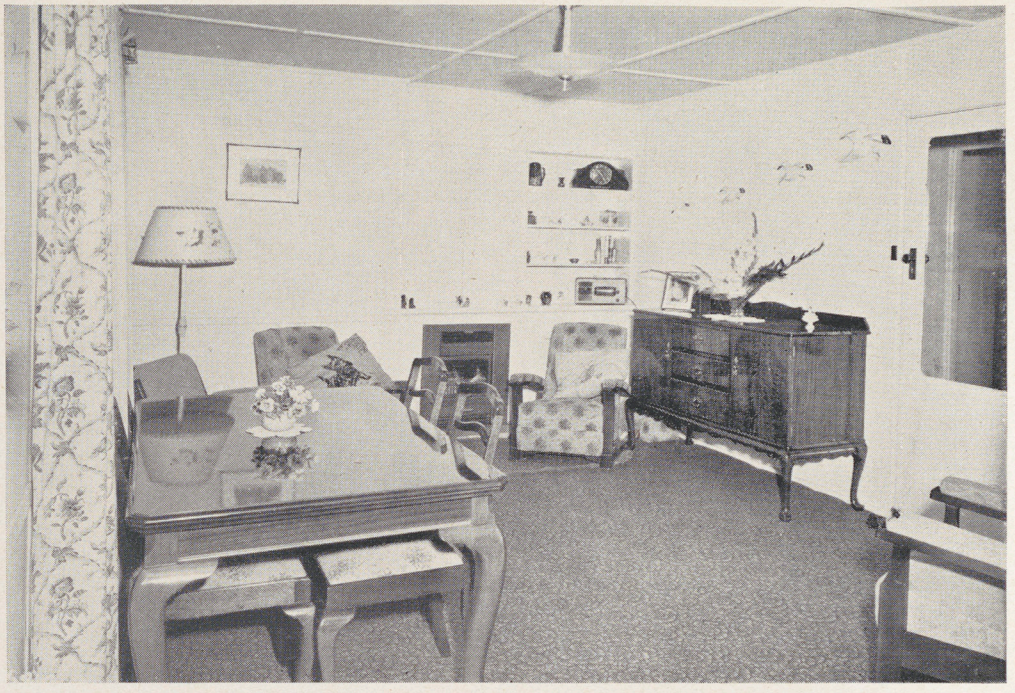
Good progress has been made on general investigations for the Scheme as a whole; also on the detailed investigations for projects scheduled for early construction. The collection of data for these investigations has in itself been no small task. It has involved geodetic, topographic, and cadastral surveys in a mountainous area 100 miles long by 30 miles wide, much of which is snow-covered throughout the winter and spring.

Aerial surveys, without which the Sceme would have been delayed some years, have been used extensively. General geological surveys have been carried out over the whole area; also detailed exploration of the surface and subsurface rock strata at the sites of dams and other structures, and along tunnel routes. This work has involved miles of diamond drilling, sometimes to a depth of approximately 2000 feet. Geologists have also had to explore areas for materials suitable for concrete aggregates and examine soil deposits for earth dam construction. One hundred and one gauging stations, seventy-one established by the Authority, provide essential information concerning river and stream discharges. Well over two hundred miles of light roads and access tracks have been constructed, in most cases through extremely rugged country, to provide supply lines to men engaged on diamond drilling, river gauging, and other field investigations. These tasks represent only some of the work undertaken by the Authority for the collection of data for the Investigating Engineers.

Designs have followed the detailed investigations for the projects selected for early construction. Here, too satisfactory progress has been achieved, largely due to the very valuable assistance given by the Bureau of Reclamation, U.S.A. As already mentioned, this great engineering organization has carried out on the Authority's behalf the major portion of the general designs for the Upper Tumut Works.

The Authority's Headquarters have been transferred from Sydney to Cooma, where a new township and extensive workshops and stores facilities have been established. Over 630 cottages have been completed. These, together with hostels, barracks, messes, shops, recreation buildings and other community facilities, and the necessary municipal services, have provided accommodation for nearly 4000 people. Good progress has been made on works townships at Jindabyne and Island Bend in the Upper Snowy Area, and at Cabramurra in the Upper Tumut Area. Large camps and workshop facilities have been established elsewhere.

Over eighty miles of new heavy-duty roads have been constructed, mostly in difficult mountainous country, to service projects under way or those programmed for early commencement. In addition, the Department of Main Roads, New South Wales, is carrying out on the Authority's behalf the reconstruction of over 100 miles of public roads. All of these roads are being constructed to a high standard to carry the heavy traffic between the railhead at Cooma and the works. Loads up to 120 tons in weight are involved.



A view of the interior of one of the transportable housing units built by the Authority for accommodation in the mountain townships established for the construction of the Snowy Mountains Scheme.

The Department of Public Works, New South Wales, has progressed with the construction of preliminary works for Adaminaby Dam. The coffer dam has been commenced, the diversion tunnel which will carry the Eucumbene River during the construction of the dam is nearing completion, and the control gates are now being installed to enable the river flow to be regulated during the construction of the dam. Advance preparations have been made for large-scale construction operations on the dam itself.

As already noted, the Guthega Project on the upper Snowy River is now in operation, with two of the planned three generators. The third will be added later and will give the Guthega Power Station a total capacity of 90,000 kW. The switchyard and transmission lines are also complete, and power is being transmitted at 132, 66, and 11 kV to the New South Wales system and to other points in the Authority's construction works.

During 1954 three very important contracts were let for projects in the Snowy-Tumut Development. The tender of £19,233,399 was accepted for the construction of the Eucumbene-Tumut tunnel, 13.8 miles long and 21 feet internal diameter, with necessary associated works. The same tenderer, Kaiser-Walsh-Perini-Raymond, a group of experienced American engineering firms, was also awarded the contract for Tumut Pond Dam. This will be an arch-type concrete dam, 290 feet high, on the Tumut River. The associated pressure tunnel to the T.1 Power Station will be 1.5 miles long, 21 feet diameter, and concrete-lined. The contract price for the dam and pressure tunnel, with the gate shaft at the pressure tunnel intake and T.1 surge tank, was £5,667,882. Work on these contracts is now in progress.

The third contract, for the underground T.1 Power Station, includes the machine hall, transformer hall, control room, and two associated pressure shafts each 1200 feet deep, a tailrace 4000 feet long, surge chamber, access and cable tunnels each about 1200 feet long, a bridge across the Tumut River, and two miles of access road. The contract price is £3,894,751 and the successful tenderer is a group of French contractors sponsored by Etudes et Entreprises. Work on the site began in 1954.

The electrical installations in the T.1 Power Station will incorporate four 80,000 kW turbo-generators, control equipment, seven single-phase transformers, and associated equipment. The underground machine hall necessary for these items of equipment will be 330 feet long, 55 feet wide, and 110 feet high. The separate transformer hall will be 125 feet long by 65 feet wide, and 40 feet high, and this too will be deep underground.

The contract price for supply of the first two vertical Francis turbines, to develop 100,500 horsepower at 960 feet net head and 375 revolutions per minute, was £456,746, landed in Australia. These machines will be supplied by the English Electric Company. The first two generators are to be supplied by A.S.E.A. Electric (Aust.) Pty. Ltd., acting on behalf of A.S.E.A., Vasteras, Sweden. The contract price, delivered at the site, is £552,320.

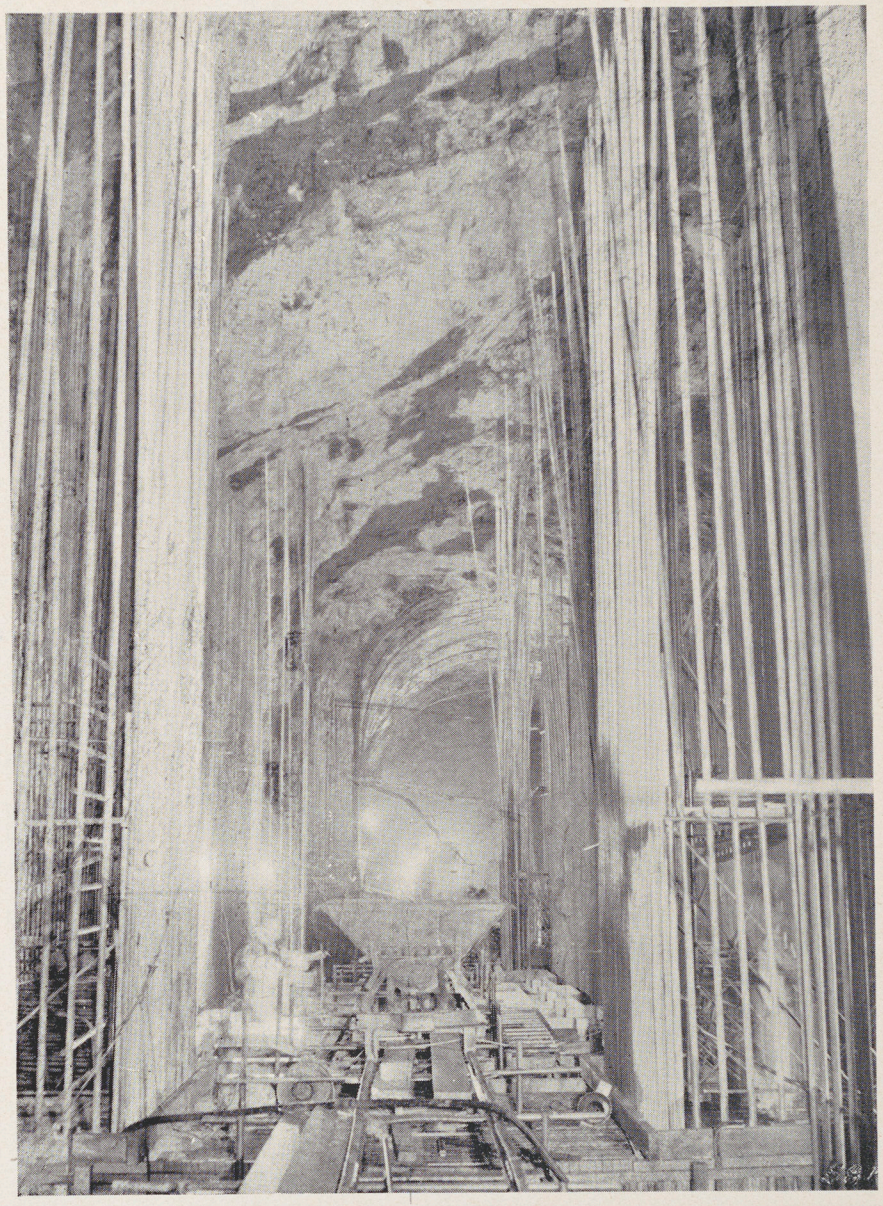
Supply of electricity from this power station is scheduled to commence in 1958. Completion of the Eucumbene-Tumut tunnel during 1959 will bring the output up to 320,000 kW and will enable approximately 300,000 acre-feet of water per annum to be diverted into the Tumut River for irrigation in the Murrumbidgee Valley. During the following two years, the quantity of water diverted into the Tumut will be increased to 500,000 acre-feet per annum.

These diversions will be the first large-scale use of the waters of an Australian coastal river system in an inland valley. Here they can be used in irrigation of both existing areas of agricultural production and for important extensions of these areas in fertile but dry lands—they will give vital help in Australia's most important problem, that of how to increase the productivity of some of our vast inland.

Since major works were started, the Authority has been faced with heavy increases in all costs. These have affected imported and local materials and equipment, wages and salaries, and the money costs of associated works such as housing, road construction, all types of maintenance, and so on. It is obvious that early estimates of the total capital cost of the Scheme, made before 1949 in terms of a pound that would purchase about twice what it now does, must be greatly increased.

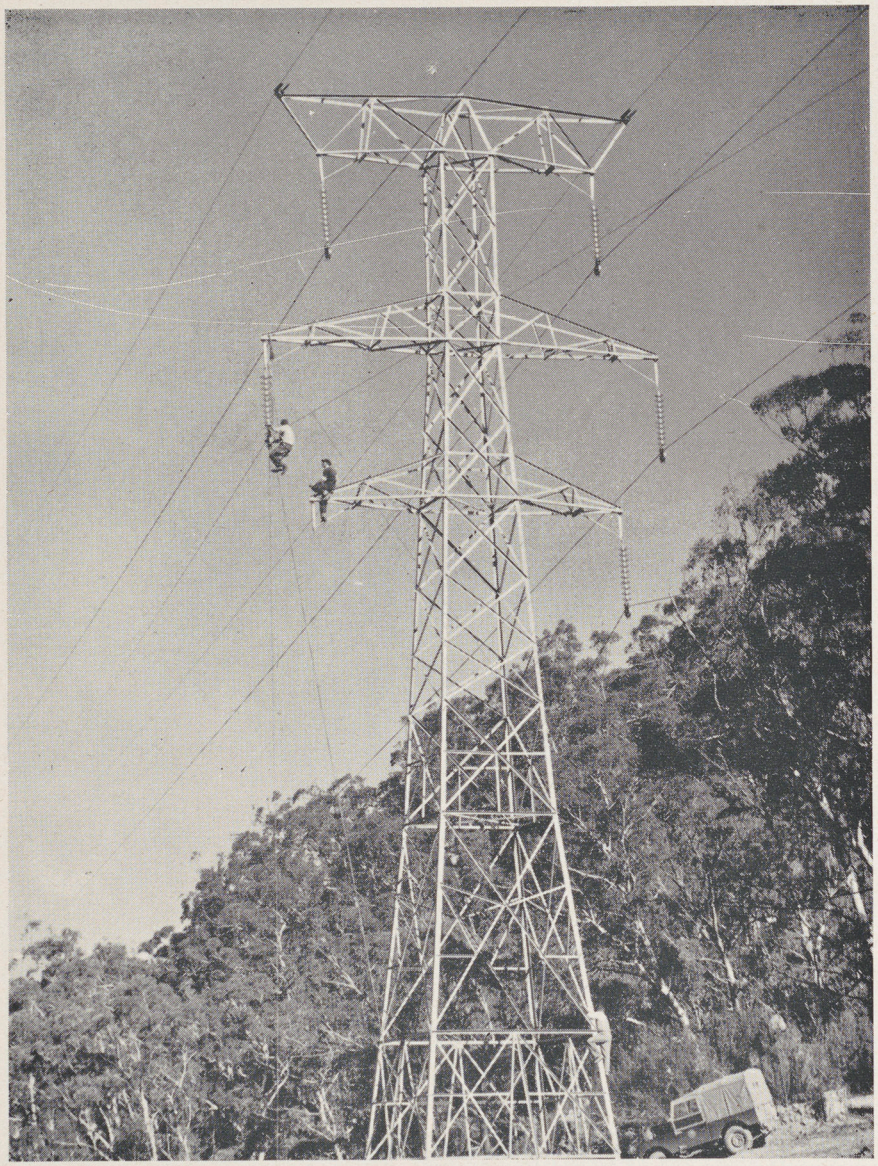
Another matter having an equally serious adverse effect on the economics of the Scheme has been the increase in the interest rate from 3-1/8 per cent. to 4½ per cent., the result of which will be an increase in the operating costs of approximately 40 per cent. No ordinary hydro-electric undertaking could successfully withstand the impact of blows such as these and at the same time finance the huge cost of providing irrigation water from the sale of electricity.

The fact that the Snowy power can still compete with power from thermal generating stations is due very largely to the increase of approximately 50 per cent. in the guaranteed energy output, brought about by changes in the basis of operation devised by the Authority. This involves the operation of the Scheme as a single integrated unit rather than as two separate groups of projects.



When storage begins in the Adaminaby Reservoir, the Eucumbene River will be controlled by gates in the underground chamber shown here during construction.

WHAT THE SCHEME WILL MEAN TO AUSTRALIA



Stringing and clipping in conductors on the steel tower section of the Authority's transmission line from Guthega Power Station to Cooma.

Power Aspects

Probably no single factor has a greater influence on the prosperity of a country than the use made of power. Canada recognizes this—undoubtedly the remarkable industrial development of this enterprising country and its high standard of living can be attributed in no small measure to the use it has made of its abundant power resources, mainly in the hydro-electric field.

A feature of power development in the U.S.A., Canada, Scandinavia, Great Britain, France, and in fact most progressive countries, has been the rapid and consistent rate at which power usage continues to increase. For instance, in the 25 years period 1925-50, the power consumption per capita in the U.S.A. increased three and a half times. Although minor fluctuations can be expected from time to time, there is every reason to believe that power demand will continue to double itself every 8 to 10 years. Most progressive countries are planning the amplification of their supplies on this basis.

What of Australia? Although our power demand has increased and continues to increase, at about the same percentage rate, our usage of power on a per capita basis lags far behind that of many other countries. For instance, the average consumption per person in Canada for industrial, rural, and domestic uses is over three times ours. Similarly, the average quantity of power provided in U.S.A. to each factory worker is about three times the average quantity we make available to our industrial workers. The position is further illustrated in the following table, which shows the annual consumption of energy per head of population in Australia compared with that in the countries named.

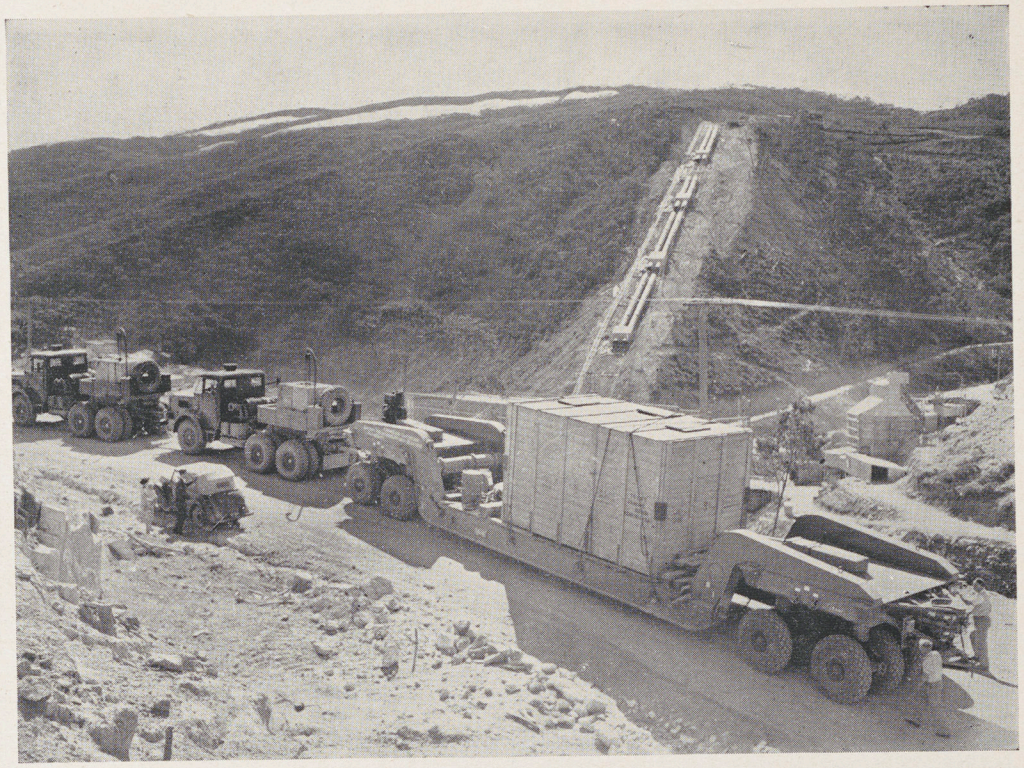
Country	kWhr per head
Norway	5360
Canada	4017
U.S.A.	2825
Sweden	2758
Switzerland	2605
Australia	1122

Throughout the world, on a per capita basis, industrial output follows almost exactly power usage. Whilst it can be argued that per capita power usage in Australia will not catch up with Canada, Norway, Sweden, and other countries endowed with abundant supplies of cheap hydro-electric power, there can be no doubt that very considerable increase in Australia's power consumption on a per capita basis is essential for the general progress of the country. Without this increase our standard of efficiency in industry must remain below that of many other countries.

There is another reason why the situation in Australia is more difficult than in most other countries. As well as coping with the normal growth in demand, we must make provision for the additional increase in power requirements arising from immigration.

With regard to defence, experience during the last war showed, both in Australia and abroad, the need for maintaining an adequate reserve of generating capacity to tide over any period of intensive war production when large-scale expansion of power plant would be impossible. New South Wales commenced World War II with a generating capacity of approximately 40 per cent. above that required to meet the load. This excess of capacity over load should not be regarded as surplus or unwanted power, because any generating system which is to function efficiently and avoid interruptions to supply should have a reserve of capacity over demand of at least 20-25 per cent. The 1939 reserve disappeared before the end of the war and later deteriorated into a deficiency of over 20 per cent., resulting in daily blackouts, serious loss of production and consequent increase in living costs. Similar but less severe difficulties were experienced by Victoria, and in fact by most of Australia. One required little imagination to realize how our war production would be affected if to-day we were forced into a war of four or five years duration.

How can our power resources best be developed? Excluding hydro-electric projects in Tasmania, we have in the past relied mainly on coal for the generation of our power. It is not claimed that as far as New South Wales and Victoria are concerned the situation cannot be met by an accelerated programme for building new thermal stations, but by taking advantage of the available water-power resources in the Snowy Mountains the growth in demand for electricity can be met more economically and with greater security of supply by constructing a small number of new thermal stations and supplementing the output from the expanded thermal system with hydro power.



The Authority's "Mighty Antar" Thornycroft road train, loaded with part of a stator unit for the Guthega Power Station.

It is on the latter basis, i.e. the combined development of thermal and hydro power, that the Snowy Scheme has been designed.

In countries like Australia, with ample coal resources and only limited water power, the operation of a combined system of thermal and hydro power can be carried out most economically by arranging for the hydro stations to provide peak load power, and the thermal stations to meet base load requirements. For this reason only, the Snowy has been designed as a peak load scheme. It would have been equally practicable to base the design on the production of base load power, but with less economic advantage. It is pointed out, however, that in cases of interruption of supply from thermal plants, such as might occur from coal shortages or from enemy action in time of war, the Snowy Scheme as designed could operate continuously and over long periods supply both peak and base load power.

A Technical Committee of the Commonwealth-States Interim Advisory Council has provided up-to-date figures on

certain financial aspects of the Scheme. The Committee was composed of Engineers of the Electricity Commissions of New South Wales and Victoria and of the Snowy Mountains Authority, with a senior Commonwealth Engineer as Chairman. An examination covering the period up to 1963-64 was made of the effect on the costs of the New South Wales system of using power from Snowy Stations T.1 and T.2. It is important to point out that the approach used in this study, and in fact in most financial analyses made to date, has been to ascertain the direct saving in cost to the State Electricity Commissions. As explained below, this method of approach does not take account of the real economic value of the Scheme to the nation, in that irrigation benefits are disregarded.

Soil conservation protective work adjoining Guthega penstocks. The Authority has given special attention to the prevention and repair of soil erosion arising from engineering works.

A number of assumptions as to the trend of future costs were necessarily made by the Technical Committee, but even on the basis that improved efficiency in new thermal plants would reduce the present average overall cost of power from all New South Wales thermal stations by about 40 per cent. (assuming stable wage rates), the Committee's analysis showed a further saving resulting from the use of Snowy power for 1963-64 of about 7 per cent. For the full seven years period between the commissioning of T.1 Power Station and 1963-64, the indicated saving by the introduction of Snowy power was 18 per cent.

As indicated, the Technical Committee's analysis does not allow the Scheme any financial credit for the very substantial capital outlay for supplying irrigation water to the Murray and Murrumbidgee Rivers. Under the basis on which the Scheme is being financed, as agreed upon in 1949 by the three Governments, the full cost of supplying this very valuable product to the western rivers must be met from the proceeds of the sale of the electrical energy. No allowance is made for the monetary gain to the Nation of the supply of very large quantities of additional irrigation water, quite apart from the importance of the Scheme for defence. This fact deserves special mention because for the same reason numerous published conclusions on the economics of the Scheme have not brought to account the total benefits which it will contribute to the national economy and therefore do not show the Scheme in its true light.

The Scheme is not just a long-term project. The first power station is already in operation and as work proceeds, project by project, increasing quantities of electricity will become available. Power will be supplied from the first group of projects in the following stages:

Project	Estimated Dates when Projects will Produce Power	Power Added (kW)	Cumulative Total (kW)
Guthega	Now available	60,000	60,000
T.1	1958-59	160,000	220,000
T.1	1959-60	160,000	380,000
T.2	1961-62	140,000	520,000
T.2	1963-64	140,000	660,000

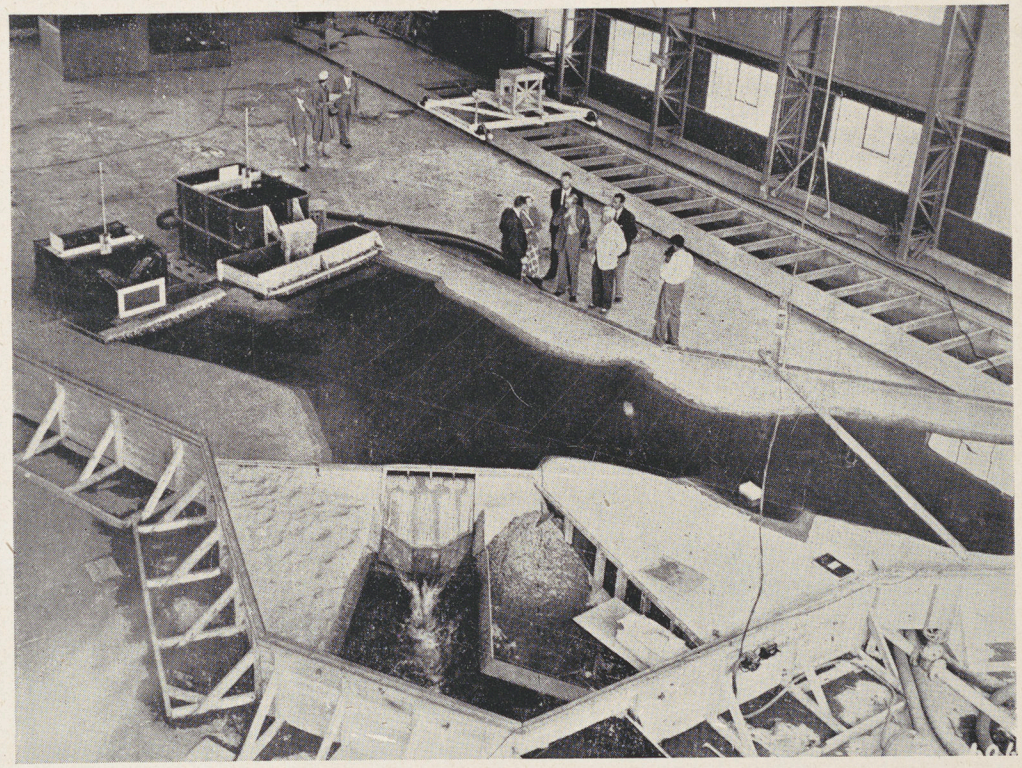
During the remainder of the construction period additional power will become available at a rate determined by the rate of growth of demand, with an ultimate yield of over three million kilowatts. Notwithstanding the fact that the Scheme will operate mainly on peak load, its annual energy output (kW hr) will be almost equal to the total output of all generating stations in New South Wales and Victoria during the year 1949-50.

Defence Aspects

The importance of augmenting electricity supplies as a defence requirement has already been stressed. It is also pointed out that the present location of generating plant in New South Wales, 90 per cent. of which is on or near the coast, is a defence liability. The Snowy Mountains Power Stations will be mostly underground and widely dispersed in remote areas, protected in most cases by several hundred feet of solid rock. In addition, in times of emergency there are other important advantages such as saving in manpower for operation and the saving of coal. The advantages, in terms of human effort, of running hydro stations are so great as to make this form of power production extremely useful in any abnormal times.

In this connection it is mentioned that the production of power from thermal stations, including coal winning and transport, normally requires about 40 times more manpower than required for the production of an equal quantity of hydro power. Furthermore, the huge reserves of water to be held in the main storage reservoirs to safeguard power supplies during drought periods could also be used for producing additional power in the event of a major catastrophe to thermal stations during time of war. For example, the stored energy in Adaminaby Reservoir, when full, will alone amount to approximately twice the present total output of energy consumed annually in New South Wales.

Even apart from the obvious fact that a nation's defence depends on its economic strength, Australia has already experienced the imperative need to be a supply base for troops of its own forces and those of its allies. This means that we must continue to keep our primary industries so productive that they have export surpluses available for trade abroad and for supply to armed forces when the need arises. Food, clothing, and many other items that depend on rural production are no less essential than guns or aeroplanes—or power.



Studying operating conditions on a model of the Guthega Pond at the Engineering Laboratories at Cooma.

Irrigation Aspects

There are three basic reasons why Australia must increase agricultural production. These are:

(a) To maintain its export revenue;
(b) To support its increasing population without a reduction in exports; and
(c) To meet defence and strategic requirements.

During recent years the population of Australia has been increasing at the rate of 2 to 3 per cent. per annum whereas the corresponding total increase in agricultural production has been about one-third of this rate. As a result, the volume of exports per head is now about 20 per cent. below the pre-war level.

Primary products are also great dollar earners. Food is a major item of United Kingdom dollar expenditure and every ton of food sent to the United Kingdom represents a dollar saving. No Australian needs to be told the importance of wool to our export trade. The use of irrigation water to enable the establishment of improved pastures, in conjunction with other production in irrigation areas, will help to boost wool production.

The position has to be faced that if ways and means are not found of increasing food production and our population continues to grow, we shall, within a few years, either have to become an importer of certain foodstuffs, with disastrous effects on our economy, or we shall have to severely reduce consumption. There are several methods of increasing food production, all of which must be looked to if this country is going to progress, but few, if any, present better prospects than irrigation. An expert Advisory Committee recently appointed by the New South Wales Government said:

> "The obvious means of accelerating food production is by the rapid development of new irrigation schemes, and, where possible, intensification of production by existing schemes."

In its report of February, 1952, the recently appointed Commonwealth - State Consultative Committee for Water Conservation and Supply said:

> "It will be observed that the increased food production to meet the needs of the larger population and to maintain exports is very considerable. The contribution of irrigation schemes to production will result in meeting an appreciable portion of the food requirements of the Nation."

Tunnelling is speeded up by working from both ends, and from intermediate points as well wherever practicable. Here is the final break-through in the Guthega tunnel.

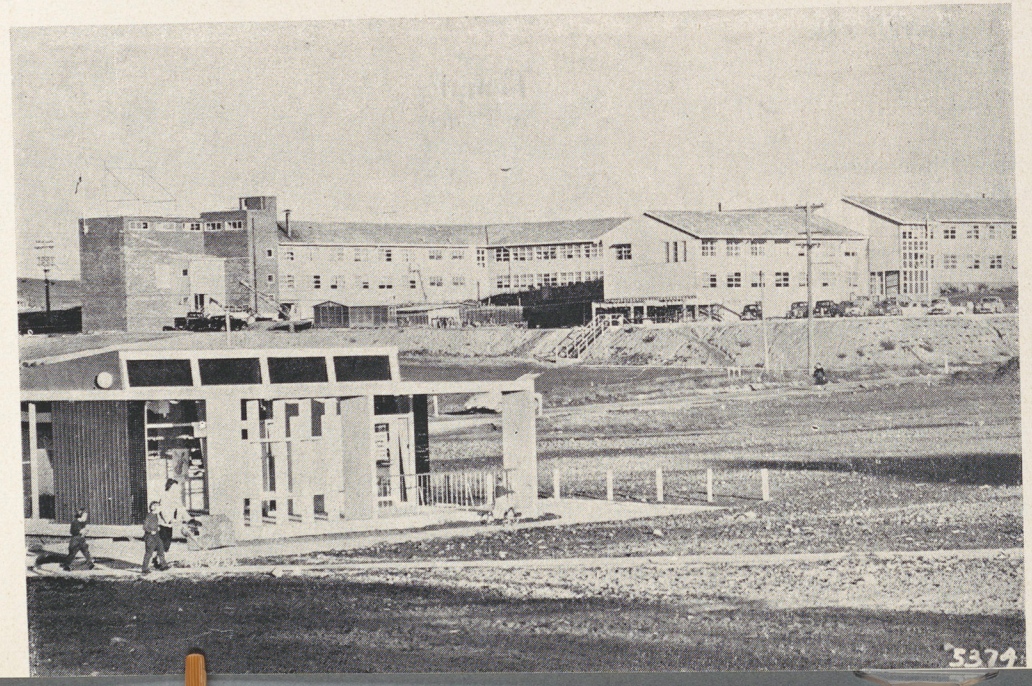
As far back as 1945 the Commonwealth Rural Reconstruction Commission recommended "that the maximum economic development of irrigation should be regarded as a national objective." Later an Advisory Committee appointed by the New South Wales Government, commenting on this recommendation, said:

> "The position is that encouragement of food production has moved from being a *desirable objective* in 1945, to an *imperative demand* of 1952."

In the Murray and Murrumbidgee River basins there are very large areas which offer by far the best prospects in Australia for an early and substantial increase in irrigation development. The soil and climatic conditions are particularly suitable for irrigation farming, but the desired expansion cannot take place without augmentation of the flow of the two rivers. The regulated flow of the Murrumbidgee is already fully absorbed and the same will apply to Victoria's allotment of the Murray water when irrigation channels, etc., now under construction or about to be commenced, have been completed.

Few Australians realize the benefit the country has derived from irrigation development already carried out in the Murray and Murrumbidgee Valleys. As a direct result of irrigation in the Murrumbidgee area, population and production have increased 25 to 50 times. Irrigation works, including the construction of Burrinjuck Dam, cost approximately £13,000,000 and for this capital expenditure the present annual value of primary production is in the vicinity of £8,000,000. Achievements in the Murray Valley have been even more spectacular. These developments have turned out to be two of this country's soundest investments.

In the tunnel built to divert the Eucumbene River while the Adaminaby Dam is being constructed. Reinforcing steel is in position for the concrete lining.



Part of the Authority's Administrative Building in Cooma North, with one of the new shops in the foreground.

The Snowy Scheme will by 1962 or 1963 supply the Murrumbidgee River with 500,000 acre-feet per annum of additional water, a quantity which, after allowing for evaporation, channel leakage, and other losses, exceeds the total present usage in the whole of the Murrumbidgee Irrigation Areas. Ultimately the Scheme will provide by diversion and regulation approximately 1,818,000 acre-feet per annum to the two rivers, of which 1,020,000 acre-feet per annum will go to the Murrumbidgee and 798,000 acre-feet to the Murray. The quantity of water is sufficient to produce food-stuffs to the value of over £25,000,000 annually, plus considerable additional production of other agricultural products. These large quantities of water will be supplied to the irrigation rivers at no cost to the States as the Scheme will be financed by the sale of electricity.

The development of the Scheme for the production of power is a good business investment and of real defence value, but its development for the supply of water for food production is becoming a National necessity.

STATISTICAL SUMMARY

(Detailed figures subject to amendment as investigations proceed)

Dams and Storages

Development	Dam	Height Above Stream Bed (feet)	Spillway Level (feet above sea-level)	Storage Capacity (acre-feet)
Snowy-Murray	Jindabyne	260	3058	1,200,000
	Kosciusko	90	5773	30,000
	Upper Murray	Hume Dam to be raised		250,000
	Gungarlin	145	4355	56,000
Snowy-Tumut	Adaminaby	390	3822	3,860,000
	Tumut Pond	280	3800	43,500
	Tantangara	185	4113	600,000
	Lob's Hole	180	1790	50,000
	Cumberland	300	1580	150,000
	Blowering	250	1200	800,000
			Total storage	7,039,500

Note: The storages on the Upper Murray and on the Tumut at Blowering are required primarily for regulation of water for irrigation. They are the responsibility of the States.

Tunnels

		Length
(a)	**Snowy-Murray**	
	Jindabyne-Geehi River	18 miles
	Geehi-Bogong Creek	3½ miles
	Bogong Creek to Swampy Plain River	6 miles
	Spencer's Creek to Island Bend	8½ miles
	Upper Geehi	2½ miles
(b)	**Snowy-Tumut**	
	Eucumbene River to Tumut Pond	14 miles
	Tumut Pond to Power Stations T.1 and T.2 on Upper Tumut (2 tunnels)	9½ miles
	Tooma River to Tumut Pond	9 miles
	Tantangara Reservoir to Yarrangobilly Valley	5½ miles
	Yarrangobilly Valley to Lob's Hole	4 miles
	Lower Tumut River	3 miles
	Total length of tunnel	83½ miles

Power Stations

SNOWY-MURRAY—10 Stations

	Capacity	Net Head
Spencer's Creek (M.1.A)	60,000 kW	555 feet
Guthega (M.1.B)	90,000 kW	810 feet
Island Bend (M.2.L)	60,000 kW	415 feet
Finn's River (M.2.H)	10,000 kW	605 feet
Island Bend Shaft (M.3)	265,000 kW	900 feet
Windy Creek (M.4)	75,000 kW	1775 feet
Geehi Pond (M.5.H)	40,000 kW	285 feet
Geehi Shaft (M.5.L)	20,000 kW	145 feet
Bogong Creek (M.6)	540,000 kW	950 feet
Swampy Plain (M.7)	540,000 kW	930 feet
Total	1,700,000 kW	

SNOWY-TUMUT—7 Stations

Upper Tumut River (T.1)	320,000 kW	1065 feet
Upper Tumut River (T.2)	280,000 kW	863 feet
Tantangara to Lob's Hole (T.3)	150,000 kW	1354 feet
Tantangara to Lob's Hole (T.4)	150,000 kW	863 feet
Lob's Hole (T.5)	180,000 kW	221 feet
Cumberland (T.6)	230,000 kW	378 feet
Blowering Dam (T.7)	60,000 kW	195 feet
Total	1,370,000 kW	
Grand Total	3,070,000 kW	

Aqueducts

More than 330 miles of aqueducts will be built, mostly at high elevations, to pick up the mountain streams and lead them to tunnels and storages.

Water Available for Irrigation by Diversion and Regulation

(1) Gross Diversion Quantities—

Snowy at Jindabyne to the Murray	722,000 acre-ft. per year
Snowy's tributary the Eucumbene to the Tumut	248,000 acre-ft. per year
Murray's tributary the Tooma to the Tumut	280,000 acre-ft. per year
Murrumbidgee to the Tumut	280,000 acre-ft. per year
Total	1,530,000 acre-ft. per year

(2) Gain to Murray by Diversion and Regulation—

(a)	Due to diversion from Snowy to Murray	722,000 acre-ft. per year
	Less diverted from Murray to Tumut	280,000 acre-ft. per year
	Net gain due to diversion	442,000 acre-ft. per year
(b)	Due to regulation	356,000 acre-ft. per year
	Total	798,000 acre-ft. per year

(3) Gain to Murrumbidgee by Diversion and Regulation—

(a)	Due to diversion from the Eucumbene and Tooma	528,000 acre-ft. per year
(b)	Due to regulation	492,000 acre-ft. per year
	Total	1,020,000 acre-ft. per year

(4) Total Gain to Murray and Murrumbidgee—
1,818,000 acre-ft. per year

(5) Sharing of Water by New South Wales and Victoria—

(a)	N.S.W.	From Murrumbidgee	1,020,000 acre-ft. per year
		From Murray	520,000 acre-ft. per year
		Total for N.S.W.	1,540,000 acre-ft. per year
(b)	Victoria.	From Murray	278,000 acre-ft. per year

Western Aspect of Mountains from Geehi River

The Geehi River rises on the western slopes of the Snowy Mountains and runs for some distance parallel to the main range before turning north-westerly and becoming the Swampy Plain River, under which name it flows into the Murray. A small camp has been constructed beside the Geehi River, and tracks are already being pushed through the precipitous country to gain access to future working points. Extensive surveys and field investigations are now being carried out on these western slopes to gather data for the construction of pondages, racelines, shafts, tunnels, and power stations which will harness the fast-flowing rivers and creeks. The upper waters of the Geehi River will be dammed and dropped into the main diversion tunnel from Jindabyne.

MOUNT KOWN SCHEME

TUMUT

WOLLONDILLY

TUMUT

ADELONG

TUMUT

TUMUT-TWEED DIVERSION

TUMUT-TWEED DEVELOPMENT

KIAMA

ARRAWARRA

ARMIDALE

AMOTT

GREAT

SNOWY MOUNTAINS SCHEME

LEGEND

ROADS
RAILWAYS
TUNNELS
DAMS & STORAGES
POWER STATIONS (T2)

SCALE OF MILES
4 0 4 8 12

SNOWY-TUMUT DEVELOPMENT

THE DIVERSION OF THE EUCUMBENE RIVER FROM ADAMINABY RES^{R} THROUGH A 14 MILE TUNNEL TO THE TUMUT RIVER, A TRIBUTARY OF THE MURRUMBIDGEE

SNOWY-MURRAY DEVELOPMENT

THE DIVERSION OF THE SNOWY RIVER FROM JINDABYNE RES^{R} THROUGH A 30 MILE TUNNEL TO THE SWAMPY PLAIN RIVER, A TRIBUTARY OF THE MURRAY

TUMUT
BLOWERING RESERVOIR
BATLOW
TALBINGO
TUMUT
CUMBERLAND RESERVOIR
YARRANGOBILLY POND
TANTANGARA RESERVOIR
TUMBARUMBA
LOB'S HOLE RESERVOIR
RIVER
RANGE
KIANDRA
GREAT
DIVIDING
CABRAMURRA
TOOMA
RIVER
TUMUT POND
△ Mt Cabramurra 5853'
△ Mt. Wallgrove 4581'
ADAMINABY
ADAMINABY RESERVOIR
Adaminaby Mt △ 5779'
△ Mt Jagungal 6758
△ The Bulls Peak 6180'
EUCUMBENE RIVER
SWAMPY PLAIN RIVER
KHANCOBAN
CREEK
BOGONG CK POND
WINDY CK POND
ISLAND BEND RESERVOIR
GEEHI RIVER RESERVOIR
MUNYANG POND
GUTHEGA POND
JINDABYNE RESERVOIR
JINDABYNE
BERRIDALE
△ Mt Youngal 4967'
Mt Twynam △ 7203'
KOSCIUSKO RESERVOIR
MT. KOSCIUSKO 7313'
△ Mt. Ramshead 7175
MURRAY RIVER
SNOWY RIVER
DALGETY
CANBERRA
QUEANBEYAN
MURRUMBIDGEE RIVER
BREDBO
COOMA
NIMMITABEL
RANGE

SOUTH-EASTERN AUSTRALIA

Showing the Snowy Mountains Area and Irrigation Areas of the Murray Murrumbidgee Rivers System.

SCALE 50 0 50 100 150 MILES

SOUTH AUSTRALIA
ADELAIDE
Renmark
Mildura
MURRAY
NEW SOUTH WALES
Hay
Griffith
MURRUMBIDGEE RIVER
Wagga
Swan Hill
Kerang
Albury
Echuca
Yarrawonga
Shepparton
Cooma
CANBERRA
SYDNEY
VICTORIA
MELBOURNE
DIVIDING RANGE
GREAT DIVIDING RANGE
SNOWY R.
SOUTHERN OCEAN
SOUTH PACIFIC OCEAN

LEGEND
IRRIGATION AREAS
SNOWY MOUNTAINS AREA
EXISTING RESERVOIRS