Chapter Eighteen

Water Resources

Contents

GEOGRAPHIC BACKGROUND

Rainfall, or the lack of it, is the most important single factor determining land use and rural production in Australia. The chapter on Geography contains details on geographical and climatic features that determine the Australian water pattern. The scarcity of both surface and ground water resources, together with the low rates of precipitation which restrict agriculture (quite apart from economic factors), has led to extensive programs to regulate supplies by construction of dams, reservoirs, large tanks and other storages.

The major topographical feature affecting the rainfall and drainage patterns in Australia is the absence of high mountain barriers. Australia's topographical features range from sloping tablelands and uplands along the east coast Main Divide, through the low plain and marked depression in the interior to the Great Western Plateau.

Only one-third of the Australian land mass drains directly to the ocean, mainly on the coastal side of the Main Divide and inland with the Murray–Darling system. With the exception of the latter, most rivers draining to the ocean are comparatively short but account for the majority of the country's average annual discharge. Surface drainage is totally absent from some arid areas of low relief.

Australia's large area (7.7 million square kilometres) and latitudinal range (3,700 kilometres) have resulted in climatic conditions ranging from alpine to tropical. Two-thirds of the continent is arid or semi-arid, although good rainfalls (over 800 mm annually) occur in the northern monsoonal belt under the influence of the Australian–Asian monsoon, and along the eastern and southern highland regions under the influence of the great atmospheric depressions of the Southern Ocean. The effectiveness of the rainfall is greatly reduced by marked alternation of wet and dry seasons, unreliability from year to year, high temperatures and high potential evaporation.

The availability of water resources controls, to a large degree, the possibility and density of settlement; this in turn, influences the quality of the water through production and disposal of waste. Most early settlements were established on the basis of reliable surface water supplies and, as a result, Australia's population is concentrated along the coast, mainly in the comparatively fertile, well-watered east, south-east and far south-west.

As settlement spread into the dry inland grazing country, the value of reliable supplies of underground water was realised. Observations of the disappearance of large quantities of the rainfall precipitated on the coastal ranges of eastern Australia eventually led to the discovery of the Great Artesian Basin which has become a major asset to the pastoral industry. Development, however, has not been without costs. Significant environmental degradation and deterioration in water quality are becoming evident.

Permanent rivers and streams flow in only a small part of the continent. The average annual discharge of Australian rivers has been recently assessed at 398 teralitres (TL) of which 100 TL is now estimated to be exploitable for use on a sustained yield basis. This is small in comparison with river flows on other continents. In addition, there is a pronounced concentration of run-off in the summer months in northern Australia while the southern part of the continent has a distinct, if somewhat less marked, winter maximum.

Even in areas of high rainfall, large variability in flow means that, for local regional development, most streams must be regulated by surface storage. However, in many areas evaporation is so great that storage costs are high in terms of yield. Extreme floods also add greatly to the cost of water storage, because of the need for adequate spillway capacity.

The portion of run-off able to be diverted for use is very low compared with other continents, and results from the high variability of streamflow, high rates of evaporation and the lack of storage sites on many catchments. On an Australia-wide basis, only 21.5 per cent of the divertible resource has currently been developed for use; much of the remaining resource is available in remote regions where development is impractical and uneconomic. In areas such as the Murray–Darling Division, where water is scarce, there are few resources not yet developed, and management is focusing on greater efficiency in water use.

SURFACE WATER RESOURCES AND USE

Drainage division		Surface water resources (teralitres per annum) Mean annual run-off	Divertible resource	Developed resource	Use	Use as % of developed resource
I	North-East Coast	83.9	22.9	3.5	0.97	28
II	South-East Coast	41.9	15.1	4.3	2.03	47
III	Tasmania	52.9	10.9	1.0	0.17	17
IV	Murray–Darling	24.3	12.4	10.0	8.05	81
V	South Australian Gulf	0.9	0.3	0.1	0.23	(a)100
VI	South-West Coast	6.7	2.9	0.4	0.38	95
VII	Indian Ocean	4.0	0.3	—	—	—
VIII	Timor Sea	80.7	22.0	2.0	0.10	5
IX	Gulf of Carpentaria	92.5	13.2	0.1	0.12	(a)100
X	Lake Eyre	6.3	0.2	—	0.01	33
XI	Bulloo–Bancannia	1.1	—	—	—	—
XII	Western Plateau	1.6	0.1	—	—	—
Australia		**396.8**	**100.3**	**21.5**	**12.06**	**56**

(a) Includes use of water from unregulated sources.

Source: Australian Water Resources Council, 1987.

The resource is assessed within a framework comprising four levels:

- the **total water resource** is the volume of water present in the environment, measured as mean annual run-off for surface water, and mean annual recharge for ground water;
- the **divertible resource** is the portion of run-off and recharge which can be developed for use;
- the **developed resource** is the portion of the divertible resource which has been developed for use; and
- **resource utilisation** is a measure of the portion of the developed resource which is actually used.

Emphasis is given to the second level of assessment, the divertible resource, as the prime measure of the resource. The divertible resource is defined as 'the average annual volume of water which, using current technology, could be removed from developed or potential surface water or ground water sources on a sustained basis, without causing adverse affects or long-term depletion of storages'.

WATER MANAGEMENT

Australia's water resources are managed by a large number of resource management agencies, irrigation authorities, metropolitan water boards, local government councils and private individuals. State authorities dominate the assessment and control of water resources as, under the Commonwealth Constitution, primary responsibility for management of water rests with the individual State Governments. The Commonwealth Government is responsible for matters relating to its Territories, and participates indirectly through financial assistance or directly in the coordination or operation of interstate projects through bodies such as the Murray–Darling Basin Commission. In other instances where political boundaries intersect some river basins, cooperation between Governments has been necessary to develop resources.

Australia's attitudes to water resources management have changed substantially over the last twenty years. Water management is no longer seen just in terms of storing water and regulating streams for consumption, but also in terms of conserving unregulated streams in an unmodified landscape for wildlife preservation or recreation purposes or for possible social or economic use by future generations. In addition, agricultural, industrial and urban development has led to greater attention being paid to water quality management.

The Australian Water Resources Council, consisting of the Commonwealth, State and Territory Ministers with portfolio responsibilities for water resources, is the peak forum for the water industry. The water resource situation and arrangements in each State and Territory are described below.

Water resources research

The Department of Primary Industries and Energy is responsible for Commonwealth interests in water resource matters.

In July 1990, the Land and Water Resources Research and Development Corporation (LWRRDC) was established to provide leadership and national coordination of research and development of land, water and related issues. It is also responsible for determining national research priorities and in doing so consults its five 'representative organisations': the Australian Conservation Foundation, National Farmers' Federation, National Association of Forest Industries, Standing Committee on Soil Conservation, and the Standing Committee of the Australian Water Resources Council. Projects funded include research on salinity, ground water, stream ecology, waste water management, hydrology and water treatment and quality. Activities to effectively disseminate the results of research were also undertaken.

In 1990–91, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) spent approximately $9 million (of direct appropriation funds) on water research. Competitive research grants, consultancies, and collaborative research provided an additional amount of approximately $8 million for work of direct relevance to the Australian water industry. The Division of Water Resources (resulting from the amalgamation in 1987 of the Divisions of Groundwater Research, Water and Land Resources, and the Centre for Irrigation and Freshwater Research) has a total staff of more than 230 with laboratories in Perth, Adelaide, Canberra and Griffith. The Division's task is to develop new and improved practices for the definition, use, and management of Australia's water resources. The Division of Chemicals and Polymers, based at Clayton, Victoria, has significantly expanded its research on new methods of treating municipal water and waste water, and cleaning up effluents from a wide range of manufacturing industries, resulting in some of the new technologies being marketed world wide. The Centre for Environmental Mechanics conducts research on soil-water processes, evapotranspiration and the physical phenomena of lakes. The Division of Coal and Energy Technology carries out research aimed at assessing the impact on natural waters of mining and industrial processing. Research on soil-water processes and erosion is conducted by the CSIRO Division of Soils.

CSIRO is a partner with LWRRDC, the Murray Darling Basin Commission, and the Albury–Wodonga Development Corporation in the Murray–Darling Freshwater Research Centre.

At the State level, water agencies have extensive laboratory facilities for water quality testing. However, most water related research is undertaken in research centres associated with agriculture, fisheries, forestry and environmental authorities. At the regional level, some of the larger authorities providing water supply and sewerage services undertake applied research on a very limited scale.

A significant proportion of Australian water research is undertaken by researchers in tertiary education institutions with the aid of either internal funding or grants from outside bodies, such as LWRRDC or the Australian Research Grants Committee. Water research is carried out within a range of disciplines, including the biological and social sciences and engineering.

New South Wales

Irrigation takes up the largest volume of consumption water use in New South Wales, on average 75 per cent, with urban water consumption in Newcastle, Sydney and Wollongong taking up the bulk of the remaining 25 per cent.

Major metropolitan urban water supplies are managed by central water boards at Newcastle and Sydney. Water sources for Sydney, Wollongong and the Blue Mountains are good quality rivers and associated storages on the Hawkesbury, and Shoalhaven Rivers and various streams in the Blue Mountains. Newcastle's water supply is taken from the Chichester and Grahamstown Reservoirs and from ground water in coastal sandbeds. Country towns develop their own water supply systems ranging from run-of-river pumping to ground water extractions, to dams built specifically for urban water supply. Metropolitan water authorities are increasingly managing urban water demand to reduce water consumption by a range of mechanisms including pricing and persuasion. Drought management and asset management are more

recent areas of concern for metropolitan water utilities which are also increasing their interest in balanced environmental management of water supply catchments.

The bulk of irrigation in New South Wales is within the Murray–Darling Basin, the centre of recent Commonwealth/State initiatives in land and water management to reduce salinity problems. Twenty-four storages, including four shared with Victoria and South Australia and one shared with Queensland, regulate water supplies in the Basin.

Two main irrigation arrangements exist Statewide. Licensed irrigation occurs where licensees take water from rivers, usually by pumping at their own cost. Around 1.5 million megalitres per annum is used in this way.

Irrigation Areas and Districts form the second type of irrigation. These are located on the three southern inland rivers — the Murray, Murrumbidgee and Lachlan and include over 6,300 farms and holdings covering nearly 1.4 million hectares. About a third of this area is usually irrigated using 1.4 million megalitres per annum. Extractions from licensed high-yielding bores now approach 300 gigalitres per annum.

The annual gross value of production in the Murray–Darling system is around $800 million, about 20 per cent of the State's total agricultural production. Nevertheless the growing extent of land degradation and salinisation in the Murray–Darling Basin is reducing productivity and increasing costs of production.

Water management is coordinated through the NSW Water Resources Council, composed of the heads of government agencies which have a role in water management along with representatives of major interest groups.

MAJOR WATER STORAGES NEW SOUTH WALES, 1990–91

Storage	*Catchment area*	*Storage capacity*	*Inflow during year*	*Outflow during year*
	sq.km	megalitres	megalitres	megalitres
Blowering Dam	1,600	1,628,000	2,078,137	2,189,557
Brogo Dam	400	9,000	189,535	189,375
Burrendong Dam	13,900	1,188,000	2,917,704	3,423,424
Burrinjuck Dam	1,300	1,026,000	1,804,668	1,775,968
Carcoar Dam	230	35,800	66,595	77,611
Chaffey Dam	420	61,800	105,174	106,113
Copeton Dam	5,360	1,364,000	650,673	416,773
Dartmouth Dam, Victoria(a)	3,600	4,057,000	1,040,300	1,388,600
Glenbawn Dam	1,300	750,000	229,632	81,422
Glenlyon Dam, Queensland(a)	1,330	253,000	71,353	159,386
Glennies Creek Dam	230	283,000	43,051	66,871
Hume Dam(a)	15,300	3,038,000	6,802,100	6,684,200
Keepit Dam	5,700	423,000	445,757	423,367
Lake Brewster(b)	—	153,000	—	—
Lake Cargelligo(b)	—	35,900	—	—
Lostock Dam	280	20,000	75,409	78,284
Menindee Lakes	—	1,678,000	5,376,886	5,667,240
Pindari Dam	2,000	7,500	238,064	238,474
Split Rock Dam	1,650	397,000	70,145	6,385
Tombullen(b)	—	11,200	—	—
Toonumbar Dam	90	11,000	6,324	8,794
Windamere Dam	1,070	368,000	119,037	47,507
Wyangala Dam	8,300	1,220,000	1,762,714	2,042,459

(a) Operated on behalf of the Murray–Darling Basin Commission. (b) Re-regulatory storages.
Source: Department of Water Resources, New South Wales.

Ameliorating waterlogging and salinisation of farming lands is an environmental management priority for the Commonwealth and States, and New South Wales is pursuing this through a State funded SALTACTION initiative and through the Murray–Darling Basin Ministerial Council. For further information on salinisation, *see* the special article *Salinity — An Old Environmental Problem* in *Year Book Australia 1990.*

Victoria

Water resources are administered by three major agencies, the Office of Water Resources (in the Department of Conservation and Environment), the Melbourne Metropolitan Board of Works, and the Rural Water Commission.

In an average year water consumption in Victoria is as follows:

- 77 per cent irrigated agriculture;
- 16 per cent urban; and
- 7 per cent rural stock and domestic.

The table which follows shows the principal water storages in Victoria.

STORAGE CAPACITY OF RESERVOIRS IN VICTORIA
(gigalitres)

Reservoir	*Storage capacity*	*Reservoir*	*Storage capacity*
Dartmouth	4,000	Upper Yarra	207
Eildon	3,390	Blue Rock	198
Thomson	1,175	Glenmaggie	190
Waranga	411	Cairn Curran	148
Mokoan	365	Yarrawonga	117
Rocklands	348	Toolondo	107
Eppalock	312	Winneke	100
Cardinia	289		

Source: Australian National Committee on Large Dams.

The main rural water supply systems are:

- **Goulburn–Campaspe–Loddon.** The main storage is Lake Eildon with a capacity of 3,390 gigalitres. The main products in these systems are dairy products, fruit, wool and fat lambs. Annual production of deciduous canning fruits in the eastern part of the system is about two-thirds of Australia's total.
- **Murray River System.** The Murray Valley Irrigation Area and the Torrumbarry Irrigation System are irrigated by water diverted at the Yarrawonga and Torrumbarry weirs respectively. These areas are devoted mainly to dairying, fat lambs, fruit, vineyards, orchards and market gardens. Downstream from Swan Hill, the First Mildura Irrigation Trust and four Commission Districts are supplied by pumping, and produce mainly dried vine fruits, citrus fruits and table and wine grapes.
- **Southern Systems.** The Macalister district, supplied from the Macalister River and regulated by Lake Glenmaggie, is devoted mainly to dairying.
- **Werribee and Bacchus Marsh.** These districts produce fresh fruit, vegetables and dairy products mainly for the local domestic market. Irrigation is supplied from the Werribee River system which is regulated by three main storages: Pykes Creek Reservoir, Melton Reservoir and Lake Merrimu.
- **Wimmera–Mallee Domestic and Stock Supply System.** Storages in the Grampian Ranges ensure farm water supplies for dry land, pastoral and cereal farming in the Wimmera and Mallee. There are small areas of irrigation supplied from this system near Horsham and Murtoa.

Nine sub-regional salinity management plans are in various stages of preparation or completion. (Four salinity management plans: Shepparton, Goulburn dryland, Campaspe West and Tragowel Plains, have been accepted by the Government.) The plans are prepared by community based planning groups assisted by a technical committee made up of State Government officers. A lead State agency has been nominated for each management plan. Priority has been given to the Northern Victorian irrigation areas because of the size of their salinity problems and the relationship to the interstate River Murray issue.

Queensland

The management of surface and underground water is exercised by the Water Resources Commission.

Approximately half of the area irrigated in Queensland now uses water from storages constructed by the Commission. The balance is irrigated from unsupplemented surface or ground water supplies spread widely throughout the State. Because of the predominance of irrigation by private diversion from streams, as opposed to channel systems delivering water to farms, most of the storages release water to maintain supplies downstream.

Approximately one-third of the area irrigated in Queensland each year is concentrated in eight Irrigation Areas constituted under the *Water Resources Act 1989* where the supply is generally reticulated by channel systems to the farms. Irrigation projects are schemes established under the Act, where water is released from storages to maintain supplies for pumping under licence to land adjacent to the streams. Details of the projects are set out in the accompanying table.

IRRIGATION AREAS AND PROJECTS, QUEENSLAND, 1990–91

	Announced allocations(a)				*Actual use(a)*		
	Irrigation		*Other uses*				
	Outlets	*Allocation*	*Outlets*	*Allocation*	*Irrigation*	*Other uses*	*Area irrigated*
	no.	megalitres	no.	megalitres	megalitres	megalitres	hectares
Irrigation Areas							
Bundaberg(a)	2,374	397,250	7	15,008	219,719	12,861	49,455
Burdekin River	820	125,891	81	378	122,451	136	10,640
Dawson Valley	301	53,494	7	2,915	24,109	1,482	4,620
Emerald	208	111,933	87	15,494	88,359	17,615	16,611
Eton	617	53,763	41	10,229	38,561	8,876	15,531
Lower Mary River	172	14,254	—	—	11,425	—	4,553
Mareeba–Dimbulah	1,287	84,194	118	47,627	68,507	77,612	13,739
St George(b)	311	70,913	7	2,854	79,380	3,597	14,003
Sub-total	*6,090*	*911,692*	*348*	*94,505*	*652,511*	*122,179*	*129,152*
Irrigation projects							
Awoonga–Callide Pipeline	—	—	1	10,373	—	10,373	—
Barker–Barambah	134	29,797	5	1,600	9,722	1,669	3,000
Blackwater Water Supply System	—	—	28	6,641	—	6,690	—
Bowen–Broken Rivers	—	—	45	6,400	—	4,974	—
Boyne River	59	13,249	—	—	7,687	—	1,120
Callide Valley(a)	441	30,872	71	5,844	23,001	5,448	12,450
Chinchilla Weir	30	2,876	1	1,160	1,747	964	1,200
Condamine Groundwater(b)	352	65,420	18	4,008	33,478	3,140	14,500
Dumaresq River	111	84,964	21	2,011	88,272	1,794	13,439
Fitzroy River Barrage	140	11,650	—	—	6,719	—	1,000
Logan River	160	11,338	6	4,065	8,117	2,148	3,920
Lower Lockyer	189	14,172	—	—	10,904	—	4,300
Macintyre Brook	113	18,587	2	466	10,080	412	2,400
Mary Valley	235	17,125	4	7,014	9,833	4,287	2,760
Proserpine River	76	4,903	6	1,393	5,232	1,075	3,085
Tarong Water Supply System	—	—	36	29,362	—	29,350	—
Three Moon Creek(a)	141	14,144	13	727	10,310	645	2,350
Upper Burnett	279	25,847	4	1,560	25,017	1,540	3,082
Upper Condamine(b)	119	26,774	13	3,345	40,362	2,410	16,420
Warrill Valley	422	24,338	6	10,775	18,447	5,858	8,170
Sub-total	*3,001*	*396,056*	*280*	*96,744*	*308,928*	*82,777*	*93,196*
Total	**9,091**	**1,307,748**	**628**	**191,249**	**961,439**	**204,956**	**222,348**

(a) Includes ground water component. (b) Irrigation includes some waterharvesting component.
Source: Water Resources Commission, Queensland.

The availability of underground water, particularly the Great Artesian Basin, has played a major part in the development of the pastoral industry in Queensland. Underground

water is also used extensively for irrigation on individual farms, particularly along the coastal fringe, and for domestic purposes. Some 45 per cent of the area irrigated in Queensland receives its supplies from underground sources. In accordance with the requirements of the *Water Resources Act 1989* the investigation of the availability of underground water is being pursued by geological mapping, investigation drilling and hydro-geological assessment. The predominant areas where water from this source is used for irrigation are the Burdekin Delta, Condamine Valley, Bundaberg, Lockyer Valley, Callide Valley and Pioneer Valley.

Western Australia

The Water Authority of Western Australia manages the majority of water-related services.

Western Australia has a great variation in the size and complexity of water supply schemes, which range from town schemes serving fewer than 50 people to the Perth metropolitan scheme serving a population of 1,200,000.

The table which follows shows the principal water storages in Western Australia.

STORAGE CAPACITY OF RESERVOIRS IN WESTERN AUSTRALIA, 30 JUNE 1989
(megalitres)

Reservoir	*Storage capacity*	*Reservoir*	*Storage capacity*
Lake Argyle (Ord River)	2,797,000	Logue Brook	24,300
South Dandalup(a)	205,350	Waroona	14,954
Serpentine(a)	194,500	Victoria(a)	9,460
Wellington	184,900	Samson Brook	9,170
Kununurra Lake (Ord River)	97,400	Harvey Weir	9,126
Canning(a)	90,350	17-Mile Dam(b)	5,489
Harris	72,000	Fitzroy	4,650
Harding	63,800	Serpentine Pipehead(a)	2,640
Mundaring	63,600	Drakes Brook	2,290
Wungong(a)	59,800	Churchman Brook(a)	2,240
Stirling	56,123	Glen Mervyn	1,490

(a) Serves the Perth Metropolitan Area. (b) On Uralla Creek, an anabranch of the Fitzroy River.
Source: Water Authority of Western Australia.

Considerable use is made of ground water by individual farmers, pastoralists, market gardeners, etc., and it is estimated that over 100,000 bores are in use in the State. Both artesian and non-artesian sources are used to supply or augment the supplies of numerous towns, including such major centres as Perth, Albany, Bunbury, Busselton, Carnarvon, Dampier, Esperance, Exmouth, Geraldton, Karratha and Port Hedland. In a number of mining towns in the north-west, mining companies are responsible for the provision of their own water supplies. Industries also use ground water in substantial quantities, particularly in the processing of titanium, iron and alumina.

Perth is supplied from a number of dams and pipeheads in the Darling Range and from ground water schemes located on the Swan Coastal Plain. Water gravitates or is pumped from these sources to service reservoirs and tanks located at high points over the metropolitan area for gravity feed to consumers. Perth's water consumption is currently about 210 gigalitres per year and is increasing.

The Water Authority is responsible for all town water supply schemes in the country towns of Western Australia, with the exception of the Bunbury and Busselton schemes which are run by local Water Boards. There are also a small number of town water supply schemes operated by mining companies. Individual water supplies serve railways, timber mill towns, isolated mines, pastoral properties, stock routes and agricultural areas, mainly from dams, tanks, wells and bores.

In country areas total control has been exercised on ground water usage in Broome, Gascoyne, Swan and South West Coastal Ground Water areas. The control of other

areas has been tailored to the specific problems known to exist.

- **Goldfields and Agricultural Areas Water Supply.** This scheme provides water from Mundaring Weir to consumers in the Central Agricultural Areas and the Eastern Goldfields.
- **West Pilbara Water Supply Scheme.** The West Pilbara Water Supply serves the towns of Dampier, Karratha, Wickham, Point Samson and Roebourne as well as the industrial complexes at Dampier, the Burrup Peninsula and Cape Lambert. Water is supplied exclusively from the Millstream aquifer and the Harding Dam.
- **Geraldton Regional Water Supply Scheme.** The Geraldton Regional Water Supply serves consumers in the towns of Geraldton, Dongara, Port Denison, Mullewa, Walkaway, Eradu and Narngulu with water being drawn from the Wicherina, Allanooka and Wye Springs borefields.
- **Great Southern Towns Water Supply.** This scheme provides water to the coal mining town of Collie together with towns and farmlands in the Great Southern Area. Water is drawn from Harris Dam, which has a capacity of 72 gigalitres, and supplied to towns from Brookton and Kondinin in the north to Kojonup and Gnowangerup in the south and to Lake Grace in the east as well as 600,000 hectares of farmland.
- **Port Hedland Regional Water Supply Scheme.** The Port Hedland Regional Water Supply provides water for the consumers of Port Hedland and South Hedland from the complementary De Grey and Yule River borefields.
- **Lower Great Southern Towns Water Supply Scheme.** This scheme supplies the towns of Albany, Mt Barker and Kendenup. Water is drawn from three sources: Two Peoples Bay east of Albany (from which the water is treated for colour removal), Limeburner's Creek and bores which are located on the west of Princess Royal Harbour.
- **Mandurah Regional Water Supply Scheme.** This scheme provides water to the town of Mandurah and areas to the south and east. Approximately 90 per cent of the water consumed is supplied by gravity from the South Dandalup Dam with the remainder supplied from bores at Ravenswood.
- **Supplies to other country towns.** Nearly 150 towns are supplied with water from stream flow, dams, tanks, wells and bores, the schemes being administered under the provisions of the *Country Areas Water Supply Act 1947.*

The Water Authority is responsible for the provision and maintenance of tanks and wells as a source of cartage water for farmers and a number of small communities in gold mining and agricultural areas.

The Water Authority also undertakes design and construction of water services for Aboriginal communities on behalf of the Aboriginal and Torres Strait Islander Commission. The Authority under contract to the Aboriginal Affairs and Planning Agency assists communities in operating and maintaining schemes and training community operators.

The Water Authority is responsible for the operation and maintenance of seven irrigation and 15 drainage schemes throughout the State from Albany in the south to Kununurra in the north.

Irrigation schemes have been established by the State Government on the coastal plain south of Perth in the Waroona, Harvey, Collie River and Preston Valley Irrigation Districts between Waroona and Donnybrook, the water being channelled from dams in the adjacent Darling Range.

There is a thriving plantation industry situated at Carnarvon near the mouth of the Gascoyne River. This centre is one of the major producers in Western Australia of tomatoes, watermelons, pumpkins, cucumbers, capsicums and runner beans. Carnarvon also supplies capsicums, zucchinis and pumpkins to the eastern States. It produces over half the bananas consumed in Western Australia as well as limited supplies of citrus fruit, mangoes and avocados.

The rainfall at Carnarvon is extremely variable and averages little more than 230 millimetres per annum. Agricultural development has been made possible only by irrigation with ground water. Water is obtained from the growers' own irrigation pumping plants and from the government-controlled Carnarvon Groundwater Supply Scheme which is supplied from bores along the Gascoyne River.

The Ord Irrigation Project provides for the ultimate development of 72,000 hectares of clay soils and additional areas of sandy soils adjoining the clays. Water is currently supplied to 18,000 hectares.

South Australia

All major water resources and most public water supply schemes are administered by the Engineering and Water Supply Department under various statutes.

Currently water diversions totalling more than 509,172 megalitres (supplying an area of 43,000 ha) are made for government, cooperative and private irrigation schemes in the South Australian section of the River Murray. The authority controlling River Murray irrigation is the Engineering and Water Supply Department.

Except for quantities held in various lock pools and natural lakes, no water from the Murray is stored within South Australia for irrigation purposes. In addition to irrigation from the River Murray there are considerable areas irrigated from underground sources.

In 1990–91, River Murray pipelines supplied 95,100 megalitres, which represents 48 per cent of the total intake to the Metropolitan Adelaide Water Supply System, compared with 36 per cent for the previous year. The principal sources of supply for the nine storages in the Mount Lofty Ranges are the Rivers Onkaparinga, Torrens, South Para, Myponga and Little Para. Total metropolitan consumption was 200,100 megalitres.

A number of reservoirs in the Barossa Ranges and other local sources are augmented by the Morgan–Whyalla, Swan Reach–Stockwell and Tailem Bend–Keith pipelines which provide River Murray water to extensive country areas. Surface and underground resources have been developed to supply most country centres not covered by the larger schemes. Total country consumption was 73,777 megalitres.

The table below shows the main reservoirs in South Australia.

STORAGE CAPACITY OF RESERVOIRS IN SOUTH AUSTRALIA
(megalitres)

Reservoir	*Storage capacity*	*Reservoir*	*Storage capacity*
South Para	51,300	Happy Valley	12,700
Mount Bold	45,900	Todd River	11,300
Myponga	26,800	Bundaleer	6,370
Little Para Dam	20,800	Baroota	6,120
Kangaroo Creek	19,000	Warren	4,770
Millbrook	16,500		

Source: Engineering and Water Supply Department of South Australia.

The Murray–Darling Basin Ministerial Council and Commission administer the joint operation of the river system. The Commission is pursuing two main strategies to maintain and improve the quality of River Murray water and improve the management of associated lands. The first is, the Salinity and Drainage Strategy and the second, the Natural Resources Management Strategy (NRMS).

The Salinity and Drainage Strategy involves works to mitigate salinity in the lower reaches of the Murray combined with drainage proposals in the upper States, to rehabilitate waterlogged land. Under this strategy, the Woolpunda Salt Interception Scheme was commissioned in November 1990. This will intercept up to 170 tonnes of salt per day. Approval has also been granted for the construction of the Waikerie Salt Interception Scheme, and investigations are continuing for other projects including Chowilla and Loxton.

Under the NRMS Strategy, development controls administered under the Planning and Water Resource Acts reduce the risks and consequences of flooding, and of degradation of the river and floodplain. Recent attempts to link water with land management issues have been undertaken with progress on integrated catchment management in the Mount Lofty Ranges and Murray Valley. One result is a program over five years which includes obligations on land owners to modify certain land use practices in the Mount Lofty Ranges.

Tasmania

The Hobart Regional Water Board, the Rivers and Water Supply Commission, the North-West Regional Water Authority, the Department of Resources and Energy, and the Hydro-Electric Commission all play responsive roles in the administration of water resources.

Contrary to popular belief, Tasmania is heavily dependent on water conservation in maintaining reliable sources of supply for irrigation, stock and domestic requirements, and urban and industrial water supplies. This is due to an annual summer drought between January and March, when most run-of-the-river flows only support ordinary riparian needs or very limited irrigation and many smaller streams cease to flow.

The total surface water usage for domestic, industrial, and agricultural purposes in Tasmania is only one per cent of the potential exploitable yield, compared with a national figure of about 13 per cent. Despite this, economic, environmental and social constraints are beginning to restrict further development of the total yield for these purposes.

Excluding power generation storages, the total capacity of water conservation dams in the State is about 150 gigalitres, almost half of which is in on-farm dams.

There is widespread use of farm dams for irrigation which is needed to maintain overall production because of the summer drought and the lack of pasture and crop growth in the State's cold winters.

The vast majority of the State's water resources are used for power generation, based on a large, integrated system of water storages. This system also benefits other water users by enabling greatly increased regulation of many streams. The table below shows the major dams and reservoirs in Tasmania.

STORAGE CAPACITY OF RESERVOIRS IN TASMANIA
(gigalitres)

Reservoir	*Storage capacity*	*Reservoir*	*Storage capacity*
Gordon	11,316	Reece Dam	641
Cethana	4,770	Lake King William	541
Miena	3,356	Arthur's Lake	511
Scotts Peak	2,960	Devils Gate	180
Lake St Clair	2,000	Rowallan	131
Mackintosh	949	Bastyan	124
Lake Echo	725		

Source: Australian National Committee on Large Dams.

The Rivers and Water Supply Commission is in charge of three major irrigation schemes, these being the Cressy–Longford Irrigation Scheme, the South East Irrigation Scheme, Stage I, both of which supply water via open channel, and the Winnaleah Irrigation Scheme which supplies water via pipelines.

Of the three schemes, Cressy–Longford is the largest (serving 88 properties) with 10,000 hectares being fit for irrigation. The Coal River Scheme is capable of serving 107 properties of which 3,800 hectares are fit for irrigation. The Winnaleah Scheme serves 1,500 hectares on 72 properties.

The majority of land irrigated in the State is watered by private schemes either by pumping directly from unregulated streams or from on-farm storages. Pasture still predominates as the major crop irrigated but vegetables and other crops now constitute 33 per cent of the total area irrigated.

Northern Territory

The Power and Water Authority is responsible for water resources.

Of approximately 22,000 bores and wells registered in the Territory to 30 June 1990, 25 per cent were for pastoral use, 15 per cent were investigation bores, 30 per cent served urban and domestic supplies, 5 per cent were for agriculture, 17 per cent were used for mining and the remaining 8 per cent for various other uses.

The largest water conservation project in the Territory is the Darwin River Dam (259.0 gigalitres) which serves Darwin with a reticulated water supply. Ground water from McMinns Lagoon area is used to augment supply.

Most other towns and communities, including Alice Springs, Tennant Creek, Jabiru and Nhulunbuy, are supplied from ground water. Water supply to Katherine is from run of river with supplementation from ground water.

Irrigation in the Territory is expanding, but is not extensive, being confined to locations near Darwin, Adelaide River, Daly River, Katherine, Ti Tree and Alice Springs for the purpose of growing fruit, vegetables, fodder crops, pastures and some dairying. Most of this irrigation is carried out using bore water. There are no publicly owned/operated irrigation systems in the Territory.

Australian Capital Territory

The Electricity and Water Authority is responsible for the supply of water.

Surface water storages supplying the Australian Capital Territory (ACT) (population about 295,000) and the city of Queanbeyan (population about 27,000) are located to the south-west and south-east. The storages to the south-west are in the heavily timbered, mountainous Cotter River catchment within the ACT, the storages being Corin Dam (75.5 gigalitres), Bendora Dam (10.7 gigalitres) and Cotter Dam (4.7 gigalitres). The storage to the south-east in New South Wales in the Queanbeyan River catchment (over which the Commonwealth has permanent water rights) on the western slopes of the Great Dividing Range is the Googong Dam (125.0 gigalitres).

The existing storages on the Cotter and Queanbeyan Rivers have an ultimate combined capacity to serve 401,000 persons. The Coree Dam, proposed for the Cotter River, will serve an additional 75,000 persons. The remaining water resource within the ACT is the Gudgenby River which is at present not utilised but has the potential to serve approximately 150,000 persons.

Ground water has been used in the past by most primary producers to augment surface storage. Ground water production bores in the ACT have yields ranging between about 0.4 and 20 kilolitres per hour; 3 kilolitres per hour is about the average yield. However, many farm bores have fallen into disuse as a result of the Government's resumption of freehold land within the ACT, and because of the rapid expansion of urban growth. The Bureau of Mineral Resources has provided a bore-siting, ground water-quality and yield-prediction service in and around the ACT since the early 1950s and has maintained a network of observation bores which have been monitored regularly.

INTERNATIONAL ASPECTS AND NATIONAL AND INTERSTATE AGREEMENTS

For information on international aspects and for national and interstate agreements on the management of water resources *see Year Book Australia 1990*, pages 504–507.

BIBLIOGRAPHY

Publications

AUSTRALIAN NATIONAL COMMITTEE ON LARGE DAMS. Register of Large Dams in Australia, 1982

DEPARTMENT OF NATIONAL DEVELOPMENT AND ENERGY. Review of Australia's Water Resources. Australian Water Resources Council, Canberra, 1975

DEPARTMENT OF RESOURCES AND ENERGY. Review of Australia's Water Resources and Water Use. Water Resources Data set. Australian Water Resources Council, 1985

DEPARTMENT OF WATER RESOURCES, N.S.W. Annual report, 1989–90.

For information on Northern Territory ground water (and surface water) resources see the Australian Water Resources Council's publication *1985 Review of Australia's Water Resources and Water Use.*