Senate Inquiry into Salinity 2005

Supplementary Information to WfA Submission (No. 23)

- Water Grid – Schematic chart
- What is a water Grid?
- Transfer of part of the Northern Australian Run-off
- The National water and Environmental Plan (7 pages)
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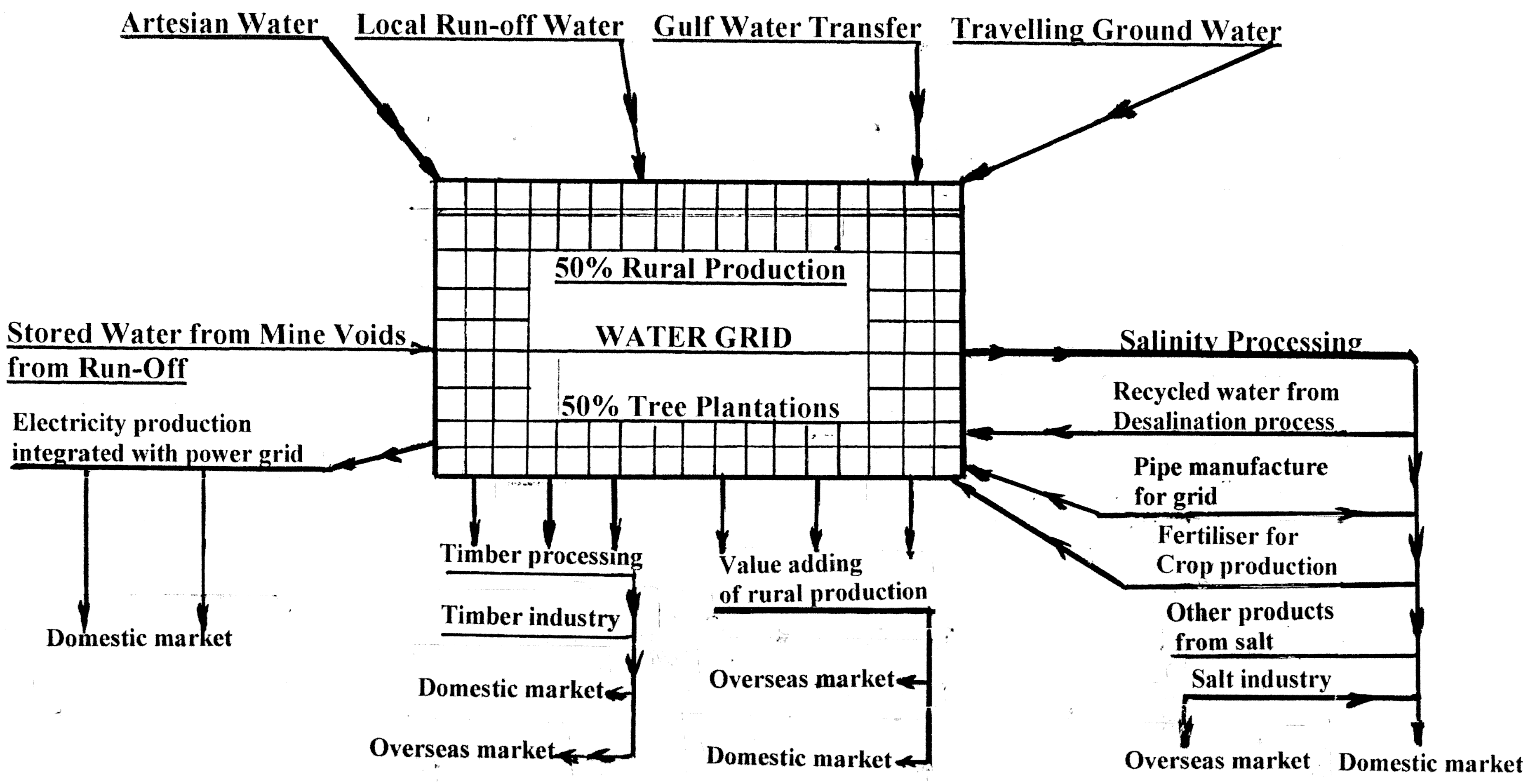
- Minerals Map with National Water Grid scematic
- Drawing of Water Grid farming
- Groundwater Salinity map
- Surface Water Resources of Australia
- Groundwater Resources of Australia

WATER FOR AUSTRALIA

Explanation of Grid Operational Flow Chart



WATER FOR AUSTRALIA

The Water Grid Transfer System

What is a Water Grid?

The water grid is a series of buried pipe mains, forming a square pattern of catchments, one square kilometer in area. This configuration can be changed to suit the topography of an undulating land surface, maintaining the one square kilometer catchment area.

Each catchment has a Water Flow Collector (WFC), situated at the lowest outfall point of the catchment boundary. Each WFC has a storage capacity of 10 megalitres of water. In times of crossland flows, including flood, the WFC is filled, and the flow proceeds into the next catchment, filling that catchment's WFC. This is repeated until the flow is diminished, or all the WFCs are filled and ready to draw on for grid transfer or irrigation needs.

The Function and Benefits of the Water Grid

Water grids are designed to harvest, store and distribute water evenly over a given area, to be used for sustainable farming activities and to supply the water needs of large-scale tree plantations.

The establishment of water grids would provide a tool to control salinity, at the same time creating profitable salt and timber industries to fulfil domestic and overseas markets.

The grid harnesses water from all the sources shown on the grid operations flow chart.

The small catchments allow for fast collection of precipitation before the clouds that brought the rain leave the area. This reduces loss from evaporation and soak that now occurs from the very large catchments that now exist.

The bore adjacent to a WFC supplies traveling ground water and artesian water. A grid allows the repeated use of traveling ground water for irrigation. Some losses will occur from evaporation and plant transpiration, before the water is returned to the ocean outfall.

The energizing of the water grid system is provided by solar power generated by a specially designed WFC roof. (The patent application has been lodged). The water grid's electricity supply could be integrated with the power grids, on an exchange basis, pumping in off peak time would make this an attractive proposition.

Water grids are designed to be centrally controlled by the use of power activated valves that are between slice and gate valve design. The system can be over-ridden by hand in times of emergency or special maintenance.

Water grids are designed to suit the irregular and scattered rain and weather patterns to collect and distribute the water where required in this low profile continent of Australia.

The Transfer of Part of the Northern Australian Tropical Run-off

This proposed transfer would supply the water grids of the three Eastern States. It is both practical and affordable and though it may appear a large infrastructure undertaking, it would be an essential asset to secure Australia's future.

The Northern Gulf of Carpentaria's mean annual run-off is in the order of 92,500,000 million megalitres per annum, which takes place in the wet season.

The plan requires the collection and pumping of 32,472,000 megalitres from this source over 300 days. As the wet season last approximately 90 to 120 days, it will require lake type storages sited along the catchments with a total storage capacity of approximately 75,000,000 megalitres. This storage is in excess of requirement but allows for evaporation and local use, also allowing for poor wet seasons.

The grid system provides the opportunity for the north/south transfer of part of the tropical rainstorms occurring in the Gulf of Carpentaria regions of water at 6,780 megalitres per day, which equals 2,034,201 megalitres per annum. The balance of the transfer is by 2 culvert tunnels, each to be designed using grade and pressure to have a flow velocity of 600 cubic meters per second. This water takes 6.7 days to reach the southern extremities of the grid, including the rainfall within the grid area. The sum total of all this storage capacity plus the artesian groundwater and traveling groundwater, and desalinated water from lowering water tables, would provide sufficient water for an estimated 660,000 square kilometres of very productive rural activity.

Taking excess water from this region should not create a damaging effect on the fish breeding mangrove area as the water disturbance created by the dramatic high tide effect running in and out provides similar conditions to land flows. The exception is the flood plumes that carry some food, but these flood flows also rip out precious soils and the plumes destroy coral reefs. In balance, taking all the relevant evidence into consideration, it could be said that reducing the amount of flood discharge along the Northern Australian coastline is an environmental improvement.

It is certainly incomprehensible to let the greater part of 92,500,000 million megalitres at a value of $18.5 billion dollars, run into the sea and then to desalinate the ocean water at great expense to both the environment and taxpayer. The grid is the answer to using the excess of the precipitation from the seasonal tropical downpours. This excess water should be used to help irrigate the drought stricken land, where farmers are trying to survive and many towns and cities are now short of water.

The National Water and Environmental Plan

Laurie Hogan and Barry Dunn

The idea of developing a plan to find a sustainable water solution for this low profile, dry island continent of Australia started in 1953. Since then until now, the national water grid and environmental plan has been painstakingly researched and developed.

Australia will not reach its true potential until we solve the water and salinity problems that inhibit long-term sustainability.

Water for Australia has produced a practical plan including cost benefit analysis. The plan has been formulated by using a holistic overview and lateral thinking, taking all of the presently foreseeable problems into account and finding answers to each.

There have been many good ideas put forward during the long investigative period of the WfA plan. We have selected five, which would work in harmony with the Water for Australia plan, to be applied where best suited in the fight against the flood, drought and salinity syndrome. They are as follows:

- The slitting and forming of earth to form a microcosm environment; this is an excellent method to restore depleted soils back to fertility.
- The Peter Andrews system, using plants to cleanse the river or creek flows and a series of detention weirs and canals to allow water to pass though topsoil of selected areas improving the soil profile.
- The old man saltbush system, to be used as a stock feed in dry marginal areas that are not gridded and are frequently drought stricken.
- The catch soak drains running in level contours around slopes, this is a well known system that allows water to soak through the top soils slowing down the run off and improving water conservation.
- No till farming, which is suitable for special soil types and for use in areas where it is necessary to reduce the cost of grain production.

These systems all require water to function, coupled with the Water for Australia plan would ensure the water required which would enable Australia to overcome most of its water, salinity and environmental problems.

Australia's total average annual water run-off (as per Civil College technical report inventory for the 90s) is in the order of 397 million megalitres. Given a rate of $200 per megalitre, the total value would be ninety seven billion dollars. We divert approximately 25% of the total run-off. This diverted amount is small by the developed world standards. This 25% represents 99 million megalitres, at a rate of nineteen billion dollars.

Water for Australia's aim is to increase the amount of diverted water from 25% to 50%. This would produce an extra water value of nineteen billion dollars per annum and make available extra storage of 99 million megalitres. We harvest this water by collecting run-off from small design catchments, by the re-use of traveling ground water, plus water from desalination of lowering water tables. In addition, we would use some of the excess of our northern cyclonic wet seasons, and when necessary, desalinated ocean water. This additional water would be stored or reticulated on to the rural zones by the use of water grids. This water would be metered and applied to the crops by drip or subsoil irrigation.

P2...

Water Grids
The design of the water grid system is harvest water from where it is in excess and transfer it to where it is needed.

WfA first promoted piped water grids in the 80s – when no one appeared to listen. Then a Queensland property piped water from a bore, serving its drinking troughs. This was followed by the Wimmera/Malley piped water scheme; and, Richard Pratt started replacing some open channel irrigation with pipes - all of which provided substantial water savings. The obvious success of these projects has proved the value of the water grid system. Water grids substantially reduce losses from evaporation and soak and the resulting salinity.

The pipe grids are made up of 300 millimetre ID plastic pipes, energised by gravitational flows through drive heads, and pressure from the artesian basin. Solar powered pumping would operate at each water flow collector.

This arrangement maintains a pressure of 276 Kpa (40 lbs per sq.inch). These pipes form a 1 square kilometre grid pattern, laid in a 1 metre deep trench for long life and ultra violet protection. A 10 megalitre water flow collector (water storage facility) is constructed in the corner of each square catchment, or in a depression in the low side of the catchment. This pattern will be used in low profile country, changing shape to suit the topography, in undulating areas zoned rural.

The enclosed water grid system allows water to be transferred long distances with minimal contamination compared with flood waters, which pick up faeces, dead animals and also spread fly and mosquito-borne diseases. One of the main benefits of the water grids is the rapid collection of water in the small designed catchments. This run-off is harvested before most of the cloud cover that delivered the precipitation leaves the area. This helps prevent huge losses that now occur from evaporation and soak in the very large catchments that now exist. Not much of the soak water ends up in the river systems, but journeys to the ocean along the impervious layers within the decayed mantle.

A bio-stabilisation system incorporated into the grids allows for desalination of the topsoil to suit the intended crops by sterilising, scrubbing, adding organic matter, correcting and balancing minerals and adjusting the pH - as the particular soil requires. This soil rehabilitation could not take place without the water grids, salt factories or bio-stabilisers. Combining the grid with biostabilisers will return our depleted soils back to high fertility production, and will guarantee the water that is needed to drought proof the selected rural zones.

The grids' operational functions are to harvest run-off water, ground water, and desalinated water, that is stored or reticulated for use in classified rural zones and for other national use. The grid operations are computerised and operated from central control stations. This is made possible by using solenoid slice or gate valves to direct water through the grids. Salinated water would be piped from farm collection dams on salt affected properties to the closest salt factory for treatment via 100 millimetre ID plastic pipes running parallel and in the same trench as the 300 millimetre ID fresh water mains. This would allow continuous operation in both salt reduction and water transfer.
All water grid pipe mains are buried along with computer control and electricity supply transfer cables.

P3...

The selection of PVC plastic pipes are made for the following reasons:

- Plastic is light to transport.
- Flexes with ground movement.
- Smooth bore reduces friction.
- Has a long life when buried.
- The main component of the pipe manufacture is our problem salt.

Land Zoning

It would be ideal to introduce land zoning of the non-urban areas of Australia. This should help settle down much of the debate by the stakeholders within each category and prevent overlapping in management of the various zones. The following is a suggested framework for the zoning:

Environmental Zone

National Parks, native forests, wetlands, lagoons, rivers and sanctuaries, native title and heritage areas, and archaeological sites, ecological corridors and reserves for protected species.

Rural Zone

All types of farming, including salt resistant tree plantations, and rural support industry.

Mining Zone

Underground, open cut mining and quarry extraction areas, designed to leave behind water storage facilities.

Forestry Zone

Land set aside for natural forests and forestry support industries.

Special use Zone

Government use, defence, water storage, utility easements, (portions of native title could be considered for rezoning to any one of the groups, at the initiative of the Aboriginal people) and areas set aside for future use.

Tourism Zone

Selected areas for tourism, which can occur in all zones.

As non-urban zoning would require much debate and long preparation for legislation to be effected, discussion should start as soon as the first grid project is on the drawing board.

Once zoning is legislated, it should help reduce the arguments between the environmentalists and other interests.

Salinity

It is now well known that the mishandling of the salinity problems in ancient Mesopotamia caused the present deserts of Iraq. Australia has used much the same open channel and flood irrigation practices as they did some 4,000 years ago in that once fertile agricultural country. Land degradation from the same causes is happening in Australia and the same deserts will result if the old practices continue. It is useless to contemplate any long-term irrigation, without putting in place a method to reduce salinity on the topsoils

P4...

That is why WfA has placed the importance of the establishment of 10 salt factories and the use of bio-stabilisers. We will be using modern technology as necessary to reduce salinity by four million tonnes of fossil salt per annum.

These salt factories would produce all of the pipes and fittings needed for the water grid, using 57% salt and derivatives of oil or coal to produce the plastic pipes of PVC (polyvinyl chloride). There would also be a range of salt products for domestic and overseas markets. This salt industry would be both profitable and sustainable adding billions of dollars to the GDP. There are critics of PVC piping, and we have taken a balanced approach with its selection.

Mining

With our current open cut mining, Australia is missing out on a great opportunity by backfilling open cut mines. We need the foresight to mine to a hydraulic design. Each one of the often very large excavations produced by current mining practice, represents a potentially high capacity safe reservoir, which would be incorporated into the national water grid plan.
This is a vital component of the plan and backs up the operation of the water grid projects.
This would not create a great outlay for the mining industry, when the cost of reclamation is taken into account.
The result would be pristine lake water storages, which can be used for aquaculture, surrounded by parklands and native vegetation for the benefit of recreation and tourism.

The problems associated with acid and leachate have been dealt with in the design criteria of the WfA plan. There are seven operational mines within Queensland's Bowen Basin.
If the largest open cut mine in the basin is worked to a hydraulic plan, it would produce a void when mining operations cease and after lining, capable of holding four Sydney Harbours of back up water.

Tree Plantations

Tree Plantations are an important segment of the National Water and Environmental Plan. These proposed plantations would be grown in 50% of the rural zoned areas. The plantations would be set out in a north/south configuration, half a kilometer east/west and five km. north/south. They are offset as shown in the plan. This design allows for fire protection access, some wind protection for crops, while allowing sufficient sunlight for crops and farm animals. These plantations help bring back fertility by returning leached nutrients to the soil from bark and leaf litter. The trees also maintain lowered water tables thus helping prevent salinity.
The role these plantations play is important in the sustainability of the plan.
They also assist in reducing global warming and preserves native forests.

The harvesting of these tree crops will support a very large timber industry, providing several thousand jobs in the country, where they are needed, and will add substantially to the Nation's GDP.

Each plantation is composed of a monoculture of fast growing native trees selected for straight trunks and salt tolerance. Overall there would be a variety of types or species of native trees used in different plantations. Some may be fire resistant or enrich the soil or be useful in other ways.

P5...

Going back some thousands of years to the ancient Middle East, examples may be found that prove the importance of native trees to survival –

(From Ronald Wright's 'A Short History of Progress')
"A small civilization such as Sumer, dependant on a single ecosystem and without high ground, was especially susceptible to flood and drought. Such disasters were viewed, then as now, as acts of God (or gods). Like us, the Sumerians were only dimly aware that human activity was also to blame. Flood plains will always flood, sooner or later, but deforestation of the great watersheds upstream made inundations much fiercer and more deadly than they would otherwise have been. Woodlands, with their carpet of undergrowth, mosses and loam, work like great sponges, soaking up rainfall and allowing it to filter slowly into the earth below; trees drink up water and breathe it into the air. But wherever primeval woods and their soils have been destroyed by cutting, burning, overgrazing, or ploughing, the bare subsoil bakes hard in dry weather and acts like a roof in wet. The result is flash floods, sometimes carrying heavy loads of silt and gravel-----like liquid concrete."

The Environment

The plan is in balance with the environment. In fact, it improves the river systems in the following ways:-
It provides most of the water for rural production by collecting water as earlier stated. Without the plan this water would not be available. The grid water lessens the rural demand now taken from the river flows.

The environmental part of the plan is to protect the running rivers and creeks by gradually installing fenced wild life corridors between 20 and 50 meters either side of the riverbanks. The make up of this bush filter plan would be of native trees, shrubs and grasses. This allows wildlife to access National Parks and habitat areas by the river routes.

The riverside growth acts as a filter for farm chemicals and nutrient run-off. These fenced corridors protect riverbanks and the extra shade provided by the trees plus the increased river flows, helps to reduce toxic algae growth. The protecting tree and shrub cover on the banks also reduces flood damage.

In times of long, intense drought, the plan provides the river systems with some water to maintain a low flow.

Tree plantations are another environmental improvement. They supply the timber industry needs, without destroying old growth forests. The salt tolerant plantations are grown in harmony with the farming operations; by protecting the soils; and crops, and reducing salinity by controlling water table levels. The timber crops are rotated with the farm crops when a plantation is harvested. This rotation procedure, using mainly organic fertilizers and chemicals if needed, guarantees sustainability in our future farming practices.

Ten salt factories also benefit the environment by gradually reducing the salinity problems of Australia.

The footprint of the grids is not as big as one might think when first hearing the plan unfold. The rural production zones are the only areas where the grid system would be laid, apart from some single pipe easements, bringing in water from some of the storages.

P6...

Surely there is sufficient balance provided in the plan for the adoption and construction of the national water and the environment plan.

We should cease the rhetoric and construct a rational future plan using a blend of modern technology and common sense. The mistakes of the past are there for us to see so that we can now overcome thousands of years of the sad history of land abuse by people not understanding the consequence of their actions.

Financing the Plan

The Water and Environmental Plan is broken up into eight segments. They are as follows:-

1/ Construction of the pipe grids and water flow collectors, including energising and running costs, funded by governments.

2/ Construction of major back-up mine storage, funded by governments and miners.

3/ All work associated with river restoration and environmental matters, funded by governments and part of the allocations to the following instrumentalities; the environment, National Parks, tourism, Landcare and private donation of work or cash.

4/ Soil restoration and tree plantations within the rural zones will take place, funded by governments, forestry, farmers and the timber industry.

5/ Salt factories would be funded, owned and managed by farming co-operatives and private investment.

6/ Access roads and public utilities, funded by governments.

7/ Area bio-stabilisation, funded by farmers with help from governments by way of interest free loans.

8/ All other parts of the plan funded by government and stake holders.

All expenditure will be returned to government with a profit over a reasonable time span by the following cash flows and expenditure savings:-

- The sale of 196 million megalitres of water per annum equals thirty eight billion dollars. The return on this water would be from rural activities which ultimately would be returned to the Government
- A reduction of government funding for drought and flood relief.
- An expected doubling of rural income from rural production.
- Income from newly established manufacturing industries created by the plan.
- Income from growing our timber industry to be one of the largest in the world.
- Income from a large salt industry producing billions of dollars per annum.

P7...

- Income from the increased tax take
- A large increase in gross domestic product
- The projects will breathe life back into the declining inland towns and cities.
- Create hundreds and thousands of new jobs, over time.
- Stop the population drift to the coastal cities.
- Rebuild our depleted topsoil and improve our environment
- The new industry of area-rehabilitation, for our now unproductive agricultural land.

The Council of Australian Governments is quite capable of funding this nation-building project.

It is vital to build this infrastructure now, while the economy prospers.

The plan should remain intact; no part of the plan should be removed; only input into the improvement of the plan should be considered.

Salinity 'fortunes for taking'

By ALAN DICK

IMAGINE a scheme where products worth hundreds of millions of dollars are extracted from Murray-Darling basin salt in a way that helps provide a long-term solution to basin salinity woes, and townships with new sources of fresh water.

That's what Dr Hal Aral, of CSIRO Minerals, has in mind, and small demonstration scale projects are already underway, or in the wind, to help bring it about.

Dr Aral says substances dissolved in the salty groundwater can be used in a wide range of processes.

They include making fertilisers, light metals, plastics, industrial chemicals, oil refining, pesticides, glass, fibre glass, ceramics, bleach, soaps, detergents, dyes, inks, sewage treatment, sugar refining and alcohol brewing.

And that, he says, is just the short list.

Some chemicals extracted from salt could be also used in processing titanium from the huge deposits of mineral sands the CSIRO has identified in an area stretching from Horsham in Victoria, north to Broken Hill in NSW and edging into South Australia.

Dr Aral said if nothing was done about salinity Adelaide's water would be undrinkable in 20 years, and in 50 years the river water would be toxic to most crops.

"By 2100 the whole system will be carrying 10 million tonnes of salt a year."

He said moves to store saline water in evaporation basins were likely to prove only a temporary solution, because they would leave a million tonnes of salt a year that over time would leach back into the groundwater.

"Plans to pump saline water into the sea require costly pipelines, high energy and constant maintenance, and are throwing away a lot of useful substances."

His plan involves setting up a network of solar powered desalination plants at evaporation ponds (where saline irrigation tailwater is collected) to extract a range of chemicals.

One by-product could be fresh water for use by nearby towns, and some chemicals extracted could be further processed on site into other useful industrial products.

Dr Aral said once common salt — sodium chloride — was extracted, the water, known as "bittern," still contained magnesium, potassium, sulphates, boron, strontium, bromine, iodine and other useful compounds.

According to program leader industrial minerals with CSIRO Minerals, Dr Graham Sparrow, an industry in value-adding Murray-Darling basin salt on the basis of a "back of an envelope" calculation could be initially worth about $200 million a year.

He said the CSIRO was working with a company called SunSalt at Mildura to extract magnesium compounds left after common salt (sodium chloride) was extracted.

Magnesium sulphate was used in making fertiliser and magnesium chloride to suppress dust.

He said magnesium sulphate cost about $400 a tonne to import and the idea was to produce it more cheaply locally.

Other possibilities included using the higher temperatures at the bottom of evaporation ponds, where salt was more concentrated than near the surface, to produce electricity.

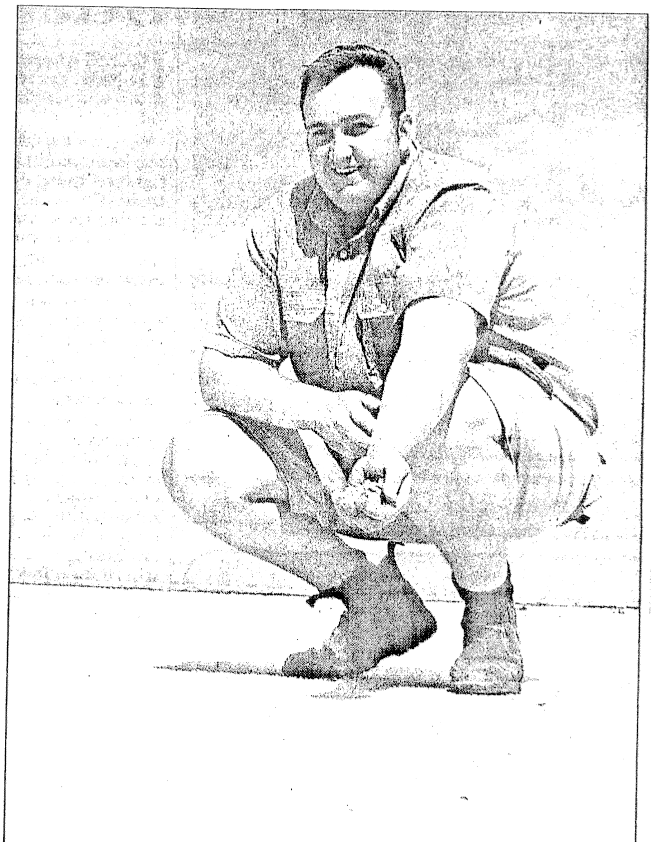


Photo: Liz Bull

Wakool salt industry

WHEN the Federal and State Governments chipped in $30 million in the early 1980s to develop a saline ground water interception and disposal scheme in southern NSW, officials perhaps didn't realise how effective it would be in reducing naturally high water tables in the area.

Set on 2100ha, the Wakool Tullakool Sub-Surface Drainage Scheme, west of Wakool in the western Riverina, has 54 Tubewell pumps across 21,000ha which suck saline water 10 and 20 metres below the soil surface.

So effective are the pumping and evaporation basins that the scheme has had a positive effect on the water table across 55,000ha of farmland, keeping the water level more than 2.5m below the soil surface.

Manager of Sub Surface Drainage for Murray Irrigation, Karl Mathers (pictured), said the saline water, which ranged from 2000ec to 130,000ec, was pumped into a gravity system of evaporation basins ranging in size from 20 to 40ha, which gradually fed into a basin which held the hyper saline water.

This is transferred into crystallising bays where it is harvested and used in various industries, such as stock feed, hide salt, or for chemicals.

The scheme pumps between 10,000 and 14,000 megalitres of water each year, with the product now being researched for its mineral properties.

As well, an aquaculture program is about to begin to raise snapper, mullaway and tiger prawns.

— LIZ BULL

AUSTRALIAN MINING INDUSTRY COUNCIL

Mining and mineral processing activities are widespread across the Australian continent. From the days of the first mineral discovery - coal in NSW in 1796 - explorers have searched the length and breadth of the continent for the riches hidden beneath the surface.

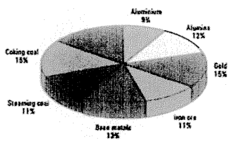
The gold discoveries of the 1850s and later gave this search added impetus, and encouraged people to move out of the main centres of population further and further into the interior.

The mineral riches won from the earth led to the establishment of many of Australia's major cities, such as Ballarat, Broken Hill and Kalgoorlie, and in more recent times new centres such as Mount Isa, Roxby Downs, Karratha and Newman.

The resource industries today produce the bulk of Australia's exports. In the year to 30 June 1991 mineral resources exports, including oil and gas, totalled $27,834 million - about 53 percent of Australia's merchandise exports and about 43 percent of all exports, including services.

In that year Australia's biggest export by value was black coal, both for steelmaking and for power generation, which earned $6,452 million. Other major mineral exports were bauxite, alumina and aluminium, $4,895 million; gold $3,684 million; iron and steel $2,828 million; and crude oil $2,004 million.

The Composition of Australian Mineral Exports 1990/91



- Mine being developed
- Mine
- Deposit
- Smelter
- Refinery
- Export port
- Coal producing area
- Individual operating mine
- Large deposit
- Oil and/or gas fields
- Individual (producing) oil and/or gas field

KEY TO MINERALS

- *Al* Aluminium
- *Cu* Copper
- *Fe* Iron
- *Pb* Lead
- *Ni* Nickel
- *Sn* Tin
- *Zn* Zinc
- *Au* Gold
- *Mn* Manganese
- *Ag* Silver
- *W* Tungsten
- *D* Diamonds
- *Op* Opals
- *Gs* Other Gemstones
- *Sa* Sapphires
- *A* Asbestos
- *Gy* Gypsum
- *Ct* Kaolin
- *Ls* Limestone
- *Mag* Magnesite
- *MS* Mineral Sands
- *P* Phosphate Rock
- *RE* Rare Earth
- *Na* Salt
- *Si* Silica
- *T* Talc
- *U* Uranium

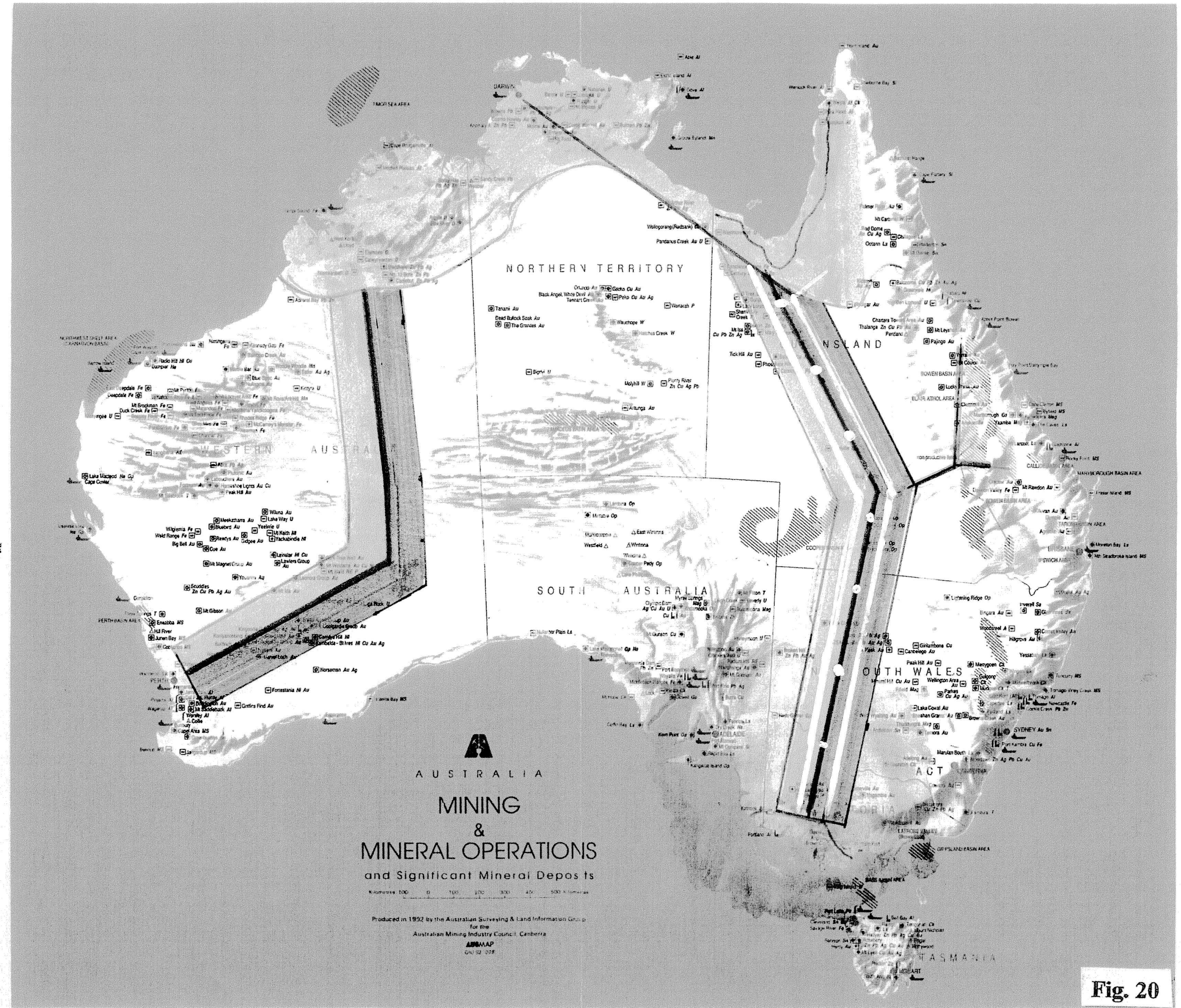


Fig. 20

COAL

Mines producing 1 million tonnes of saleable coal 1989-1990

• Underground mine

QUEENSLAND

Black coal

BLAIR ATHOL AREA
Blair Athol

BOWEN BASIN AREA
Blackwater
Collinsville
• Cook
Curragh
• German Creek
German Creek
Goonyella/Riverside
Gregory
Moura
Newlands
Norwich Park
Oaky Creek
Peak Downs
Saraji
South Blackwater

CALLIDE BASIN AREA
Boundary Hill
Callide

IPSWICH BASIN AREA
Jeebropilly

TAROOM BASIN AREA
Meandu

NEW SOUTH WALES

Black coal

HUNTER COALFIELD
Bayswater No 2
Drayton
Howick
Hunter Valley No 1
Lemington
Mount Thorley
Muswellbrook
Ravensworth No 2
Saxonvale
Swamp Creek
Warkworth No 1

NEWCASTLE COALFIELD
Awaba State
• Cooranbong
• Munmorah State
• Myuna
• Newstan
• Pelton/Ellalong
• West Wallsend
• Wyee State

SOUTHERN COALFIELD
• Appin
• Coal Cliff
• Cordeaux
South Bulli
• Tahmoor
• Tower
• West Cliff

WESTERN COALFIELD
• Angus Place
• Baal Bone
• Clarence
Ulan
• Ulan No 2

VICTORIA

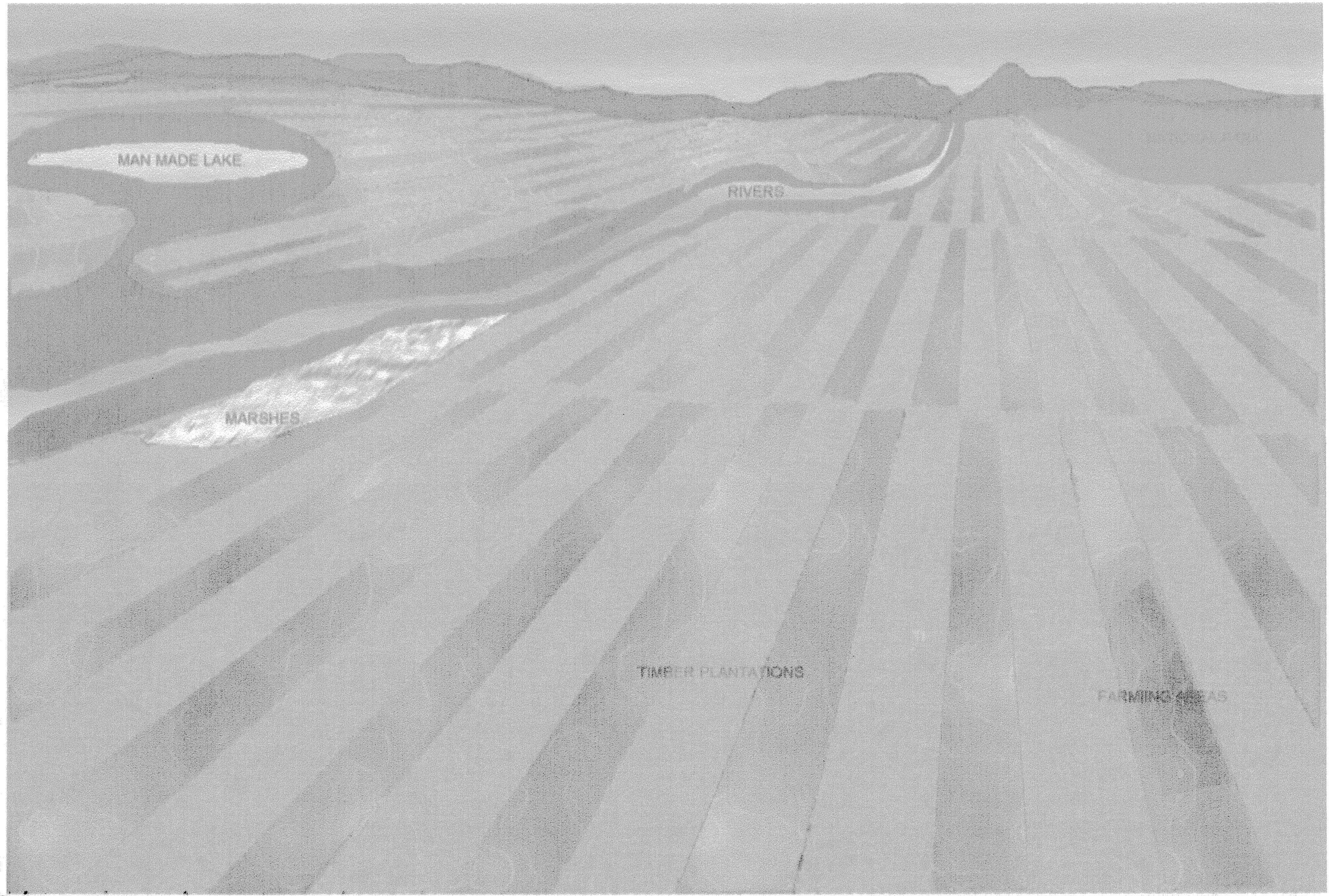
Brown coal
Anglesea

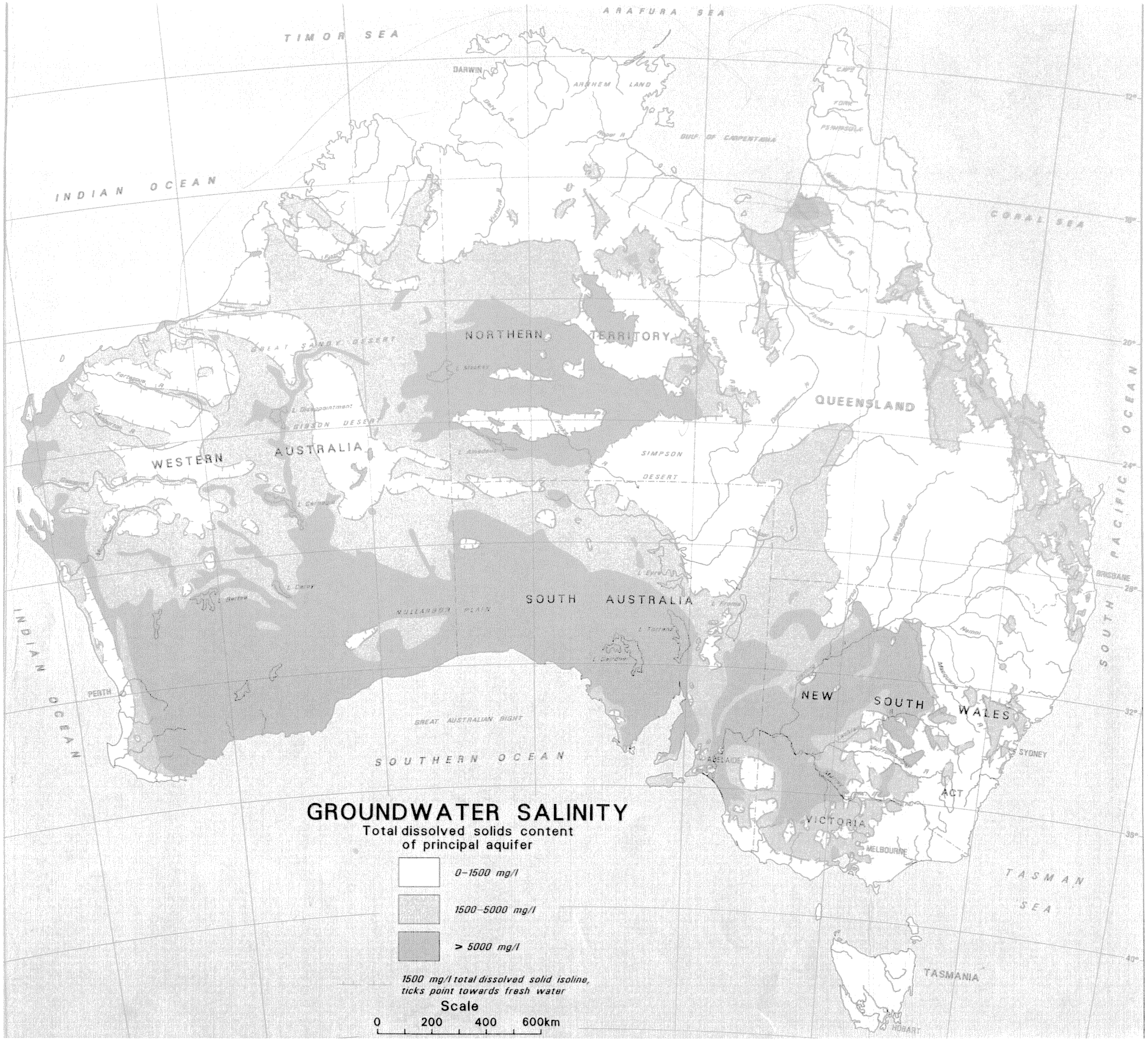
LATROBE VALLEY
Loy Yang
Morwell
Yallourn

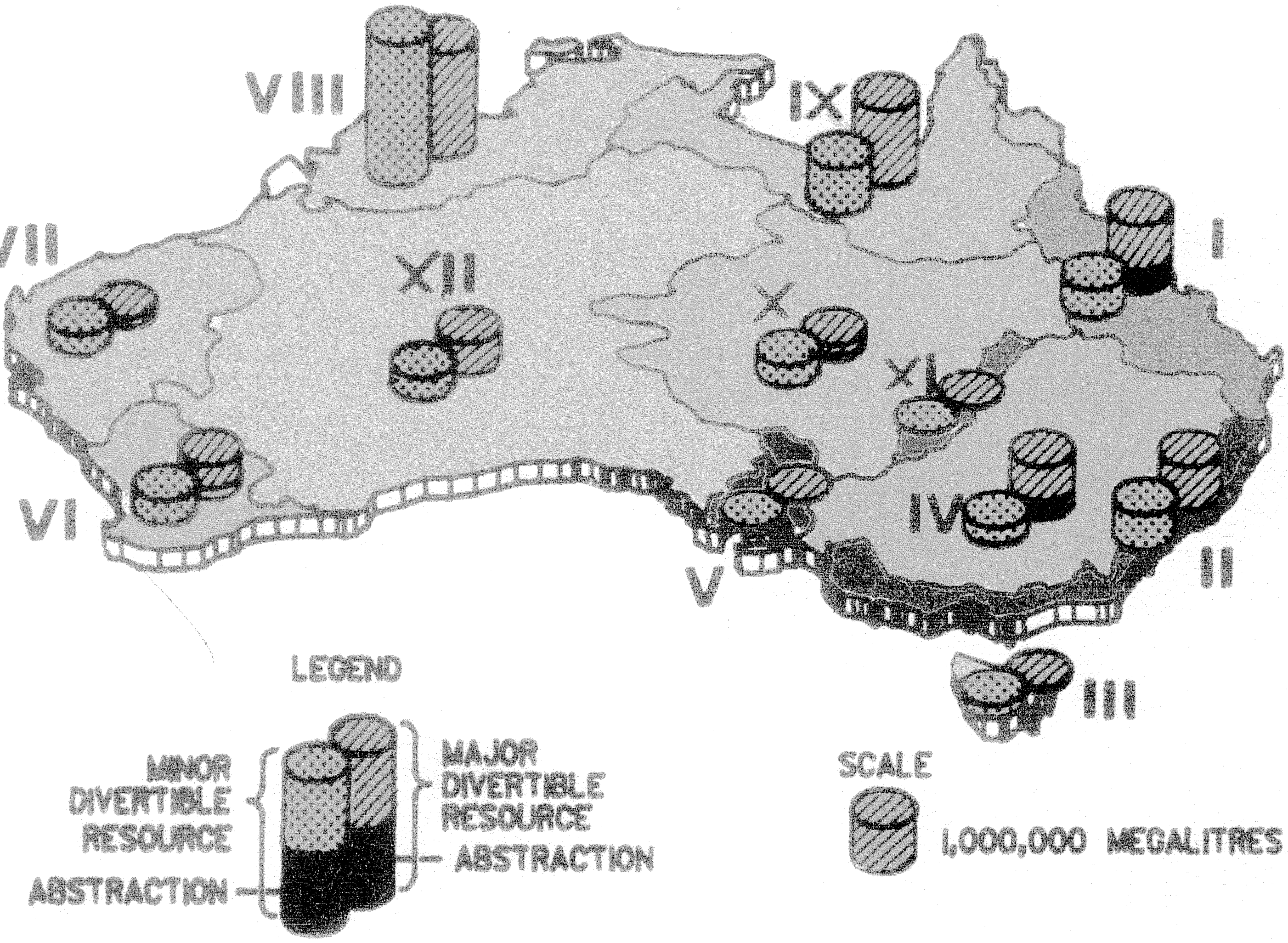
GOLD

OTHER MAJOR MINES IN WESTERN AUSTRALIA
Bardoc
Bayleys
Black Flag
Boulder (Fimiston)
Bounty
Broad Arrow
Burbanks
Galtee More
Golden Crown
Granny Smith
Harbour Lights
Hill 50
Jubilee
Kanowna Belle
Karonie
Keilor
Lancefield
Morning Star
Mount Charlotte
Mount Percy
New Celebration
Ora Banda
Orban
Paddington
Sons of Gwalia
Tindals
Tower Hill
Victory
Yilgarn Star

OTHER MAJOR MINES IN THE PINE CREEK AREA NORTHERN TERRITORY
Big Howley
Chinese Howley
Glencoe
Goodall
Pine Creek
Union Reefs
Wandie


MAN MADE LAKE
RIVERS
MARSHES
TIMBER PLANTATIONS
FARMING AREAS

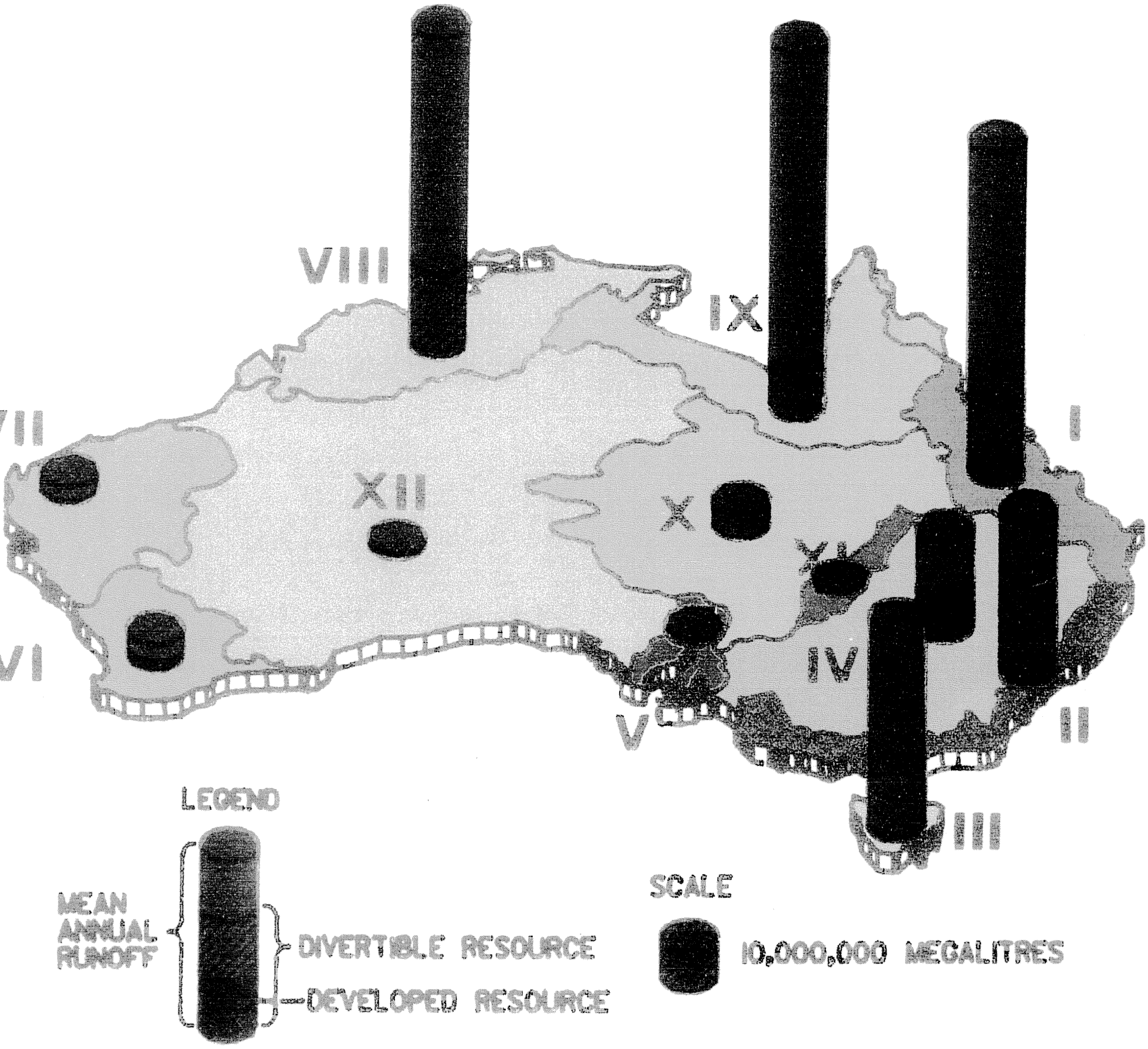

GROUNDWATER SALINITY
Total dissolved solids content of principal aquifer
0–1500 mg/l
1500–5000 mg/l
> 5000 mg/l
1500 mg/l total dissolved solid isoline, ticks point towards fresh water
Scale
0 200 400 600km
TIMOR SEA
ARAFURA SEA
CORAL SEA
INDIAN OCEAN
SOUTH PACIFIC OCEAN
SOUTHERN OCEAN
GREAT AUSTRALIAN BIGHT
TASMAN SEA
WESTERN AUSTRALIA
NORTHERN TERRITORY
QUEENSLAND
SOUTH AUSTRALIA
NEW SOUTH WALES
VICTORIA
ACT
TASMANIA
DARWIN
PERTH
ADELAIDE
MELBOURNE
SYDNEY
BRISBANE
HOBART
ARNHEM LAND
CAPE YORK PENINSULA
GULF OF CARPENTARIA
GREAT SANDY DESERT
GIBSON DESERT
SIMPSON DESERT
NULLARBOR PLAIN
L. Disappointment
L. Amadeus
L. Eyre
L. Torrens
L. Gairdner
12°
16°
20°
24°
28°
32°
36°
40°



GROUNDWATER RESOURCES OF AUSTRALIA

(Fresh and Marginal Quality Water)

SOURCE : 1985 REVIEW OF AUSTRALIA'S WATER RESOURCES AND WATER USE



SURFACE WATER RESOURCES OF AUSTRALIA

(Fresh and Marginal Quality Water)

SOURCE : 1985 REVIEW OF AUSTRALIA'S WATER RESOURCES AND WATER USE