MINE WATER PROBLEMS IN AUSTRALIA - CONFLICTS OF INTEREST

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ABSTRACT

Australia has confronted water inflow problems to its mines and quarries ever since the first European settlement. These problems were compounded by variations in world metal prices which lead to a number of the early mines being closed down before being worked out. Recent mine developments both open cut and underground have been in areas often more remote, but less troublesome, however variations in mineral prices and continuous mining have resulted in expansion of existing mines below water table and in renewed developments in areas abandoned late last century.

Conflicts of interest in relation to water, one of our scarcest resources, have required very thorough pre-evaluations of mine water conditions and careful design of control and discharge systems to ensure the best use of the total water resources is not impaired.

Specific problems of dewatering and depressurizing aquifers associated with large open cuts are considered, including coal and limestone pits, as well as specific problem aquifers and units. Problems of evaluating old mine workings will be outlined and a general review of the status of the problems will be presented. The impact of new mining and mineral recovery rechniques including in-situ leaching will be presented.

INTRODUCTION

Australia for a largely arid continent has historically suffered problems of wet mining conditions. These problems have not been restricted to the wet areas, rather they seem to be more extreme in areas having rainfall lower than 600mm per annum.

The reason for this problem resulted from the approach to mining which in the early years of European settlement was largely underground, and because of the effects of chemical weathering in more temperate climates.

One has but to cite the pumpage from the Langi Logan Deep lead goldfields in the late 19th Century *-over 70ML/d pumped from alluvium beneath basalt flows at 150m* - to see the magnitude of the problem. Again - *Tasmania, the Beaconsfield Gold Mine pumping approximately 13ML/d on average with bursts lasting up to three months requiring pumping at rates up to 55ML/d from fractured sandstones. The pumping was accomplished with Cornish Beam Pumps operating in a single lift from 460m.*

Similar experiences occurred in the Eastern Goldfields of Australia and in many cases the eventual closure of the mines could be directly or partially attributed to the high cost of controlling and removing the inflows with the technology then available.

In those early days the problems posed by the pumpage were relative only to mining engineering. In some areas the water served useful functions as mill and plant supply and rarely for domestic supply. Contaminants and salinity has largely prevented the latter.

Few major water problems were encountered in the renewed mining activity following the second world war. Those mines operating throughout the intervening period generally were dry or developing at such a slow rate that water problems were resolved by forward grouting.

The impact of world metal and energy prices has resulted in acceleration in the development of new mines and industries. This coupled with greater water demands of industry and the population has lead to real conflicts and competition for water resources.

The biggest potential conflicts which are presenting themselves surround the mining of -

- uranium
- coal, and
- iron ore

AUSTRALIAN WATER RESOURCE STATUS

With a continental average annual rainfall of only 300mm and an average annual evaporation in excess of 2300mm it is no wonder that conflicts over water occur. However, the conflicts occur in extreme area [Figures 1 and 2].

The reasons for conflict occurring in such varied climatic locations clearly does not relate to the scarcity of the resource, but rather to the status of the resource. That is value and pressures placed on water resources by the community . As a result, the resolution of conflict involves the development of mine water are as much social as they are hydrological in their implications.

Coal Examples

- Latrobe Valley, Victoria - conflict on water availability for irrigation, town water supply, power station cooling and environmental maintenance
  Mean Annual Rainfall 890mm
  Mean Annual Evaporation 620mm

- Polda Basin, South Australia - conflict on water availability for stock, domestic supply and irrigation
  Mean Annual Rainfall 410mm
  Mean Annual Evaporation 1010mm

- Kingston, South Australia - conflict on water resource maintenance for stock, town supply and irrigation
  Mean Annual Rainfall 510mm
  Mean Annual Evaporation 1010mm

Iron Example

- Yandicoogina, Western Australia - conflict on water resource maintenance for stock water supply
  Mean Annual Rainfall 250mm
  Mean Annual Evaporation 2030mm

Uranium Examples

- Yeelirrie, Western Australia - conflict on water resource maintenance stock and general
  Mean Annual Rainfall 200mm
  Mean Annual Evaporation 2110mm

- Koongarra, Northern Territory - conflict on maintenance of surface water quality for the environment
  Mean Annual Rainfall 1400mm
  Mean Annual Evaporation 1700mm

[See Figure 3 for Locations]

PROBLEMS CREATED

The problems created by mine water control operations are complicated by questions of volume, quality, disposability and contamination. In addition legal aspects of water ownership, rights to the use of water and the preservation of hydrologically controlled environments are important.

In its simplest form the cone of depression created by mine dewatering or depressurization may cause water levels in surrounding users wells to decline sometimes with loss of production. An added dimension to this problem may be due to the inflow of non useable waters (either saline or of a quality not acceptable for the original use).

Mine dewatering operations are infrequently capable of separating water qualities and hence the dewatering pumpage may be brackish, hot or simply contaminated. These aspects lead to disposal problems and further interference with other existing water uses and users rights.

In the past such problems have been accepted by the community or overcome by compensation, up to outright purchase of water rights, but in the context of present day resource administration it is the government authorities who must take the decision on how potential conflicts may be resolved.

RESOLUTION OF CONFLICTS

In Australia, water is a state controlled resource. For any new major programme detailed environmental impact statements are required outlining not only the need for water, the extent and magnitude of mine water operations considered necessary but also soundly based predictions of the extent and magnitude of effects on existing water supplies and uses both during and after the cessation of mining.

These documents must include statements of policy in regard to compensation and evaluations of the benefits and disbenefits of hydrological and water treatment management options. The best practicable technology must be utilized and a commitment to adopt such new technology as may represent best practicable technology in the future must be agreed to.

The documents become public documents and the company proposing the review must answer public criticism and examine thoroughly public suggestions to the satisfaction of the government.

Finally, it is the government authorities which decide the approval or otherwise of the project and set the license conditions for that programme.

The process, which is not unique to Australia, has had the effect of stimulating new ideas and initiatives at the same time as achieving a much higher level of public involvement in the planning of mining operations.

It has had the disadvantage of putting an added period of investigation and review into the already lengthy lead time involved in bringing new mines into production, but it pays multiple benefits in terms of avoiding both physical and social problems which have resulted from mining operations in the past -

e.g. Mufilira - South Africa
Captains Flat - New South Wales, Australia

STRATEGIES ADOPTED

Uranium Mining

Australia with 25% of the worlds proven uranium reserves has had to lead the way in the 1980's best practicable technology for uranium mines. At present mines are operating or are being developed in lode type deposits, chemical precipitates (calcretes) and on roll front deposits in sedimentary basins.

All of these have problems with mine water inflow and for reasons of safety and normal mine operation facilitation, perimeter dewatering by wells has been considered. This operation immediately creates problems of water resource degradation both by pumping and disposal.

Despite the fact that around many of the mines the water pumped from the wellfield rapidly becomes uncontaminated, it has been agreed that a policy of no deliberate release should be adopted. Hence all waters pumped must be either exhaustively used or evaporated.

The volumes of water involved in such operations varies from as low as 4ML/d up to over 38 ML/d. Since the mill requirement is quite small dependent upon climatic conditions the disposal problem and long term effects on surrounding water users due to dewatering and leaching of evaporite deposits were major considerations.

These problems have been overcome in three ways -

(i) disposals by evaporation with final evaporites buried subgrade with the tailings under a stratified gravel, clay and laterite cover above water table and remote from water courses in mineralogical environments selected to fix the contaminants.
- Koongarra, Yeelirrie, Ranger and Narbarlek.

(ii) avoidance of problem by adoption of solution mining (in-situ leaching) operations with all wastes returned to the ore zone out of the biosphere.
- Beverley and Honeymoon.

(iii) statement of disposal quality standards requiring treatment of all effluents. Any wastes must be handled within the system or disposed of via outfalls to land or ocean areas with agaiin certain quality standards being met.
- Latrobe Valley coal fields.

For the latter case overall mining conditions favoured ISL from the outset, but the hydrological impact (maximum pumpage 38ML/d Year 1 with 8ML/d average over 21 years) of dewatering on overlying and adjacent aquifers in an arid environment, plus the problem of long term and widespread contamination of shallow aquifers by leaching of radioactivity caused this new technology to be adopted.

Coal Mining

Black Coal and Anthracite

Few Problems with water are experienced by the black coal mines in Australia though active predewatering and drainage of headings is practiced to avoid gas drive. Subsidence of goafs beneath and adjacent to major public water storages (New South Wales) has been the subject of a detailed enquiry and a policy relating to backfill and pillar extraction adopted to ensure major failure and disasters do not occur.

Many inland mines suffer problems of small but persistent saline water inflows which disrupt haul road compaction and add some salt load to the coal. These are a problem both in disposal particularly into ephemeral streams with often flash flood character.

Serious problems occurred in one such mine when a stream diversion was overtapped flooding an adjacent pit resulting in large quantities of brackish to saline water being generated. The only disposal means is by discharge to diluting stream flows in ephemeral streams since the evaporation and rainfall are nearly balanced. This has proven difficult and is very expensive in terms of high lift high capacity pumps and a monitoring system on the streams which evaluates flow, natural salinity against disposal license conditions.

The impact of this experience has led to much more careful design of hydrological structures adjacent to mines.

Brown Coals

Development of new brown coal mines for power supply have confronted service problems since they are frequently in populous areas. To date at least one coal deposit (Polda Basin) has been deleted from further consideration because it was considered possible that it might deplete the limited potable ground water resources of the area by hydraulic interconnection and/or contaminate the groundwater resources with saline discharge or leachate either during or after mining. The seriousness with which this threat was taken is indicated by the fact that the decision was taken on limited data before absolute resolution was achieved. Further exploratory drilling is to be carried out in the area.

The Kingston coal project in South Australia confronts a massive mine water problem. The probable open strip mine will pump over the first year at least approximately 300ML/d from confined sands beneath the coal. The pit will be approximately 180m wide variably 5000-6000m long and has a depth of 50-60m.

The pumped water quality is over 4500mg/L and will be disposed of to sea. The overburden aquifer pumpage will cause declines in excess of 1m in an area covering more than 4km from the pit edge. This will affect stock water supply wells which will be compensated by either piped supply or deepening and re-equipping the wells.

The depresurization pumping will however affect the confined aquifer for over 20km and will reduce artesian heads and free flow in wells up to 15km away as well as cause potential pollution problems. Though the problem is short term these impacts are considered acceptable. Model simulations are being run to check the possiblity of using inter aquifer flow to minimize the extent of the cone of depression and to stabilize the cone in the critical direction.

Again in the Latrobe Valley of Victoria where coal sequences over 100m thick occur, depressurization pumping at yields in excess of 70ML/d has already caused declines extending over 30km from the mine. Policy for new mines proposed in this area is that all integrated industrial plants in the future must develop and utilize the water resources natural to them including mine water. The major use is in cooling. All effluents are to be treated back to acceptable limits and only hypersaline water or untreatable wastes are to be released. Surface waters may not be used for industrial purposes except where it is replaced by a water of similar quality but perhaps higher temperature within environmentally acceptable range.

Iron Ore Mining

At the time of writing most of the major iron ore mines in Australia are not worried by mine water problems. They are however with one exception in semi arid areas and new mines will excavate pisolitic and goethitic deposits which are both saturated and highly permeable. The water which will be pumped will feed the local towns and service industries but will be largely lost to evaporation. This will interfere with stock water supplies and represent a large scale loss of water in an arid region. Whilst the earnings from iron ore more than justify the operation, it seems likely that if this waste is to be avoided encouragement to use the water beneficially will need to be given, e.g. irrigation, silviculture, etc..

FUTURE

There is no question that in the future more and more of our mines are going to intersect water problems which will not only complicate the mining operations but also the acceptability of mining in areas where either water is scarce in quantity or quality is susceptible. Best practicable technology advancements seem likely to emerge from the rational analyses of hydrological monitoring. Monitoring at present is being required of mine operators to what is undoubtedly a level beyond that which will eventually be found to be necessary, however the intensity will be reduced as practicable and effective parameters and frequencies are identified.

Not the least important aspect of the monitoring processes will be the evaluation and effectiveness long term of subgrade disposal of tailings and of the contaminant fixation effects of re-infiltrating or injecting waste waters and mine water streams back into the ground. Similarly, the sensitivity of our river systems and waterways to the discharges they received, and the consequent effect on other users may lead to variations in attituides and controls which are less stringent than those currently applying. The opposite may also apply.

Experience gained from the multiplicity of water management techniques being applied, coupled with monitoring result assessments will provide a basis for regulatory authorities to rationally assess the level and term of risks which may result from permitting the development or expansion of mines into areas where significant mine water problems and disposal problems will be encountered. Ultimately it is these authorities who must decide whether given best practicable technology the risks to the environment and community are justified for the return to be obtained from the mining operation. In this equation it should be recognised that the return is not only financial, but must also consider the social returns of employment and community development since these are essential elements in the environmental impact assessment as well.

CONCLUSION

The problems confronted by Australian mines in dewatering have moved them into the forefront of water using industries. Unlike those they are fixed in position by the basic mineral resource location and hence will frequently be proposed for areas where water resources are scarce. In such areas it is necessary to closely evaluate the short, medium and long term affects of the mining and to require the highest standards of hydrological and water quality management, commensurate with the overall water resources management of the region.

As much effort may be required in evaluating regional hydrological and quality management options and objectives as will be required to achieve markable levels of control in and close to the mine itself. This effort does not cease with the decision to mine but rather is an ongoing task subject to review and re-evaluation of techniques of management. Only in this way will an eventual store of experience be established which will allow reasoned and rational discussion on mining, where water problems exist, to be taken.

ACKNOWLEDGEMENTS

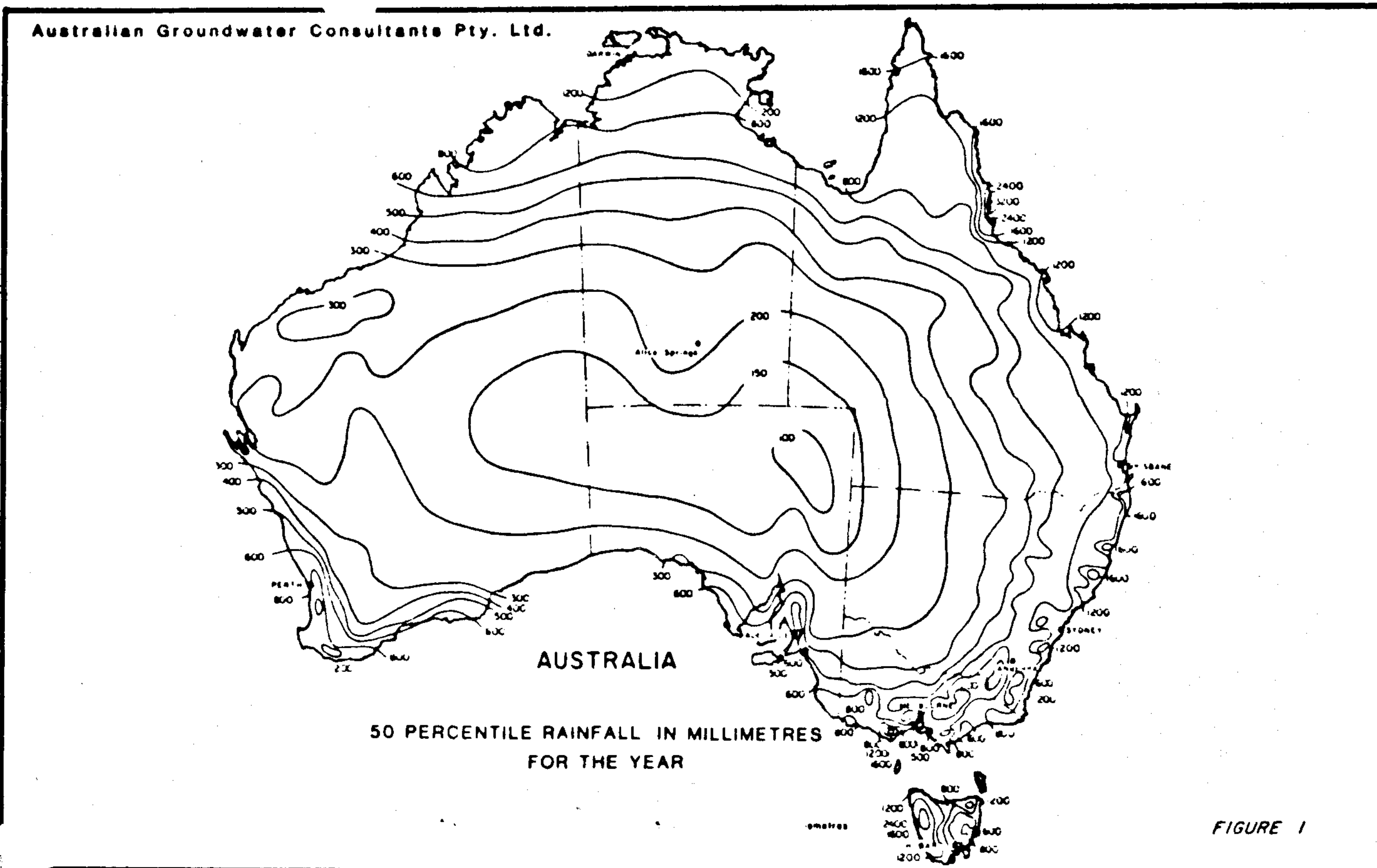
The help and assistance of the staff and directors of Australian Groundwater Consultants Pty Ltd is acknowledged as is the permission of Australian Groundwater Consultants Pty Ltd clients to use their examples.

List of Figures

Figure 1: 50 percentile Rainfall in Millimetres for the Year

Figure 2: Tank Evaporation in Millimetres

Figure 3: Locality Plan



50 PERCENTILE RAINFALL IN MILLIMETRES
FOR THE YEAR

FIGURE 1

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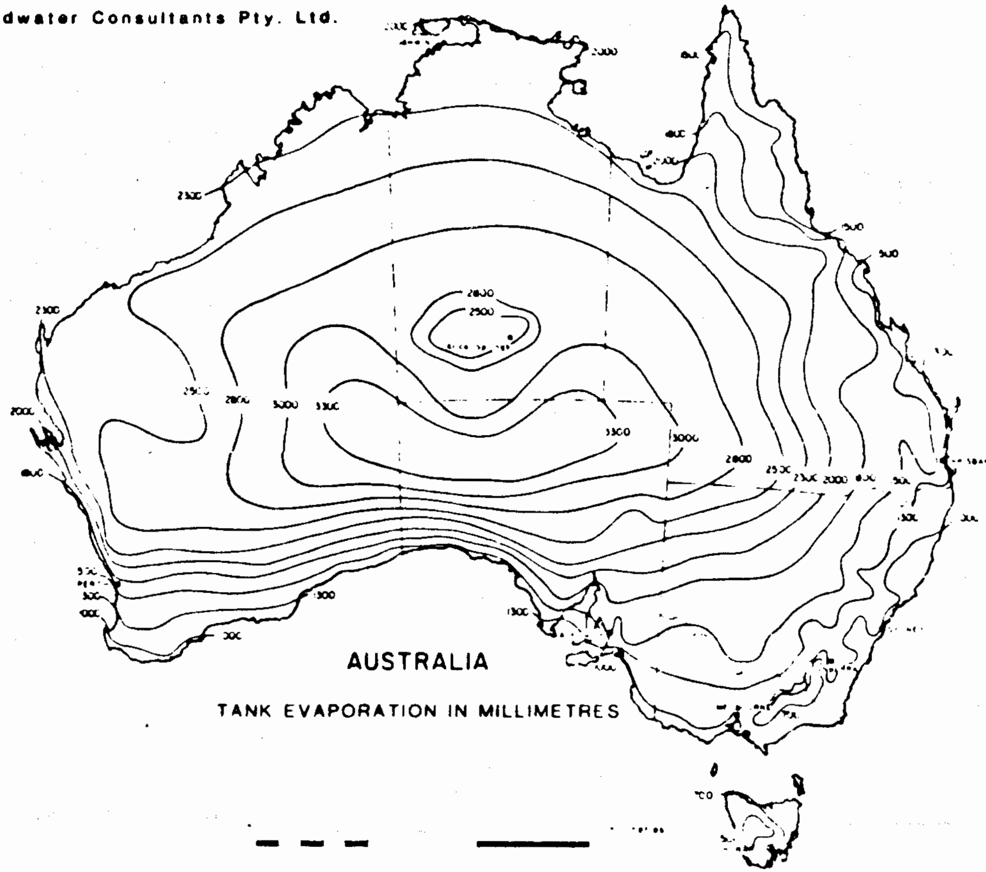
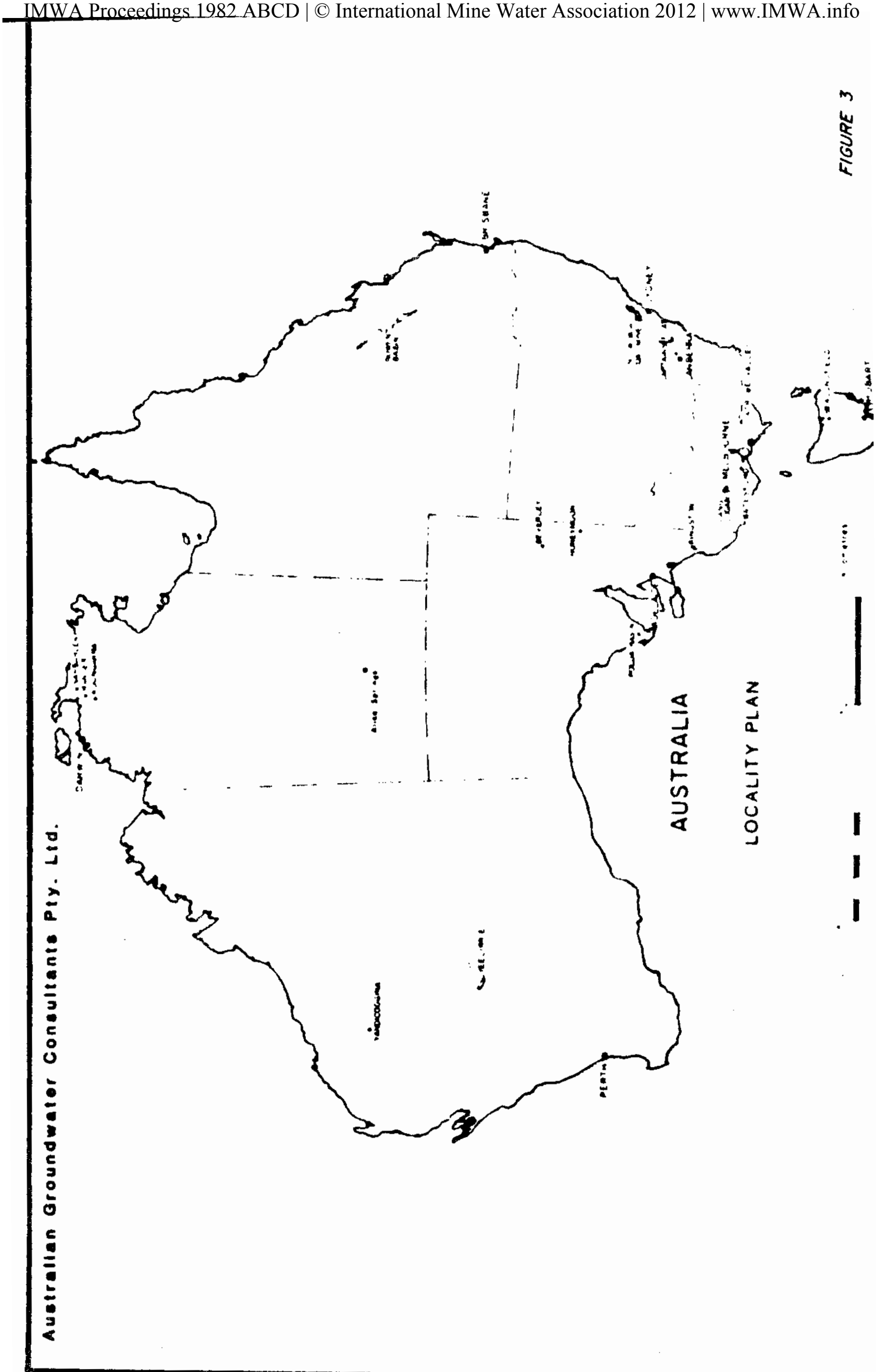


FIGURE 2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AUSTRALIA
LOCALITY PLAN
PERTH

FIGURE 3