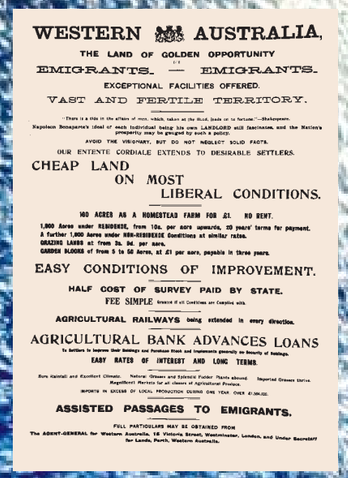
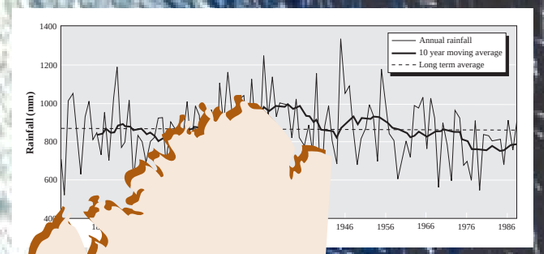
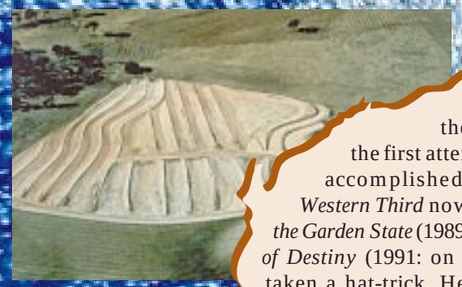
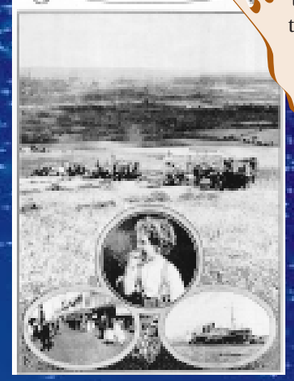
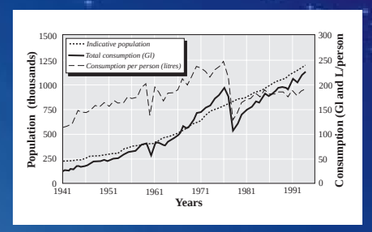










WATER AND RIVERS
COMMISSION

WATERING THE WESTERN THIRD

POWELL

Watering the Western Third

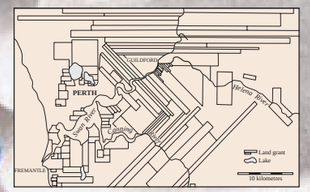
WATER, LAND AND COMMUNITY IN WESTERN AUSTRALIA, 1826–1998

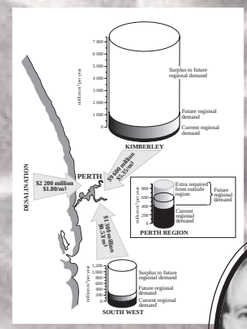
J.M. Powell

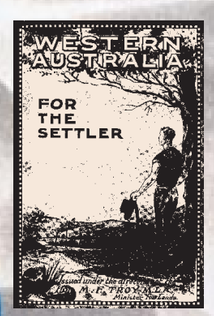
'The history of water management is a key element in the history of Western Australia, but this is the first attempt to tell it — by one of Australia's most accomplished historical geographers. *Watering the Western Third* now makes up a trilogy, along with *Watering the Garden State* (1989: on Victoria), and *Plains of Promise, Rivers of Destiny* (1991: on Queensland). So Professor Powell has taken a hat-trick. He need go no further — between them, the three books not only tell the history, but illuminate all the major players for the continent as a whole: the people, the politics, the perceptions, the economics, the rhetoric, the physical realities. This is the story of resource management at its best.

Watering the Western Third will be welcome at many levels, not least because it is short, yet comprehensive (would that there were more such) and superbly illustrated by photographs, graphs, and "boxes" of relevant quotations giving the rhetorical flavour of the day. It deserves a wide readership.'

George Seddon, noted writer and environmental planner







Condenser, customers and firewood, Coolgardie, 1895: Battye Library 20466P.

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Watering the Western Third

WATER, LAND AND COMMUNITY IN WESTERN AUSTRALIA, 1826–1998

J.M. Powell
Professor of Historical Geography, Monash University

Contents

Preface

This book is one of a series of studies tracing the centrality of water management in the history of regional development, conservation and environmental appraisal in Australia. Like its companions on Victoria, Queensland and the Murray-Darling Basin, it builds upon a range of scientific, technical and educational materials to compile a relatively brief survey. It attempts to locate and illustrate the history of water management in Western Australia in the contexts of public concern, community involvement, and economic, environmental, political and social change.

Like its predecessors, it recognizes an emerging interest in the bonding and focussing capacities of historical perspectives for those scientists, technologists and administrators who have been grappling with the kaleidoscope of multi-disciplinarity, and in addition tries to address a growing sense of the absence of cultural anchoring in our modern environmental movement. The very rapidity of institutional change has combined with increased educational opportunities and community expectations to produce an escalating demand for 'applied' scholarship.

But this short account is scarcely comprehensive. That is not its purpose. While it summarizes an extensive range of literature, its final, bird's-eye viewpoint misses the kinds of detail picked over by the close-range expert. Syntheses of this nature should nonetheless provide an 'accessible' route to the specialized evidence. In the process, they may promote further interdisciplinary work within the water sector, and between public and private water managers and their clients in the wider community.

The very liberally defined periodization in this latest 'water history' facilitates nation-wide reconstructions. It does not exactly ignore conventional compartmentalizations which recognize more radical punctuations — pre-convict years, the convict and gold rush eras, war, depression, and so forth; admittedly, however, in apparently subsuming them it puts as much emphasis on continuity as on sudden transformations. That impression of continuity can promote exaggerations, but there are three reasons for suggesting that it is not entirely deceptive. Firstly, it is impossible to point to any lengthy period when water resources were not significant in initiating and/or securing regional development. Secondly, key ideas and concerns in this diversified field of endeavour might have had profound long-term impacts without registering an immediate influence on the contemporary scene. Thirdly, standard periodizations usually focus on social and economic trends at a specific regional level, whereas progress in the appraisal and management of water resources might be more closely synchronized with advances in science and technology which are only partly triggered by, or otherwise closely associated with, social and economic change.

I am grateful to the Water and Rivers Commission for the opportunity to write *Watering the Western Third*, and particularly for assistance with travel funds and printing costs. In this case, as with the rest of the series, by prior arrangement I retained full editorial independence and received neither fee nor royalties. I thank Brian Sadler, Rod Banyard and Roy Stone of the Commission, and Adrian Peck of the former Water Resources Council, for their patience and encouragement, particularly during a lengthy period of illness which forced me to shelve the project for twelve months.

I have become accustomed to 'discovering' or being introduced to enormous stocks of specialized in-house research statements and commentaries which have serviced policy-making and policy-implementation down the years. Yet again, the quantity and quality of this material proved to be quite outstanding, and one of my objectives has been to bring a little of it before the wider audience it deserves. My repeated employment of graphical presentations is in part an attempt to continue the marked preference for that

mode of delivery in the main disciplines associated with modern water management. Where not separately indicated to alert readers to readily available library sources, the material for the maps and diagrams derives from the printed contributions of the Water Authority of Western Australia and Water and Rivers Commission.

In this regard, of course, my idiosyncratic ventures in tailoring are for bridging, or accessibility. So, too, the book's resort to vignettes, occasionally boxed: what is immediately accessible to those with literary inclinations may be far less so to the technically-minded, and *vice versa*. Bridges imply a calculated risk for all parties, and casual assignments of degrees of adaptability across the cultural or disciplinary divide ignore an increasing and partly autonomous traffic. The signs are good. For example, 'graphicacy' itself has not been a required form of literacy in orthodox history circles, but that is now changing rapidly throughout the Western world.

The sheer variety of the many sources of evidence poses another major challenge for the linked procedures of research and writing. Water pressure is far too insistent to be confined to newspaper accounts of a small number of major controversies over water-based regional development, and to those annual departmental reports, parliamentary debates and parliamentary papers relating solely to water management expertise. It can also be tracked through a very wide array of printed evidence in similar government collections addressing agriculture, conservation, forests, land settlement, mines, public health, public works, railways and other standard themes and portfolios, as well as through the manuscripts and other records of private individuals. In addition, interviews with present and former personnel of the Public Works Department, the Water Authority of Western Australia and the Water and Rivers Commission yielded far more cues than could be taken up at this juncture; and above all I intend to do more justice to the colonial era and to my contacts with the non-metropolitan west in future publications.

I acknowledge the efforts of the many earlier authors on whose works I have drawn; the pioneering contributions of Bolton, Cameron, Conacher, Crowley, Hunt, Le Page and Stannage were particularly useful in the early production stages. The bibliography lists these authors and offers a selection of other guides. The continuing support and enthusiasm of my academic colleagues and students should also be recorded: on this occasion, the timely assistance of Bill Cooper, Malcolm Howes, Roy Jones, Lynette Peterson and Catherine Robinson proved invaluable. The book also benefited from the courtesies and efficiencies of librarians at the Water and Rivers Commission and the former Water Authority of Western Australia, especially Chris Beilby, and from the assistance of the Battye Library, the State Archives of Western Australia, the Benedictine Community of New Norcia, Agriculture Western Australia, the Parliamentary Library of Victoria, the National Library of Australia, the former Rural Water Commission of Victoria, the Baillieu Library of the University of Melbourne, the La Trobe Library and State Library of Victoria, and the library system of Monash University.

The aims and format of *Watering the Western Third* have been strongly influenced by the reception accorded to my *'MDB.' The Emergence of Bioregionalism in the Murray-Darling Basin*. I have also tried to respond to general and specific advice from environmental scientists, geographers and historians in Australia, Britain, New Zealand, Israel and North America, and especially to the careful comments made by George Seddon, but the opinions expressed in this volume are entirely my own. The illustrations were prepared by my Monash colleagues Gary Swinton, Sue Drummond and Shannon Mattinson, and word-processing was completed once again by Helen MacDonald. Suzie Powell cheerfully coped with what became, quite unexpectedly, another mini-marathon.

‘the records of past seasons …’

Q.1 Is the climate supposed to be good?
A.1 The climate … is highly salubrious.

[Colonial Office, 1829; cited in Cameron, 1981]

It is often said that the science of hydrology is founded upon the basic tenet that water comes in three quantities: too much, too little and too dirty. Nowhere is this quip more appropriately applied than to Australia.

[Smith and Finlayson, 1988]

I

Introductory: Water Marks

Caveat Emptor

Henry Ambrose Hunt (1866-1946) Commonwealth Meteorologist

The records of past seasons, for instance, are, I consider, indispensable to the success of most of the inexperienced men on the land. By a study of his district's seasons in the past, a young settler is able to avoid under or over expenditure in increasing his stock or in improvements. The records will show him how many good, bad, or indifferent years he is entitled to expect; and he will not be over optimistic after a good season nor over pessimistic after a bad one. The records, too, are made available for the guidance of the majority of established farmers and graziers, for memory of past seasons can rarely be relied upon.

[H.A. Hunt, 1929]

1

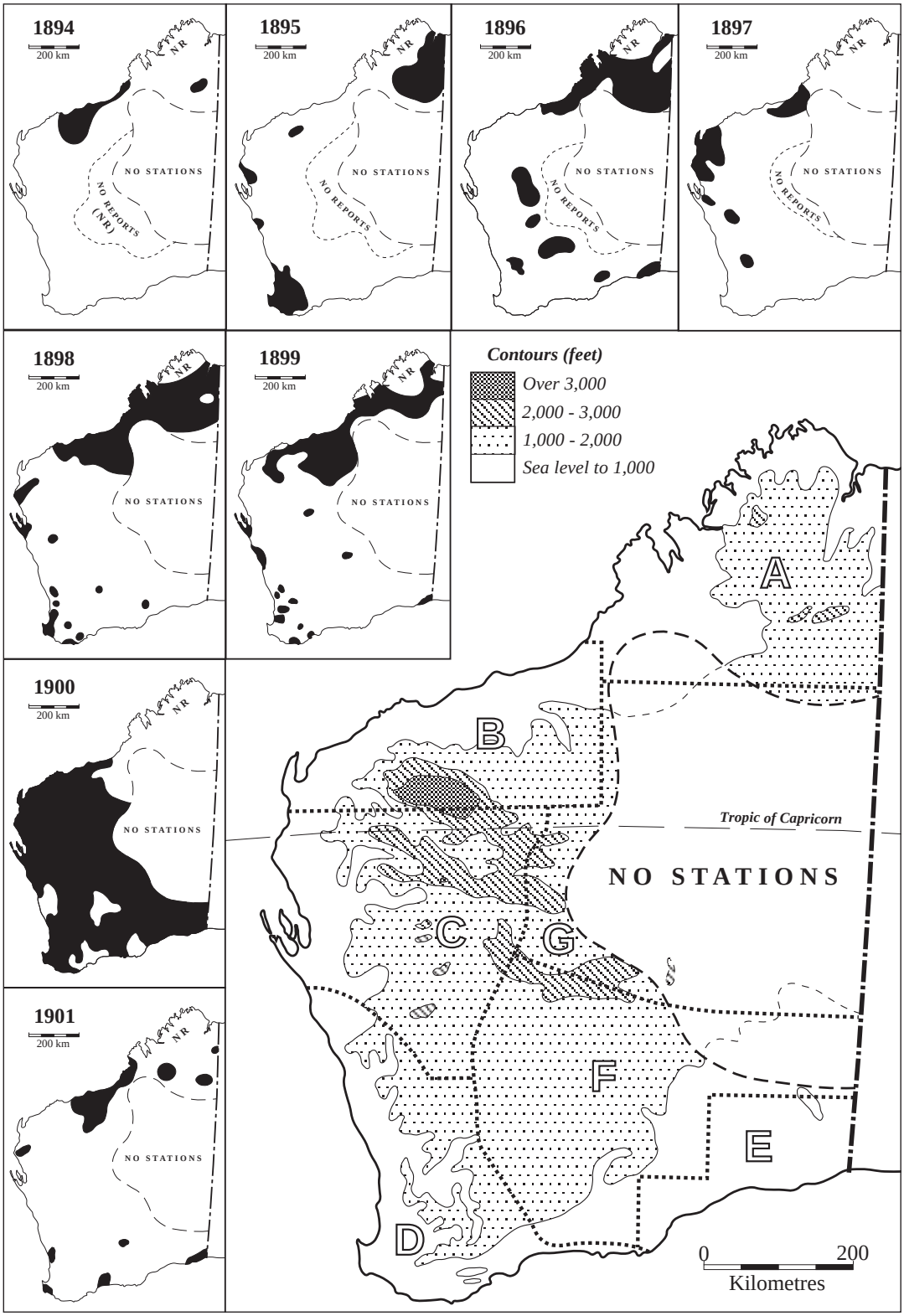
If Australia held out a special challenge to science and technology long before the official commencement of European settlement in 1788, since that inauspicious beginning our scientists and technologists have been repeatedly put in their place. In the words of one nineteenth-century journalist, 'the advancement of science in a new country is better obtained by constructing good roads and excellent railways than by setting up telescopes and gazing at the stars'. Indeed, where the taunts of 'relevance' and 'accountability' are concerned, the modern era boasts neither monopoly nor novelty.

Admittedly, Australia is the driest of the inhabited continents, and on those grounds alone it might be protested that certain kinds of expertise cannot fail to find their element here. But water itself is the element in question, and on the matter of the exclusivity of specialist knowledge the historical evidence remains equivocal. And that is not only because most of us feel entitled to some sort of opinion on the supply and use of this fundamental resource. The recognition of its indispensability to our very existence as well as to our livelihoods persuades us to query — not to say dilute — the experts' demands and pronouncements, and then to seek out fresh kinds of expertise.

Historical research may never succeed in bridging the gaps between specialist (or 'expert') and lay (or 'vernacular') modes of thinking, but it can underline the need for a greatly improved dialogue between these estranged and occasionally dangerously divergent approaches. In its entirety, this short book represents one of several recent efforts to elaborate that conviction. It is of necessity a highly selective interpretation, because its audacious brief encompasses one-third of the Australian continent. And yet Western Australians form only part of its intended audience, and that consideration helped to persuade me to begin by summarizing the not-so-early expert commentary of one rather troubled interpreter of our western third. The original appeared in 1929, after more than a century of European settlement in Western Australia. Its author was pioneer Commonwealth Meteorologist Henry Ambrose Hunt.

Hunt seemed as anxious as any 1990s public servant to emphasize the financial worth of his employment. Introducing the mundanely-entitled *Results of Rainfall Observations made in Western Australia*, he insisted that special care had been taken to deliver serviceable information to any number of public agencies, private industry, and especially the 'Primary Producer' (note the pandering courtesies of capitalization). From today's perspective, however, this large volume from a young Bureau of Meteorology succeeded admirably in offering enormous quantities of useful and merely interesting data, while simultaneously exposing the chasm separating partial and reliably complete environmental monitoring.

It was undoubtedly a landmark publication, but there were still no plottable data for the far interior, and in fact by these chosen environmental measures, the bulk of the state was still being scored down as a collection of virtual *terrae incognitae* as recently as the 1890s. At the beginning of that tumultuous decade Western Australia had been granted responsible government by the British parliament and its first Premier, John Forrest, set out to make the most of a mining boom. Yet there was obviously a lag between the frontier of



Records of past seasons: examples of regional and annual rainfall variations, according to Commonwealth Meteorologist H.A. Hunt.

Inset maps show 'above average' rainfall in black. Correlations with the following drought distribution maps are not exact.

The regions depicted by Hunt are as follows:

A – the Kimberley;
B – North-West;
C – Gascoyne;
D – South-West;
E – Eucla;
F – South-East;
G – North-East.

Relief is shown in feet above sea level, as in the original. Intrastate differences do emerge, but it is not made clear that, by general Australian standards, large areas are in fact characterized by fairly low levels of rainfall variability. Similarly, there was less comment on problematical evaporation rates, which mainly resulted from high temperatures.

environmental monitoring and the ever-expanding margins of settlement, and it would take decades to achieve a match. Thus, on the Bureau's maps a jittery 'No Reports' is repeatedly stamped on the semi-arid country in the east, as well as over much of the far northern perimeter.

Elsewhere, the data were judged sufficient to distinguish regional differences in the annual and seasonal rainfall totals, and to set out elementary proofs of the existence of a rhythm of variability with cautionary hints for urban and rural water users alike. In short, the state as a whole seemed to be portrayed as quintessentially Australian in its profound aridity and semi-aridity. Furthermore, although in comparison its northern and south western sections apparently advertized a degree of water security, the statistical record — such as it was — strongly recommended prudent qualifications. Less obvious from this report was the fact that, by general Australian standards, rainfall totals and seasonal concentrations were quite reliable. Those characteristics would prove favourable for wheat farming and other rural enterprises. Hunt's warnings would have been better supported by stronger references to high summer temperatures and consequential rates of evaporation.

The Bureau's curious early decision to chart the changing distribution of 'above average' falls does not mask one crucial characteristic: whatever the region, it is extremely difficult to group any significant run of broadly identical years. For the conscientious decision-maker in parliamentary and bureaucratic circles, one of the central messages of these rudimentary graphics and tabulations was that a firm grasp of the nature and deployment of scarce and changeable water supplies was absolutely indispensable to the development of their young state.

For other contemporary observers, that much had already been revealed — by the hardest of practical experience on individual properties, in ordinary households, and in the mines and factories. The panoramic summation from Hunt and his colleagues was obviously valuable, but it supplemented an appraisal of environmental advantages and shortcomings that had been constructed incrementally, frequently by trial and error, over the previous century.

For instance, it had already been conceded that efficient water management demanded a far more imaginative array of environmental data — concerning rivers and other surface water supplies, groundwater, the incidence of drought, the changing demands made on the resource by ever-increasing numbers of users and types of user-groups, and the detailed nature of the terrain in which to locate and harvest an assured supply. Those requirements would be repeatedly emphasized over the next seventy years of momentous regional change. Whether simplistic or sophisticated, failing or succeeding, and whether emerging from the efforts of governments or private individuals and groups, at no stage were water management projects and practices divorced from the obsessive debates on the pace and character of development. On the contrary, they have been pivotal in a protracted coming-to-terms with the environments of the Western Third.

The story of this close engagement with a vital natural resource opens with a short inspection of pioneering settlement from its commencement in the later 1820s in and around Perth, the hub of the original *Swan River* district. A more modest start had been made in the far south in 1826, at what was to become Albany, but the discussion is dominated by the celebrated Swan River venture and its aftermath. The remainder of Part I moves rapidly through the nineteenth century to the discovery of gold and the young colony's upgrading to responsible government in 1890. Acknowledging that the state-wide influence of the legacy of relevant indigenous management styles is patchily researched, I have simply concentrated on the emergence of enduring water marks in an immigrant community's increasingly sophisticated efforts at adaptation.

Distribution of major and minor droughts in Western Australia, 1888-1982; adapted from Reynolds* et al., *1983.

Promised Blessings, 1826–1890

Sir James Stirling (1791-1865).

Some of the earliest European evaluations of the Swan River district were rudely lampooned. Hobbled by the immensities of scale and the weird exotica of climate and landscape, propelled by ambition, and disorientated by an all too common propensity to wishful thinking, these appraisals nonetheless launched a vital learning process. The products were imprinted on the landscape.

Water Marks and Settlement Foundations

For many years, complaints were raised about a speculative 'Swan River Mania' and especially about the misleading descriptions printed under the names of Captain James Stirling and his botanical colleague Charles Fraser. Jim Cameron has shown very effectively that the evaluation was both artfully and carelessly inflated in London, and that in consequence the first colonists seemed to expect to find an Edenic version of their British homeland.

Certainly, the initial survey (March 1827) was undertaken in a mere 16 days towards the end of an atypically cool and moist summer, and it was quite narrowly confined to the immediate coastal plain and river flats. Partly by naive extrapolation, it conveyed an undeservedly favourable impression of local soils and vegetation cover, and exaggerated the availability of fresh water. According to the jubilant Stirling, the farming and grazing qualities of the coastal plain were reminiscent of the fertile plains of Lombardy, and the likely source of its cool easterly breezes was a snow-capped mountain range.

Ample expositions of the subsequent failure of the west's first great private enterprise scheme and the connivance of government authorities have been repeated down the years without precluding similar fits of adventuring. The limited objective here is to begin a search for water marks in these initial European appraisals.

First, the selection of a site for the main administrative centre. Fremantle was soon ruled out of contention on the grounds of defence considerations, the presence of a troublesome bar across the river mouth, and the local predominance of sandy soils which were judged incapable of supporting small-scale pioneer farmers. Upstream, Point Heathcote commanded both the Swan and Canning Rivers, boasted a good anchorage and fresh water supplies, and had access to promising farming country. Stirling was less convinced about some of these qualities, however, and recent commentators — chastened, perhaps, by our historical burden of monotonous topography — have suggested that aesthetic considerations may have tipped the balance in favour of the Perth site, which offered the distinctive backdrop of Mt Eliza and relieving vistas of the Darling Scarp.

Geoffrey Bolton has joined those who are more inclined towards another very human factor — Perth's proximity to land

Is it more moist than New South Wales?

Q.1 Is the climate supposed to be good?
A.1 The climate is highly salubrious.

Q.2 Is it more moist than New South Wales?
A.2 It is worthy of remark that the Sea Breeze on the Coast is usually at S.S.W. and is therefore *charged with moisture* & very cool. This moderates the Action of the Sun in Summer while, at the same time, when condensed by the colder air of the mountains behind the Coast, the vapour it conveys descends like Showers …

Q.4 Is the Country supposed to be well watered?
A.4 The general abundance of Springs producing water of the best quality, and the consequent permanent humidity of the Soil are two advantages which do not exist in the Eastern Coast.

[Colonial Office standard information for prospective emigrants, 1829; quoted in Cameron, *Ambition's Fire*, p.2]

2

allocations on the Upper Swan, picked out by or for the colonial élite. The selection of river and coastal sites was a common feature in the foundation years of all of Australia's early capitals. That broad rationale was geared to the task of securing rapid possession of an unexplored continent on the far periphery of a mercantile empire, and in its recorded detail it often reflects the naval experience of key officials who were permitted discretion in such matters. In the exercise of that discretion the scope found for local considerations could indeed be surprisingly expansive.

For our present purposes, the consistent emphasis on water is the pertinent factor. So, too, in the second example. Stirling and his talented Surveyor-General, John Septimus Roe, also attached aesthetic and economic importance to water frontage orientations when preparing their detailed subdivisional plans. That judgement was displayed in their designs for Perth and its environs: today, the original patterns are just discernible in the strict alignments of the modern city.

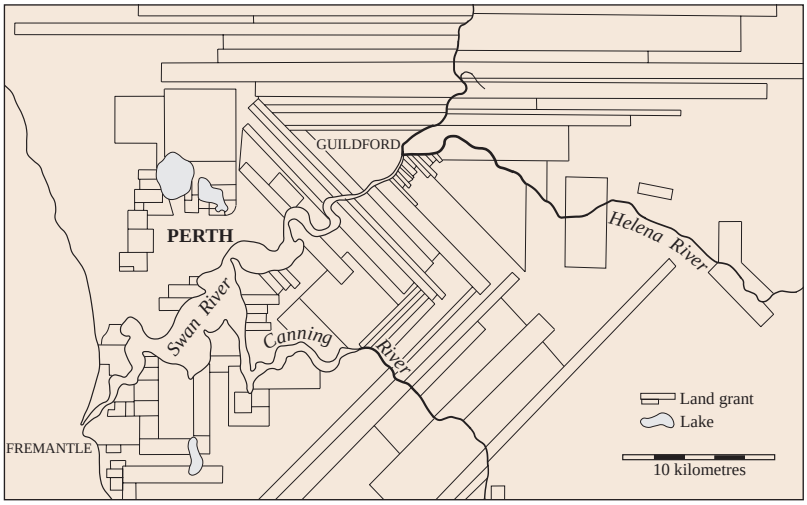
The first two decades of struggle and confusion necessarily brought additions to environmental knowledge and involved the settlers in manipulations of natural ecosystems. Apart from farming activities, there were several direct attempts to alter the local hydrology — a few at the eastern end of today's Perth Water to improve movement along the Swan (making Burswood an island) — but there were neither the funds nor the demands for extensive water management operations.

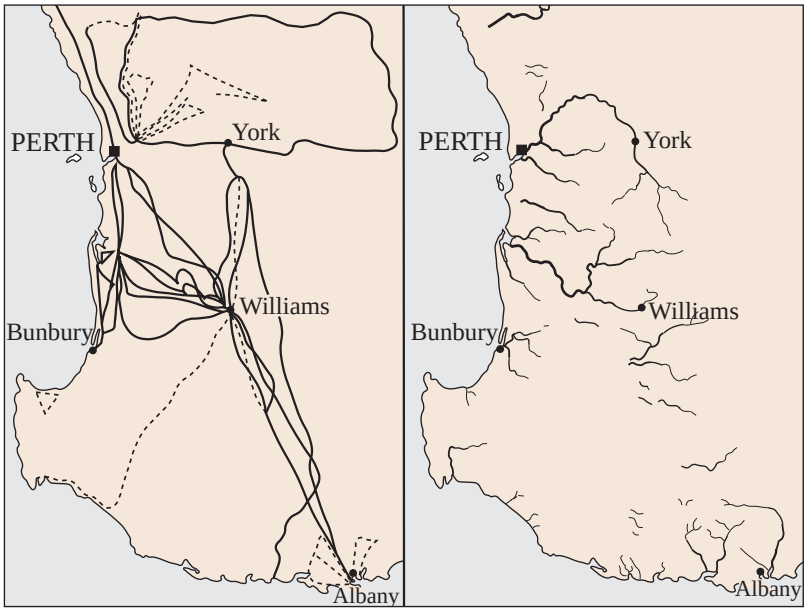
The small immigrant community remained dispersed on sizeable allotments, a useful environmental attribute in itself since it reduced the risks of water pollution from waste disposal. Access to the rivers partially compensated for the absence of good roads and encouraged residents to exploit the flood-plain by sinking their own shallow wells.

Growing concerns over land shortages combined with an increasing emphasis on sheep grazing to stimulate a flurry of government- and privately-sponsored expeditions, at first from the Swan district and subsequently from a number of other reconnaissance centres, including the slightly older convict garrison at King George Sound (Albany). A few of these treks were partly inspired by rumours of inland seas and snowy mountains, but in the main the quest was for well-watered grassland with connections to the coast.

Explained in environmental terms, by the end of the 1830s the principal advances included, firstly, a strengthening preference for the higher rainfall region of the south west, except for its heavily forested heart; second, a commendably improved but still fragmentary understanding of the drainage network of that region; and third, an associated expansion of rural settlement. Water resources had featured prominently in the initiation and consolidation of each of these developments.

Early allotments under Stirling and Roe, showing the pronounced water frontage orientations. At this early stage, the downstream reaches of rivers may have been mainly valued for transportation and access opportunities, though livestock watering would have been another consideration.





Summation of significant explorations undertaken in the south west in 1835–38, indicating their collective contribution to an improved understanding of the region's river systems.

River knowledge remained elementary and fragmented — notice the large blanks in the forested country — but clearly, the river lines were principal opportunities and targets.

Adapted from Cameron, 1981.

Patterns of Indigenous Resource Management

The general pattern of indigenous occupation had picked out areas of relatively dense settlement in the south west, where wetlands and rivers were favoured above the forested tracts because of the availability of abundant waterfowl, fish, and natural fruits and vegetables, and the comparative absence of impediments to travel. In the Kimberley, local and regional migration followed and anticipated the dry-wet rhythm of the seasons. Elsewhere, the extensive deserts supported only a thin scattering of hunters and gatherers. For many years, however, except for the mining localities European modes of occupation seldom sustained greater human populations than the cultures it supplanted. In those hostile environments, reliance on the careful, inter-generational transmission of a highly sophisticated ecological consciousness gave top ranking to water knowledge. This extended from painstaking appreciations of infinitely subtle seasonal variations in regional rainfall, vegetation and wildlife, to detailed topographical data describing the micro-geography and variable qualities of natural and constructed wells, springs and soaks.

The formidable reach of Aboriginal oral traditions encompasses radical changes in coastal geography, including the very formation of large offshore islands and alterations in the nature and extent of valued wetland habitats. The ecological knowledge imported by the invading people had also been accumulated over a prodigious time-span, but in vastly different environmental and cultural settings: if nature had to be learnt anew, as it were, then the Aboriginal communities might have been seen as the most obvious teachers. In the event, the immigrants seemed determined to make their own mistakes. Yet they gradually reproduced similar regional preferences to those that had been in place for centuries before their arrival.

Numerous *Dreamtime* stories reinforce the ubiquitous criticality of water to land and livelihood. Some respected anthropological reconstructions insist that broad-scale differences in social organization (notably the so-called 'tribal' groupings) also indicate the underpinning significance of basic natural divisions such as river basins. And in the last quarter of the twentieth century, the wheel turned again when the successors of the white invaders were urged to adopt an integrated *catchment* approach as part of a concerted effort to rehabilitate Western Australia's damaged land and water environments.

Over the next 70 years the focus of primary exploration shifted to the eastern, north-western, and northern sectors. Most of the accusing blanks were sketchily filled in, and the learning process continued to embody the coalition of commercial and intellectual aspirations. Comments on the presence and absence of major rivers characterized the finest exploration accounts and enlivened public debate, but there were literally dozens of epic journeys and I am aware that the perceived randomness of any small sample of named explorers leaves this point coloured rather than substantiated.

Even so, it is incontrovertible that the efforts of a range of individuals and teams, from highly qualified surveyors in government employ to enterprising pastoralists and military personnel, delivered a stunning accretion of basic environmental information, layer upon layer. The practical outcomes were not always immediate or commensurate with effort, but the total effect was to sketch out a geographical framework. It was that somewhat taken-for-granted template which continued to guide twentieth-century data acquisition by the likes of meteorologist Hunt and other specialists.

One of Grey's expeditions opened up agricultural and grazing lands in the north-west, and is also credited with the discovery of ten rivers and two mountain ranges. The Ashburton, de Grey, Fortescue, Gascoyne, Murchison, Oakover and Yule rivers are all associated with explorer Frank Gregory; Frank's brother Augustus followed Grey into the Kimberley and compiled credible observations on the region's weather and river regimes.

In so vast a Crown Colony, exploration served invaluable practical ends, but could also confer special status or mystique. For settlers of high and low degree the profundity of western isolation, or alternatively the existence of an eastern buffer of desert and semi-desert, was confirmed by a succession of cross-continental journeys. One of the most notable of these forays was led by John Forrest, subsequently the West's first Premier. Expeditions headed by Forrest's brother Alexander, and later by Frank Hann, opened up new pastoral territory in the Kimberley; yet there, as elsewhere, the uncovering of the finer topographical details was left to the daily exertions of pioneer families.

Until the 1850s, European settlement remained largely restricted to the south western coastal fringe, and to those scattered patches further in which enjoyed a reliable and moderate winter rainfall. The localities which were to become the bases for the main northern and eastern wheat belt were opened up by pastoralists during an unusually good rainfall period in the 1860s and early 1870s, when interconnected

salt-lake systems were said to have experienced spectacular flood seasons.

Good progress, given the unpromising launch. Burvill's (1979) survey indicates that the total area held in pastoral leaseholds increased from 4.8 million hectares (12 million acres) in 1870 to 42 million hectares (105 million acres) in 1890. The sheep and cattle grazing frontiers were extended into the north-west and far north, and livestock numbers rose markedly. Not so the total human population, which increased from a mere 25,000 in 1870 to some 49,000 — the size of a very minor town in contemporary England — 20 years later. At that point the colony's main export product was wool, but gold had become prominent after the discoveries at Hall's Creek and Southern Cross, in 1885 and 1887 respectively.

By the late 1880s the giant's jigsaw was coming into focus. To that extent, each exploration had promoted a complex learning process. But a host of unheralded discoveries, especially at the micro-level of actual settlement where trial-and-error approaches were inevitable, had also been contributing to the history of environmental appraisal. Other studies have found much the same for the interpretation and management of natural water supplies in Australia's early townships. As the next section suggests, the observation can be extended to that tiny capital, Perth, where pioneering administrators and pioneering settlers laboured cheek-by-jowl to stake viable claims in a distant rim of empire.

'always thirsty', Often Flooded: Perth and its Region

If the first victims of Swan River mania had been stung by the fierce storms of the winter of 1829, the following summer left many of them king-hit and pathetically huddled on Fremantle's sizzling beaches. And while Mary Anne Friend's 'always thirsty' lament (in 1830) was rightly connected with brackish water from shallow beach wells, the statement heralded a relentless chorus of alarms about the quantity and quality of the new colony's water supplies. The first two decades displayed a precarious reliance on springs, streams and rough-hewn wells, and on the ready availability of the kind of seasonally moist terrain we have learnt to call *wetland*. The key environmental process is associated with impeded drainage behind ancient coastal dunes.

White on black

It was one of the giant ironies (and tragedies) of the Europeans' occupation of Australia that, as they set about transforming the environment to suit their own ends, they obliterated the signs of former occupancy. The Aborigines' tracks laid the basis of the road network; their yam grounds became arable fields; and their hunting grounds, managed by fire, became ideal pastures for sheep.

[Cameron, 1979, p.218]

The latter relationship deserves a comment. At the coarsest level of description it could be said that the pattern of immigrant settlement had endorsed the ancient locational preference of the indigenous groups, and in this sense the theme of continuity can be emphatically extended to the wetlands.

On the other hand, hindsighted descriptions of the new immigrants' approaches are littered with such terms as 'aggressive', 'exploitative' and 'intrusive' — to contrast with a 'symbiotic', 'spiritual' and 'harmonious' Aboriginal engagement. Most of the established characterizations are unsatisfactory. Centuries of indigenous hunting and gathering partly *fashioned* the landscapes which were ultimately occupied by the invaders. And the European settlers could scarcely conceive themselves in a privileged relationship with environments they considered well-nigh incomprehensible. In the case of the wetlands, on the contrary, in most of its essentials a partly dependent relationship was still noticeable in and around Perth towards the end of the nineteenth century.

In contemporary water management accounting the nearby Fremantle would gain an unusual bonus from its redoubtable prison complex, but in other respects its residents also had cause for complaint about water quantities and qualities. At the southern extremity, Stirling gave Albany its name and helped to re-focus the harbour facilities and mini-garrison in the vicinity of a freshwater spring. The history of that area makes special claims, but for brevity, attention must be fixed on the Perth–Fremantle node.

Spanish Benedictine monk, Dom Rosendo Salvado (1814–1900) was one of the founders of the impressive mission settlement at New Norcia, north-east of Perth.

It is tempting to suggest that he was more advantaged by his national background than other nineteenth-century immigrants to Western Australia. Though he was a native of Galicia in the moister north-west of Europe's driest and hottest country, his upbringing and refined education would have established that the pivotal significance of water in Mediterranean and semi-arid regions is deeply entrenched in Spanish traditions. Building to some extent, perhaps, on his cultural origins — and certainly on Aboriginal advice and his own competence in basic surveying techniques — Salvado became highly successful in staking out large expanses of territory, especially by means of pioneer investments in well-digging and the strategic selection and occupation of small areas which secured valuable water points.

The accompanying illustration is a detail from the back of one of his rough but effective maps of the new frontier: the amateur cartographer charted and quite assiduously updated the key topographical features — wells, springs, soaks and watercourses.

By courtesy of the Benedictine Community of New Norcia.

Enterprizing residents in each of these small townships exploited a number of local marshes which had been observed to be seasonally transformed into freshwater lakes. In Fremantle, two of these natural sources (near the Roundhouse) were quickly rejected and made over for general development purposes, and there was a growing preference for the sinking of deep wells. According to Stirling, Perth provided an enviable selection of ten significant 'freshwater lagoons'. But unforgiving summers undermined the simplest kinds of opportunism, and in fact severe failures of supply were registered within six years of the explorer's optimistic pronouncements. Increasingly, residents turned to the wells and springs, and the former choice proved curiously durable — a reflection, arguably, of its perceived assertion of a measure of self-reliance. Similar individualistic enterprise introduced two water-driven flour-mills, though both required official sanction and a little patronage.

For all their benefits, however, the wetlands also represented impediments to land transport and residential expansion. Drainage operations went hand-in-hand with the provision of water supplies, and at times contributed quite as directly to the shaping of the township. There was a more sinister aspect. British immigrants were discovering that it was in the nature of the 'Mediterranean' climate of their adopted region to balance the searing summers with winter floods. On the coastal plains, this rhythm aggravated imported anxieties about conjectured links between 'marshy exhalations' or comparable 'miasmatic' vapours (or foul smells) and the spectre of disease.

A ruling management aim, therefore, was to find ways of reducing the lakes' seasonal excesses without jeopardising

regularity of supply. Lake Kingsford was deepened and provided with an outlet drain in the late 1840s, and decisions were made to drain Lakes Sutherland and Irwin into Kingsford. It was appreciated that these local drainage efforts would somehow influence the levels of the town's numerous hand-dug wells, but such misgivings were outweighed by the arguments of 'sanitarians' who championed public health reforms. The works were undertaken during the late 1840s and, with the assistance of convict labour, in the early 1850s. Fremantle's own version of coastal 'improvement' included simple transfers between contrasting natural zones, notably from sandy tracts into the swamps.

Science and technology would eventually move to centre-stage, but in the interim water management preoccupations continued to incorporate the pioneers' intimate engagements with nature in its local setting. Nowhere was that intimacy more sharply underlined than in the multiplication of perilously juxtaposed cesspits and wells in flood-prone districts. The tiny demand for radical management responses can be partly explained by an uncertain public purse and the immaturity of local governments, but it was also a product of conditioned perception and wishful thinking.

Anxieties could be eased, indignation avoided, by resort to descriptions of the 'salubrity' of antiseptically dry summers. Similarly, the manifest health hazard was conveniently obscured and relegated to 'nuisance' status by fingering the poor as perpetrators *and* victims. Perhaps the collective perception was also dulled, in Perth but not in Fremantle, by the wide dispersal of well proportioned building allotments incorporating unusually generous set-backs from the streets — a sequestering of primitive private practices and, except for the most squalid quarters of town, a deceiving spatial punctuation in all the admonitory tales of bad smells or 'olfactory abuse'. Again, Perth's valued but struggling 'swamp gardeners' were periodically exposed to nature's seeming vagaries, and it was acknowledged that their plight offered a special justification for a more comprehensive intervention in the natural system.

The inherent claims of the environment itself, like those of the indigenous inhabitants and the native flora and fauna, were not widely debated. Given the extraordinary schedule of demands on the administrators of the young settlement, critical balances between water quantities and water qualities must have been hard to strike. Despite stuttering improvements, Perth's multi-faceted water problems dragged into the 1860s and 1870s.

Fremantle was marginally better served. Visiting ships were obliged to take on fresh water, and after a lengthy interlude of private water-selling ending in the mid-1870s, the service was dovetailed into a partial reticulation scheme for the town, drawing on wells within the limestone foundations of Fremantle gaol. Prisoners constructed these invaluable wells, together with their related storage reservoirs and tunnels. Thus, one of the most basic human needs linking the bond and the free: water always finds a level.

In concert with similar developments around Australia and building upon an appalling recent history of typhoid, cholera and other diseases in Western Australia, a Sanitation Commission reported in 1885 that priority be given to the design and construction of a satisfactory scheme for municipal water supply. It advised that Lake Monger would furnish a good short-term solution, and that the most realistic long-term approach would be to construct a pipeline from the Helena or another Darling Range river, to be used in conjunction with deep wells in the limestone strata located to the west of Perth.

'poisonous infiltration', 'beastly habits': Perth in the 1870s

… a copious supply of pure water in a city is of very serious importance, particularly when it is considered that there are few wells in the metropolis which are not vitiated by poisonous infiltration — surely, though slowly, engendering the seeds of many insidious diseases …

[*Perth Inquirer*, 6 November, 1872]

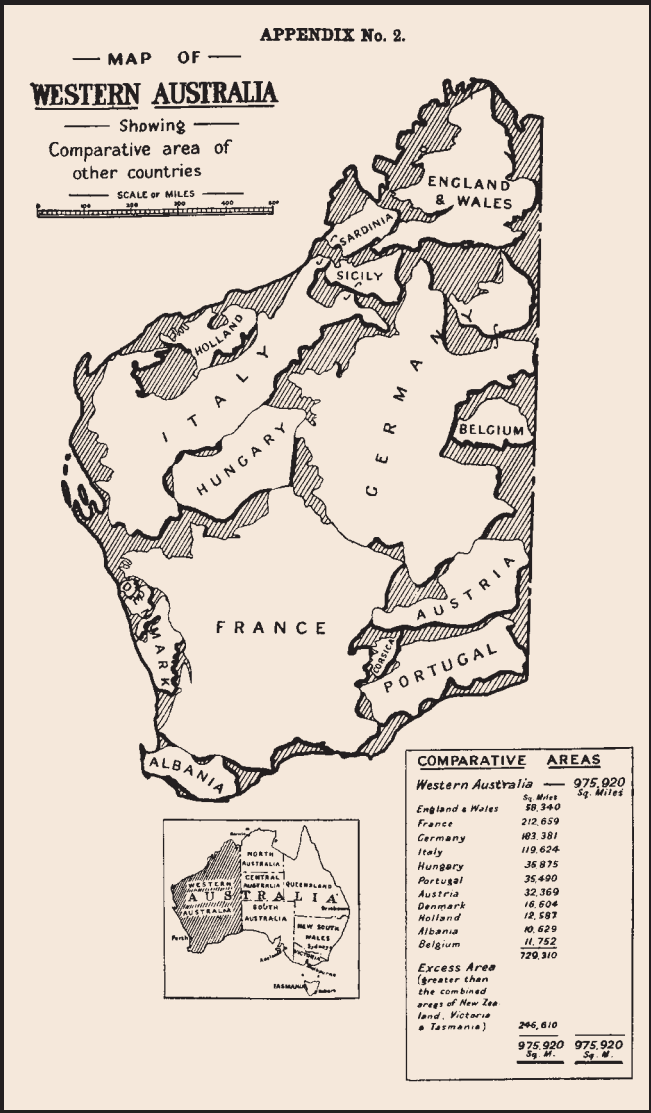
If the present state of affairs is allowed to continue, let us never more speak of the beastly habits and customs of the Chinese, or even of the savages of the land, for a greater violation of decency setting aside all sanitary laws can scarcely be pointed out.

[*Perth Inquirer*, 27 November 1878]

The Darling Range option was further elaborated in a proposal from Messrs Saunders and Barrett, handily placed as engineers *and* city councillors. Then a modified version of their proposal was taken up, but in transit it was accompanied by angry protests about the alleged pecuniary involvement of key city councillors, and outrage over the consignment of an essential public utility to private enterprise.

The latter concern soon came home to roost. Still fired with sanitation insights, residents and councillors became alarmed by the evidence of pollution from cattle grazing and timber milling in the catchment of the new Victoria reservoir, and their protests were nullified by the fact of private control over these activities and indeed over the water company itself. The slow progress may also be ascribed to a combination of local circumstances. They include a number of rifts which picked out ideological and personal clashes, and conflicting views on the proposed introduction of the kind of *representative* water board already favoured in the eastern colonies. These problems had been compounded by the discovery of gold to the north and east, by a consequent rapid increase in the population of Perth and a distressing decline in public health standards, and by the mixed aspirations aroused by the granting of self-government in 1890.

The water company would be purchased by the government of Western Australia in 1896, by which time the texture of resource appraisal and environmental management was far more complex. The narrative was beginning to accommodate a much wider spectrum of agricultural, industrial and urban uses and interpretations, which would be expressed over the full vastness of the Western Third. And yet, as our next section relates, the links with the experiences of the former Crown Colony are undeniable.



Gold and Green, 1890–1950

Spatial delusions.
From The Case of the People of Western Australia (Perth, 1934)
for secession from the Commonwealth.

A Fine Country to Starve In.

[Bolton, 1972]

And thus Western Australia has struggled on since 1829, having undergone many difficulties; not much heard of in the world; never doomed like Sierra Leone or Guiana; never absolutely ruined as have been some of the West Indian islands; but never cropping up in the world, an offspring to be proud of, as are Victoria and Canada.

[Trollope, 1967, pp. 577–78]

II

Gold and Green, 1890–1950

Visiting Western Australia in 1872, English novelist and travel writer Anthony Trollope was not exactly entranced by its appearance and prospects. Abandoned, so it seemed, to touchy peripherality on the rejected side of the continent, and bludgeoned by environmental obstacles, a dubious investment reputation, 'native hostility', and a desperate resort to imported convict labour which left the mannered sojourner threatened at every turn by replicas of Bill Sykes, the Crown Colony was no jewel. On the contrary, at best it could be cast as an overlooked basement in the grand edifice of empire. At worst it was an expendable outhouse — or else it was, in the Australian context (as Trollope put it in an alternative draft) as poor, tucked-away Newfoundland was to the North American colonies.

In the end, our literary gent conceded a point or two. Perhaps it was like 'the east side of London', chiefly handicapped by the disadvantages of sentiment and fashion. Monied immigrants with big plans should therefore look elsewhere, but those with more modest financial resources who felt constrained by the 'composite luxuries and miseries of a crowded country' could do well enough in the west. In any event, the Australian experience had taught that hope — or luck — was a resource in itself.

> Gold of course may turn up even yet. For myself, I look to corn and fruit, and perhaps oil, — to the natural products springing from the earth, — as the source of the future comfort of this enormous territory (p. 617)

Flippancy and condescension never pass as prophecy, but within 20 years of Trollope's visit, the trend was distinctly towards some approximations of economic 'comfort'. Not without further crises of confidence *en route*. For instance, the historic report of a Commission on Agriculture (1887–1891) emerged when Western Australia was perched on the very cusp of change. In conjunction with other contemporary statements, it conjures an image of a limited and fragmented colonial economy concentrated on the environmentally-advantaged fringe of a huge expanse of apparently hazardous and unpromising territory.

Even in that favoured fringe, opportunities for crop farming and increased immigration had been restricted by the joint burdens of isolation and niggardly soils. Gold-mining and the application of critical trace-elements, it is now widely understood, would recast the prospectus. But it is far less generally appreciated that bold initiatives in water management were comprehensively linked with these developments and often provided, indeed, the very trigger for searching transformations.

The west's total population of 180,000 in 1900 represented almost a fourfold increase over the previous decade. By the early 1930s the total reached 440,000 and by the mid-1940s it had passed the half-million mark. Doomsayers might qualify the implicit claims in that record by setting it alongside a territorial legacy which exceeded 2.5 million sq km (about 976,000 square miles). A trifle paradoxically, the state's boosters were adept at citing raw spatial comparisons: over ten times the size of the U.K.; twice as commodious as either Peru or Tibet; between approximately four and five times larger than many of the renowned heavyweights — either Texas, or France, or Spain — and so on. Less flamboyant optimists would sometimes point, in the interwar years, to the sharp contrasts in collective productivity and settlement expansion between the nineteenth and twentieth centuries, and to the fact that the bulk of the state was still available for advanced scientific and technological exploration. Even-handedness requires, more simply, that the scale of achievement be computed from the magnitude of the task and the relatively small size of the pioneering community.

Developments in mining, urbanization, agriculture and grazing made for expanding demands on water resources. The state's water managers continued to function as both instigators and recipients of change.

Feverish Frontiering: Innovations for Mining

Acute shortages of water for both industrial and domestic uses plagued most of the goldfields districts over the turn of the century. These circumstances demanded a finely-honed stereoscopy and accentuated the politicization of the water management task in intriguing ways. Yet there is an unfortunate tendency to concentrate the historical narrative on the mining fields themselves. At the broader level, the very scale and urgency of goldfields water issues seemed to justify increased expenditure on a more varied range of public works, and it can be misleading to excise one activity from the whole.

As in most pioneering situations, road and rail construction inevitably contributed to the contemporary stock of technical knowledge, and often included the first specialist appraisals of the incidence of flood and drought, surface water volumes and reliabilities, and estimates of water's 'run-off' characteristics on slopes. Mining *per se* stimulated crucial advances, but the prior experience of road and rail construction had helped to prepare the administrative and political ground for water's sharper profile. That experience had also inscribed into the rural landscape a series of staggered lines of wells, tanks and small dams, some of them accompanied by artesian and sub-artesian bores.

Albeit in highly selective and piecemeal fashion, the comparatively late arrival of the great age of steam probed the limits of western environments. Water was still an expensive and elusive commodity, and the financially-strapped Railway Department had to devise ways of providing its locomotives with supplies of reliable quantity and quality at appropriate intervals. In the pursuit of that objective — and notwithstanding its larger claims to fame — the Department became a pioneer in rapid environmental reconnaissance and the production of small-scale, no-frills engineering solutions. Its environmental data underlined the need for a systematic, state-wide monitoring programme, and several of its practical undertakings illustrated inventive coping strategies.

Although it is now acknowledged that some of the earliest warnings of increasing salinization originated in analyses undertaken by railway personnel, the first of these cues would not be taken up for many years. That was not so in the case of the most practical exemplars. For instance, Western Australia's railway system, like any other, could be relevantly cited in support of either grandiose or modest technology, but accounts of its particular involvement in water management appeared to favour small-scale, on-the-spot ingenuity. Keen railway engineers who surveyed the dry mining areas were amongst the first to recognize the potential for good water storage in the presence of extensive surfaces of bare rock with promising run-off capacities. Improved versions of these opportunistic 'rock catchments' are now lightly distributed across Australia's dry Outback.

Stress levels were especially elevated on Western Australia's frenetic diggings, but in general the source and the response were not dissimilar: in fact the story of water management identifies extrapolations and adaptations as well as independent innovation.

As Whittington (1988) has explained, the pressure on the mining communities was partly the product of deplorable hygiene and alarming deficiencies in local water supplies. During the first generation of productive gold-mining (say, until about 1910), the reported incidence of typhoid in Western Australia was between six and nine times greater than the rate in other states. There were perhaps 18,000 cases in the

Taking on Water, 1886

This question of water supply for our engines is a most serious one. Indeed during last summer it threatened for some time to stop the service; and, had not immediate steps been taken to obtain a proper supply at York and Beverley by placing steam pumps at pools in the Avon … the consequence would have been that we should have been compelled at all events to reduce the number of trains just when there was most traffic.

… I dread that at any time we may be compelled to reduce our train service, or even to suspend it for want of water.

[J.A. Wright, Director of Public Works and Commissioner of Railways, 1886; cited in Le Page, 1986, p. 264]

3

Sir John Forrest (1847-1918), surveyor, explorer and politician; Battye Library 6253/3.

1890s, including an annual average of 300–400 deaths in the peak period of 1895–97. Gradually, the correlations with overcrowding and primitive sanitation came to be better recognized, but hopes for the diffusion of tighter explanations were defeated by lingering preoccupations with 'noxious' or 'noisome' smells and vapours.

In the semi-deserts of the eastern goldfields, there must have been times when water contended with gold for holy grail status. Firstcomers trying to make do with elementary tanks were forced to revise their boasts of topographical nous when their choices of site proved to be either ludicrous or plainly dangerous. Supplementary bores yielded salt or brackish water, possibly between two and five times saltier than sea-water, and this was boiled in a bewildering range of 'condensers'.

In theory, the condensing process should have guaranteed supplies of potable water, but the pace of development meant that large numbers of miners remained partially or wholly dependent on their own miniature storages, which were easily contaminated in situations characterized by a brutish ignorance of ordinary hygiene, neglected or non-existent sewerage disposal techniques, and hopelessly deficient drainage.

The simple condensing apparatus — whether ramshackle or sturdy, confidently arrayed in military ranks or placed discretely under a tree — dotted the landscape. The grandest of them all, the Mammoth, could distil up to 100,000 gallons in a day, directly employing more than 40 men. Quite as significantly, at full blast the Mammoth consumed about 150 tons of firewood daily. The condensing industry as a whole had a voracious appetite for firewood, and its many-sided ecological influence may never be fully assessed. It is also well-established that many of these plants were short-lived, having ominously exhausted local bore and mine water reserves in hasty attempts to capitalize on the big rushes. Thus far, the most persuasive archival evidence of this massive impact relates to the early 1920s, when the goldfields consumed about 700,000 tons of firewood and mining timber each year.

Water Training

Le Page (1986) has indicated that, before the pipeline eased the situation, a water train running from Northam to Kalgoorlie with 30 wagons, each holding a 1200 gallon tank, would itself consume more than half the 36,000-gallon load in the round trip.

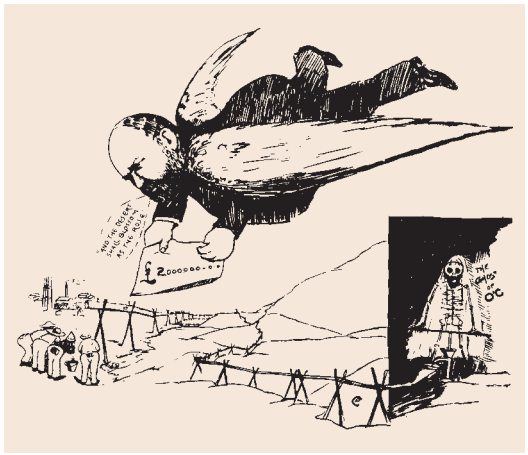
Railway condenser and operating team, c. 1895; from Le Page, 1986.

Butcher, baker … water-seller: back to basics on the goldfields; Battye Library, 5010P, 5055P.

The renowned Goldfields Water Supply Scheme was partly devised in response to the distress and confusion which were handicapping the industry and putting new communities at risk. In 1895 Premier Sir John Forrest and Engineer-in-Chief C.Y. O'Connor launched the construction of a water pipeline linking the south western settled districts with the eastern goldfields. Completed in January 1903, the scheme delivered about five million gallons daily to Kalgoorlie; the distance traversed was approximately 560 km (350 miles), from a weir at Mundaring in the Darling Range to a service reservoir on Mt Charlotte near Kalgoorlie.

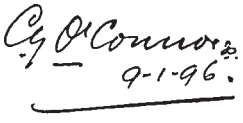
While the need was undeniable, from today's perspective it is difficult to appreciate the level of contemporary opposition to this solution. The condensers normally supplied water at between fourpence and sixpence a gallon, but the best water fetched several times that price during times of scarcity. Miners had become far too dependent on tinned food, and were reluctant to bring out their families; instead, they were remitting £56,000 monthly to their homes in the eastern colonies — hardly a vote of confidence. Gross misperceptions were entertained about the likelihood of groundwater and minewater, and the government's initial dithering with renewed boring operations (against the advice of its own experts) perpetuated that problem. Tauman's (1978) fine account gives the rest of the context most succinctly, and essentially as follows:

- strong individual and collective preferences for private enterprise were expressed in opposition to the government-controlled scheme;
- the mining boom attracted waves of newcomers who were unfamiliar with the goldfields environments and with O'Connor's earlier professional successes;
- wetter seasons invariably induced a return to apathy;
- occasionally, disgruntled and politically lively mineowners were simply spoiling for a fight;
- some of these mineowners saw opportunities in the backing of competing schemes, including alternative reservoir options and extravagant expansions of boring/condensing enterprises;



'Johnies Little Toy'. From a **Western Table Talk** *supplement, 16 October 1897. Forrest's motives are questioned; O'Connor's ghost works away in the lower right-hand corner.*

'The Chief': Charles Yelverton O'Connor (1843-1902), extraordinary engineer.



Government condensers at Coolgardie—one of the more surrealistic images. From the* Annual Report of the Department of Mines, *Western Australia,* Proceedings of Parliament and Papers, *1903-04, No. 7.

- a few newly arrived engineers focussed their own ambitions on the latter notions;
- the resultant skirmishes in a remote and relatively inexperienced parliament were often sparked by personality clashes and plain bloody-mindedness.

This is not the place to rehearse the chronic local disputation concerning the actual 'originators' of the superb project. Historical origins are seldom well traced after the fashion of modern paternity suits. Alexander *et al.* cite Forrest's political potency and O'Connor's technical prowess; Tauman finds that John Winthrop Hackett, editor of the *West Australian* and a great O'Connor fan, played the go-between or facilitator. The area of water management ideas and achievements is shot through with evidence of such complex interconnections that mixed and uncertain parentage is the norm, not the exception. Elsewhere, I have touched on the growing influence throughout Australia of administrative, scientific and technological advances in North America and in India under the British Raj. New South Wales, Queensland, South Australia and Victoria offer a number of interesting examples. So does Western Australia.

The United States' lead in drilling and pipeline technology owed a good deal to its spectacular oil industry, and American accents are discernible in the pioneering exploitation of the Great Artesian Basin in eastern Australia. There are echoes of British India in the administration of new irrigation schemes, in early interpretations of salinization problems, and in a growing interest in the adoption of more expansive regional scales for project planning.

That is not to diminish Australia's distinctive, even habitual reliance on government involvement which had encouraged the introduction of sizeable state agencies with monopolistic or near-monopolistic control over water management operations. Their plainer 'utility' functions were frequently seen as supplementary to their leadership roles in town and country planning. Admittedly, isolation is not solely responsible for putting a finer edge on claims for novelty, but on the whole it seems reasonable to say that the Western Australian experience reproduces all of these trends and characterizations. In a few areas it led and in others it followed the eastern states.

The pipeline project is justly praised for its place in the social history of Western Australia and in the (partly neglected) history of technology in Australia. It brought some stability and comfort to the mining communities and, along with other measures, helped to bolster public health standards. But some goldfields residents claim that the Western Australian government's long-range planning continued to favour the capital and the south western agricultural districts, and the historic pipeline should also be assessed against the backdrop of regionalized grievance.

Maturing Capital

As in a mirror, urban water management continued to display contemporary social structures, doubts, hopes, fears, the highs and lows of administrative and technological practice, and the interaction between scientific and populist understandings of the ecology of disease. Admittedly, over the long haul — such is the need for secure water — the account seems heavily punctuated by unequivocal signs of 'progress'. Yet if that suggests a linear route it was frequently checked by extravagant meanders.

Urban residents were alternately united and divided on water issues. The definition and presentation of those issues contributed a special civic dynamic, and that function was never completely relinquished, despite the mounting complexities of urban living and a revealingly parsimonious assignment of 'utility' status from academic historians.

As our next brief encounters with Perth will relate, water management was a primary ingredient in the messy set of processes routinely mustered under the heading of 'modernization'. Perth experienced severe growing pains in this period, and its managers were subjected to episodes of merciless abuse from a boisterous local press. One of the best-known victims was C.Y. O'Connor, talented water manager and Public Works all-rounder, who took his own life in 1902.

By the standards of the 'developed' world and of course to the non-indigenous Australian mind, the greater part of the state remained glaringly 'empty' or very sparsely settled over the turn of the century. The state's population barely exceeded 200,000 in 1901 — that is, roughly the size of a small provincial city in contemporary Britain, Western Europe or North America. The total had increased three and a half times since 1892 and it was chiefly concentrated in the south west and on the goldfields, but those observations do not blunt the telling comparison. Yet Perth itself expanded from a recorded total of less than 28,000 residents in 1901 (perhaps 15 per cent of the state's enumerated total) to 155,000 in 1921 (47 per cent) and 273,000 at the 1947 Census (55 per cent; in each case, adoption of the Perth Statistical Division returns gives higher proportions).

'from a sandbed to a first-class town', 1903

I welcome with the greatest of pleasure a Bill which should give Perth the last important adjunct needed to make her a city. She has been transferred from a sandbed to a first-class town; she has a tramway service second to none in Australia … She has a national reserve on the hill … she has parks and gardens being laid out in different directions; she is now erecting buildings in keeping with her dignity as the only capital on this side of the continent; and she badly needs a proper water service and a good sewerage and drainage scheme.

[*Western Australia Parliamentary Debates*, 10 December, 1903]

Note that word 'enumerated'. The Aboriginal population was still excluded from the Census exercise. Later reconstructions suggest that in 1901 its total was only slightly smaller than that given for Perth — so it is likely that, at that time, indigenous styles of water management were still highly significant in a few localities — whereas between 1901 and 1947 it had sharply declined, by about 40 per cent. The implications have yet to be examined. The main point here is that Perth's rate of growth and increasingly dominant share of the state's population taxed the patience and ingenuity of town planners and specialist water managers.

The most threatening 'insalubrity' seldom returned in the new century, but contests between sectional interests at the local government level, together with frequent irritating changes in the state parliament, conspired to block the resolution of disputes over metropolitan water management. Initially, 'metropolitan' signified a more expansive form of administration rather than any impressive aggregation of population: specifically, the grouping of local government areas in the penumbra of central Perth. Its adoption opened the gates for argumentation over a democratically elected *versus* a 'nominated' water board, and over the vexed question of 'expert' *versus* amateur management.

The creation in 1910 of a Metropolitan Water Supply Sewerage and Drainage Department proved to be a short-lived solution. One of the reasons for the

4

Pearls and Swine

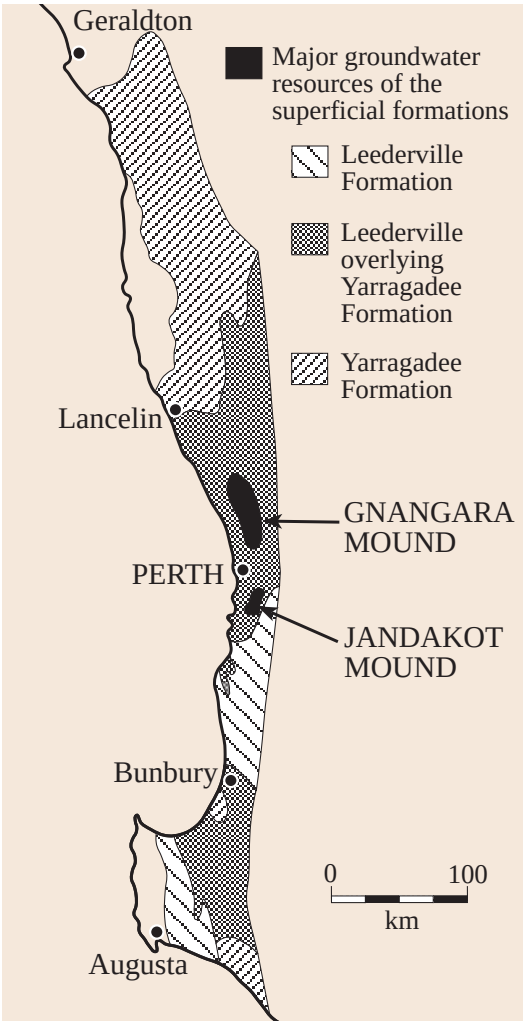
(They) … have been paying for water the quality of which has too often been such as would offend any self-respecting pig.

[*Daily News*, 14 March, 1923]

Department's demise in 1912 was the opposition to its annexation of the local authorities' powers and responsibilities. Fierce complaints about water quality, delivery efficiencies and pollution stemmed in part from this resentment. Water affairs were controlled by a state-wide body in 1912–1917; then the separate metropolitan jurisdiction was revived.

The 1920s brought a redoubled effort to *improve* the lower Swan and its frontages, including the dredging and reclamation of wetlands. Perth had experienced serious flooding in 1915 and 1917, and further floods in 1926 and 1928 increased the hostility to the old swamps and marshes. The city's artificial drainage system was gradually elaborated. Most aggressively, Herdsman's Lake was set aside for soldier settlers: it was drained by tunnel to an ocean outlet. Interventionist measures of this type were maintained through the Depression by a small army of relief workers whose efforts should be acknowledged. The same pool of 'unskilled' labour was deployed in extending the urban sewerage system and in boosting metropolitan supplies by the erection of the Canning Dam, the state's biggest public undertaking during the 1930s. The workers' support was vital.

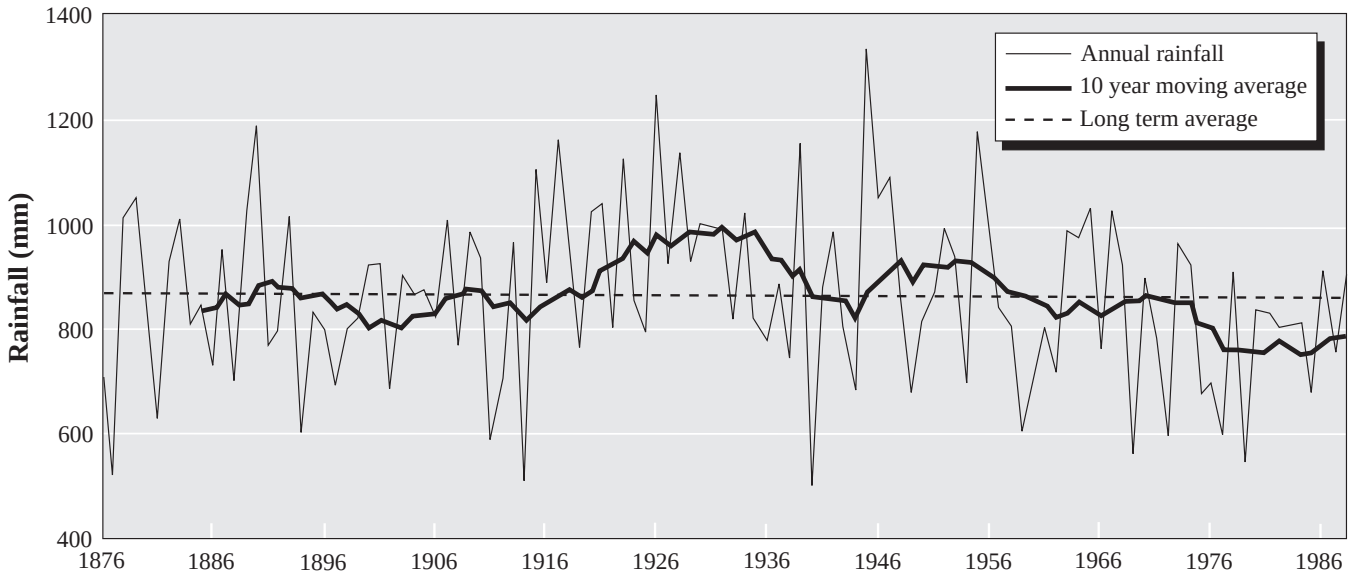
All of this was evidence of a kind of maturation, albeit as much by hard knocks as by prescient design. To leave it there, however, would be to dismiss the creative endeavours of a number of resourceful individuals who prepared the way for a planning movement that was unarguably urbane. In its most detailed texturing — that is, at the level of the suburb, neighbourhood, streetscape and household — the appraisal and management of water in and for the growing city progressed *pari-passu* with the development of the ideas and practices of modern town planning. In such a demanding location, each required the other.



Perth's chief groundwater aquifers, vital to regional wetland ecology and human occupation for aeons. Indigenous communities made intensive use of the wetlands for at least 40,000 years, especially during the dry summers. The Nyungar ('Nyoongar', etc.) people established seasonal camps in the wetlands of the Swan Coastal Plain; there they exploited native fruits and vegetables, including the bulbous roots of various kinds of 'bullrush', together with waterfowl, fish and tortoise.

Early European occupation left the aquifers largely intact, but swiftly transformed several of their associated wetlands. Many later occupants of the coastal plain appear to have only a very limited understanding of its 'pre-European' condition and of the problems posed by what was considered to be its 'poor drainage'.

Any list of visionary civic statements might begin with W.G. Brookman, who served very briefly as Perth's Lord Mayor in 1901. Advocating the adoption of a considered development policy which would efficiently orientate the deliberations of the city's elected managers, he proposed the setting aside of more parks and gardens;



Perth rainfall profile, 1876–late 1980s.

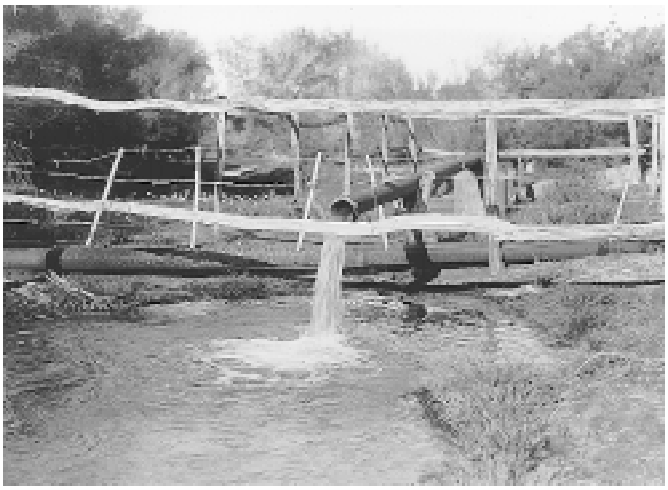
the opening up of shopping streets; a northerly shift of railway operations from the centre proper and the selling of the released land for shops and offices; construction of a riverside drive along Perth Water to Mt Eliza; and a deep drainage system. A decade later, Town Clerk W.E. Bold began to address Brookman's main challenge, the need to formulate a comprehensive plan before the momentum of growth became too far advanced. The episode is recounted in Webb (1979).

Bold returned from a study tour of town planning and municipal conditions in Europe and North America in 1914, and his detailed report aired a range of current overseas themes, including the 'Garden City' notion and its rivals and derivatives. The report located Bold in good company, and Perth hosted a succession of influential national and international planners. Each visit injected fresh confidence into a local planning movement in dire need of it, because legislators were stubbornly ignoring or rejecting every advance. The *Town Planning and Development Act* of 1928 was the product of this long struggle for recognition. It held out the prospect of more public control over private development and a better co-ordination of public sector investments in the process of urban improvement.

A Metropolitan Town Planning Commission made telling recommendations in 1930, particularly with regard to urban transport and the need for an open space network to accommodate a total population of one million. Another small step in the getting of wisdom? Undoubtedly, but the preference for suburban living on small independent blocks was becoming entrenched by the 1940s, when new manufacturing industries were congregating in the metropolitan area.

Government water managers braced to take in the implications for their own sphere; then the Depression and World War II called different tunes. When sophisticated planning in the manner of Bold and others returned in earnest after the War, water managers of every ilk knew they would be required to move up a gear.

Increasing the Margins: the Cropland and Grazing Frontiers



Left:
Artesian bore (with a daily flow of 500,000 gallons) on the Neeagoorlia Station, Gascoyne District, inter-war years; Battye Library 816B/B1855.

Right:
Government well on a stock route 75 miles east of Wiluna, 1935; Battye Library 816B/B3254.

5

From the late 1880s, John Forrest and his colleagues had legislated to foster an expansion of intensive rural settlement and to reduce the dependence on imported foodstuffs.

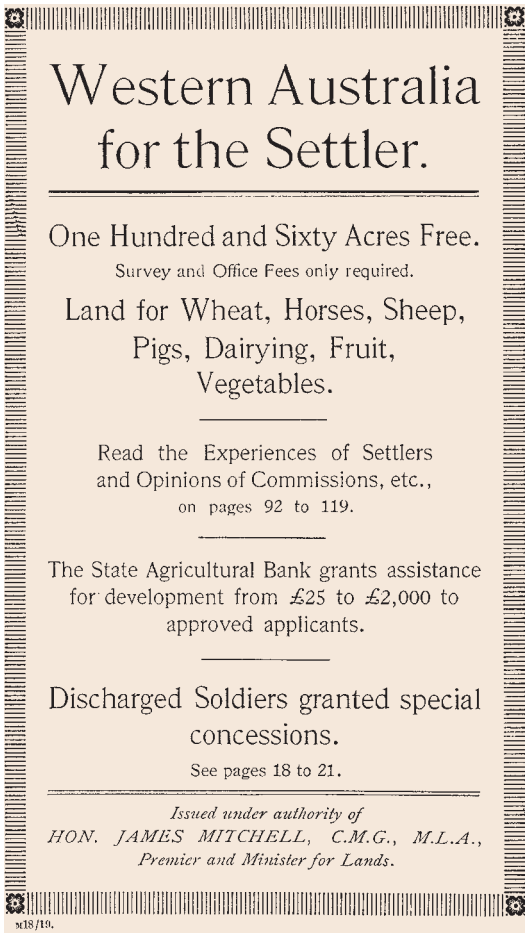
The *Homestead Act* of 1893, essentially confirmed and consolidated in the *Land Act* of 1898, was roughly akin to the American prototype of 30 years earlier: settlers could obtain very small but nominally free blocks, provided they showed proofs of residence and specified improvements. A new Agricultural Bank would assist impecunious families, and the general development programme was bolstered by rail, road and other infrastructural supports which were partly funded by government-negotiated loans from Britain.

Successive governments continued to reinforce Forrest's policy, and advances in clearing, cultivation, harvesting and other farming technology, together with the introduction of phosphate fertilizers, brought reduced costs and steadier yields. Put at its simplest, the most tangible outcome was a remarkable transformation of the regional geography of the state. Despite all the instabilities and episodes of pig-headedness, the arduously negotiated partnership between politicians, bureaucrats, farming families, scientists and technologists, rural institutions and private industrial enterprises shaped a portentous new wheat belt. It was created in previously thinly settled areas of the south west, wedged between the forested country and the eastern goldfields. By 1914 Western Australia was a net exporter of wheat, and some of its caricatured insecurity could be disputed.

The broad economic, political and social aspects of this transformation have been explored by academic researchers and local historians. For example Bolton (1972), Snooks (1974) and Glynn (1975) critique the general developmental thrust of government policy, the roles of banking innovations and railway expansion, and the initial and cumulative social effects.

Albert Facey's (1985) biographical memoir vividly illustrates one worker's 'participant observation' of a number of the developmental activities and stiffens the case for more 'bottom-up' history in 'institutional' studies, but that is not the present assignment. Most of the available commentaries on this period allude to the place of water management as one of the key infrastructural supports of pioneer settlement, but the water picture itself remains fragmented.

The shards begin to come together when we sieve through the historical record to identify other contemporary aims and concerns which have been overshadowed by the success of the campaign to relieve



Western Australia for the Settler.

One Hundred and Sixty Acres Free.

Survey and Office Fees only required.

Land for Wheat, Horses, Sheep, Pigs, Dairying, Fruit, Vegetables.

Read the Experiences of Settlers and Opinions of Commissions, etc., on pages 92 to 119.

The State Agricultural Bank grants assistance for development from £25 to £2,000 to approved applicants.

Discharged Soldiers granted special concessions.

See pages 18 to 21.

Issued under authority of HON. JAMES MITCHELL, C.M.G., M.L.A., Premier and Minister for Lands.

xd18/19.

the goldfields. For instance, evangelists and agnostics alike came to favour certain terms when trying to justify the watering of a remote mining industry with a notorious economic reputation for producing nine-day wonders; and in particular, references to the need for a *comprehensive* scheme gained a wide currency during the opening years of the twentieth century.

The specific term and underlying principles can be traced, however, to earlier decades in the west, and to an interest in 'multiple-use' water projects in eastern Australia deriving from the mining focus of the 1850s and 1860s (cf. my *Watering the Garden State).* In Western Australia the miners' pipe dream was made to subsume other visions: of an expanded, water-secure railway system; and of pioneering families reclaiming dry and riverless territory underwritten by regular water supplies from a munificent government. 'Comprehensive' therefore signalled 'inclusive' — of a multiplicity of uses and users. In conjunction with a battery of other public works, the pipeline scheme would be an investment in *long-term regional development*.

During the first phases, new and existing farms could be supplied by short extensions from the main conduit without too much drama. After about 1905, the wheat belt was pushed into streamless areas characterized by granite outcrops and sandy plains with scattered soaks and springs. And on otherwise problematical 'light land', livestock were watered from government bores — the reference is to drilling, not to exiled politicians and bureaucrats. Many settlers personally selected and maintained natural reservoirs, collected rainwater from every roof they possessed, carted from strategically-placed government wells and earth tanks, and eventually made their own dams or hired contractors to do the job. The face of the land became scarred and pitted with all these water lines and water points — deftly incorporating, here and there, a less geometric physiognomy which had been sculpted by Aboriginal water managers.

As in the other Australian states, the speed of change and the variety of undertakings posed major organizational questions: centralization or decentralization, that persistent antipodean theme; separate departments for 'functional' or task-driven distinctions, rather than monolithic bodies emphasizing foot-loose 'management' above any of the more precisely-defined activities. Then there was a lurch towards the single, state-wide Water Supply, Sewerage and Drainage (WSSD) Department in 1912, noted earlier.

Administration of a number of projects and regional functions was taken up by this magnetic monolith — the Metropolitan Water Supply, Sewerage and Drainage undertaking; the Goldfields Water Supply undertaking; Agricultural Water Supplies, Artesian Boring, Country Towns Water Supplies, Irrigation, and Land Drainage; together with 'Water Supplies, Stock Routes, etc., in Mining Districts'. A small North West Water Supplies division continued to be managed within the Public Works Department, but hydraulic matters were to be reported to the Under Secretary of the new department. This radical amalgamation was justified on a mixture of 'efficiency' grounds, principally accountancy and administration savings and the pooling of technical expertise.

A new base for a pioneer family in the Brunswick district (pre-1920); from Brady, 1918.

Rather similar arguments would mark the reformist surges of the 1980s and the 1990s, but the contexts differed: in 1911–12 the impact of a big drought had taught some unsubtle environmental imperatives.

Although it was informally and incompletely disassembled at the end of World War I, the WSSD Department's annual reports give useful insights into the scope of contemporary water management and its role as a change agent.

The Department's rural activities should be assessed over both the short- and long-terms. It was required to be reactive as well as diagnostic or anticipatory. The government's reliance on tank excavation in the new wheat belt was exposed by the drought, and well-boring probably constituted the most visible official response to the old environmental enemy. That strategy was quickly implemented by the use of modest boring plants which could be despatched in answer to local appeals — on the flying squad principle, except for those localities where the plodding reliability of camels was preferred.

In 1911–12 about 80 plants were at work, and a frantic shift-work arrangement was producing about 20 or 30 successful wells each month. Each completed well was fully equipped with windlass, rope, buckets and troughing — and often just in time to prevent an exodus of settlers and stock.

Elsewhere, settlers were assisted by the upgrading of soaks and rock holes, and by the provision of iron tanks at railway sidings.

This hurried shoring-up of frontier investments studded the new farming landscapes, nailing down the gains. The resulting pattern necessarily reflected the compound of human needs and natural conditions, and was the opposite of haphazard. Boring parties were carefully instructed to remain more or less adjacent to the main roads, and to try to space the wells so as to ensure that the settlers' carting distances would be no greater than about eight kilometres (five miles). The Department's progress encouraged a spate of copy-catting amongst frontier settlers, who borrowed government equipment or financed their own water ventures.

In the interim, tank excavation remained significant, though the dependency on surface run-off meant that they were at their most useless precisely when demand reached a desperation maximum. Distribution controls broadly followed those set down for government wells. Conventionally, the fully equipped tank was fenced and its surrounding catchment was cleared, improved and scored with contour drains; all the paraphernalia of pumps, stand-points, and troughing was installed; and the tank might be covered, into the bargain. Rough roads were cleared and grubbed, quickly meshing in with the new railways to facilitate the carting of produce, stores and equipment, and to ensure reasonable access to the water points.

On the pastoral frontiers of the north-west, settlers were persuaded to attempt deep drilling for artesian supplies. For its part, the government would meet the expenses of unsuccessful or 'dry' bores, and would arrange deferred repayments on low interest for the better strikes.

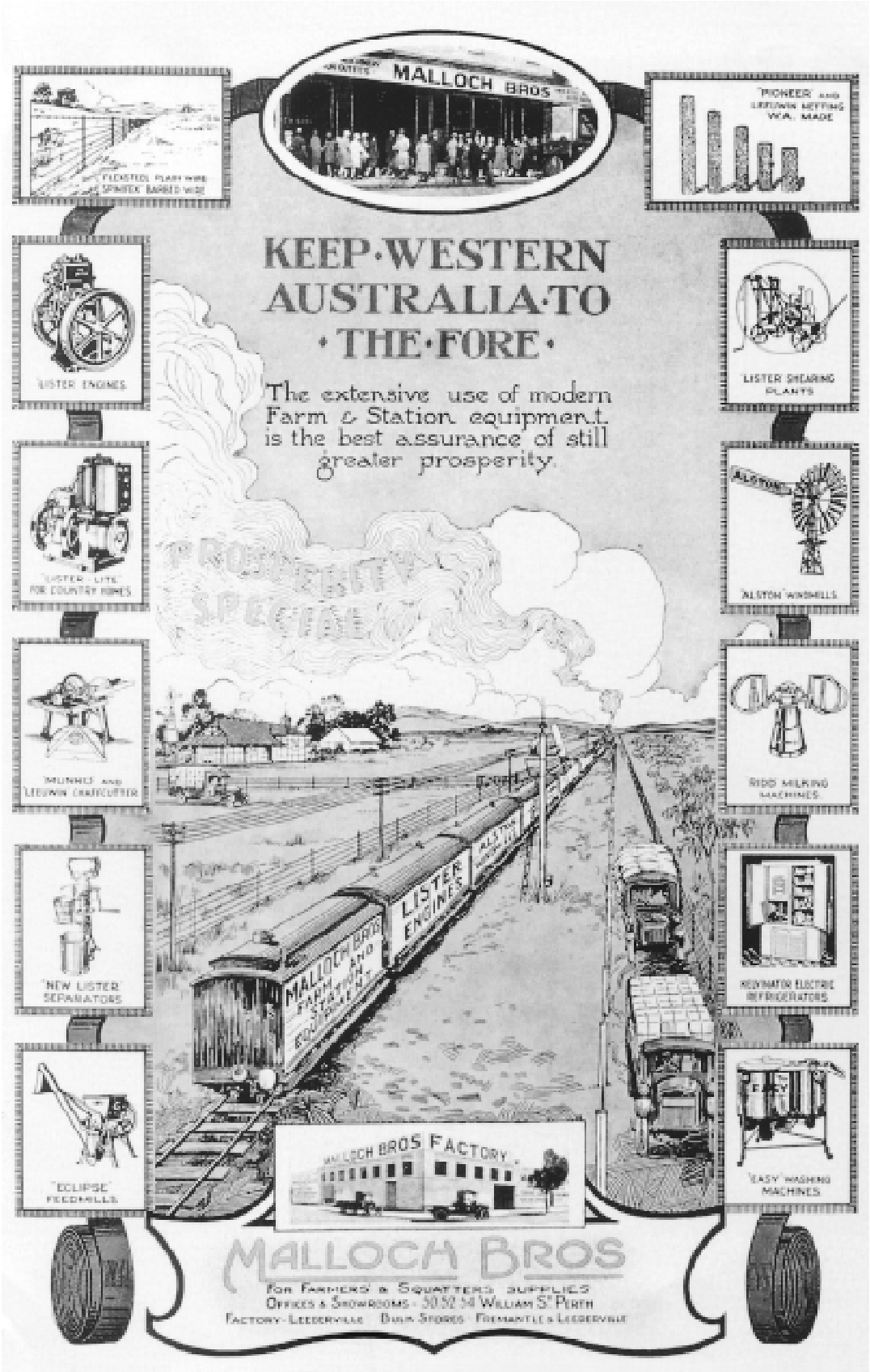
Throughout Australia, the dynamism of the cropland and grazing frontiers were exhibiting similar evidence of the dialogue between governments and families on the land. Drainage and irrigation continued the theme in Western Australia. Several projects were commenced in the south west under the *Land Drainage Act* of 1900. One ploy was simply to hasten the movement of flood waters into their natural drains, the rivers themselves, which were cleared ('desnagged') of trees and other impediments to expedite the drainage flow. Local initiative and responsibility received high priority, to the extent that the Public Works Department was often content to supervise work carried out by or for nine elected Drainage Boards. By 1921 the government was beginning to assume a more dominant role and the total number of local Boards had been reduced by one.

Flooding on the coastal plain would continue to cause more problems than these introductory forays could handle, and where the other unwelcome seasonal visitor was proving more amenable to small-scale irrigation, that success usually followed two or three frustrating decades of starts and stops.

In 1913, lobbying from south western settlers finally promised a genuine breakthrough. Hugh Oldham, Acting Engineer for Metropolitan and Agricultural Areas, drew up a list of 17 likely sites which could supply good volumes of water by gravity to about 40,000 hectares (100,000 acres) of irrigable land on the coastal plains. The government then selected the Harvey Agricultural Area for its first determined effort at sponsored irrigation, and it botched the job. The Harvey Dam, completed with high hopes in 1916, delivered water through open, unlined channels to a notoriously badly drained locality. The scheme was mauled by a Royal Commission in 1918. As predicted by locals and other critics, it had suffered expensive losses through seepage and repeated waterlogging following the disruption of drainage caused by the irrigation works. The very idea of distributing water through established, ungraded orchards should have been condemned at the start. In addition, the Commission noted that the WSSD had banked on the optimistic advice of its own fruit expert and on the work of its inexperienced engineering team, foolishly neglecting the glaring drainage problem and by-passing the prognoses of other experts, including those in the Department of Agriculture.

Floods and crop failures had been common around Harvey since the inception of intensive settlement in the early 1890s. According to Cooper (1979), in 1900 a Department of Agriculture report lamented that 'the settlers can do little more in the winter months than grow water cress and hope to become web-footed'. Over the next few years a 12 km main drain was

'West Australia Junior: The Child and His Heritage', from the* Western Mail Xmas Number 1921. *Note 'Xmas': the* Western Mail *adopted a very secular line on progress.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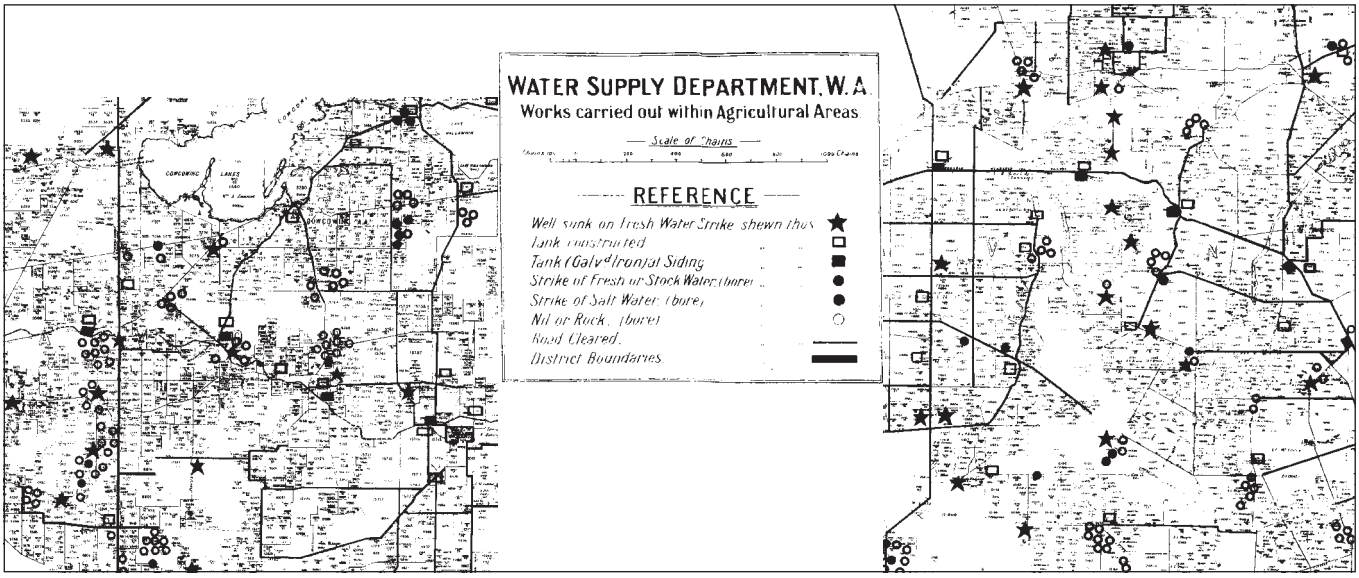
The ever-present water problem — this time near the mining settlement of Youanmi on the Murchison goldfield, possibly in the early 1930s. Camel power was used to draw from the well and then (lower) the same camel pulled the water-tank. Battye Library 60853P, 60854P.

constructed to speed flood water into the lower Harvey, and work on a suite of feeder drains became well advanced.

This focus on south western development had been sharpened by the opening of the Perth-Bunbury railway line in 1893, and the government's failure to integrate drainage and irrigation did not cancel out the region's attraction. During the early interwar years, plans to settle returned soldiers on Crown land and repurchased estates favoured the Harvey-Brunswick area. They were backed once again by bursts of interventions in the natural system.

'Compensating basins' were constructed in the hills to act as flood regulators, but after fresh appraisals they



Extracts from a Water Supply Department map locating work undertaken to shore up the wheat frontier (1912).

were employed for irrigation. Harvey's farmers were turning to irrigated dairy pastures and supplementary fodder crops, and they joined neighbouring settlers in an appeal for more irrigation supplies. The turning point came with the mixed blessings of the Depression, notably via bank advances for specified unemployment relief works in the area.

Irrigation projects were commenced for the Collie River and Waroona districts, and a Harvey River Diversion Drain sent the troublesome stream directly west to Myalup and into the sea. Oldham's old list was dusted off and several of his phantom dams were given substance; channels were progressively lined in concrete; paddocks were systematically graded; and struggling orchards continued to give way to irrigated dairy properties. Regional landscapes were clearly experiencing an accelerated metamorphosis.

Returning droughts in 1911 and 1914 had questioned the levels of popular and official confidence in the 'moist' south west, but runs of better seasons could normally be depended upon to restore the collective amnesia. Farmers who enjoyed good or reasonable profits over the first decade of this century tended to blot out the earlier dry years, and the process was repeated. The wheat belt expansions of the 1920s were partly underwritten by that familiar psychology and by special investment agreements connected with British immigration.

One consequence was that the frontier was driven well beyond a 'safe' rainfall limit mapped towards the end of the war by Surveyor-General F.S. Brockman. A number of contingent outcomes surfaced over the next few decades. Although government water managers were rapidly despatched in support of the farthest edges of new settlement, each farming family would be reminded that its own approach to rainfall management represented one of the most vital elements of any successful pioneering matrix. Crises brought by lower prices were intensified during the droughts of 1935–38 and 1940. The swiftly developed eastern margins of the wheatbelt came to be dubbed 'marginal', and the inevitable revision fostered farm amalgamations and switches to sheep grazing.

Between 1900 and 1950, the recorded number of rural holdings in the state increased by more than three-fold — although naturally, that simple statistic glosses over important fluctuations. Over the same period and employing essentially identical official sources, the total area cleared for farming purposes swelled by a factor of 14 to about 6.8 million hectares (16.8 million acres); the area reportedly sown to wheat (that is, excluding rotation-related lands in fallow) was increased 40 times over; and the total number of sheep rose to 11.4 million, just about five-fold.

And there was of course a wide spectrum of commensurately rising needs for water. How were these needs defined and met? This section has pointed to one answer: by means of uneasy, uneven,

Emigration, a field for British boys

The bush in all its beauty,
The wheat lands in their pride,
The forest in its freedom,
The sand plains far and wide —
They are waiting, waiting, waiting
With their struggles and their joys;
They are waiting to be conquered
At the hands of British boys.

Australia, land of promise,
A prize the wide world knows;
Is envied by her neighbours;
Is coveted by foes;
But she's waiting, waiting, waiting,
With her rich rewards and joys;
She is waiting to bestow them
On the heads of British boys …

Australia calls her kinsmen
Across the ocean blue:
'Come! Join us, boys of Britain!
Here's wealth for us and you.'
We are waiting, waiting, waiting.
Come! Share our toils and joys;
For the land that bred the Anzac
Is the land for British boys.

[Extracts from 'British Boys', by Lillian Wooster Greaves, reproduced with appropriate illustrations in the *Western Mail* Annual for 1926]

Michael Patrick Durack (1865–1950), son of pioneer pastoralist Patsy Durack and champion of northern development.

occasionally raucous negotiations between governments and people. Whether subsidiary or dominant, the water topic was an indispensable ingredient in the contemporary debates on 'progress' and 'development'.

The planning and un-planning of south western development continued to hold the spotlight in the 1940s, but it was not in exclusive occupation. Nor indeed did water resource concerns enjoy any monopoly in government circles or in the public mind.

Scientists and technologists had been explaining the need for a soil conservation programme and were testing methods to correct the trace element deficiencies of the ambiguously entitled 'light lands', a problem which still seemed quite weighty. In the far north, the Duracks, a family of great pastoral pioneers, had backed the development of the Kimberley, particularly the Ord River region, for irrigation; so had a promoter of Jewish refugee settlement.

Western Australian authorities had rejected a federal take-over bid for the entire northern section of the state lying above latitude 26° south, and at the time it had been vaguely understood that the decision entailed some renewed commitment to tropical development. Easier said than done, but war had a habit of exposing prevaricators. Director of Public Works Russell Dumas prepared a reassuring report on the Ord's likely dam prospects, and a research base was started at a site that would become the project township of Kununurra.

Most of the rest of the designatedly 'useful' areas of Western Australia remained the province of pastoralists. In the period under review they were to be served by an impressive feat of bushmanship by the surveyor Bill Canning. He is credited with identifying, provisioning and later rehabilitating Australia's longest stock-route, over which Kimberley cattle could be driven 1400 km (870 miles) to a railhead.

But pride of place must be given here to a 1946 proposal for a *Comprehensive Water Supply Scheme* — notice the revival of the old term — which sought to take advantage of nation-wide plans for 'Reconstruction' after World War II. By contemporary international standards, the scale of this project was breathtaking. The area it encompassed was larger than that of either of the national territories of Denmark, Switzerland or the Netherlands, or more than twice that of Israel or Wales. Alternatively, it was the equivalent of 60 per cent of Scotland's national space.

Such coarse comparisons are only worth citing because they were then accruing a strange mystique in the west. The total population of the state was then only about half a million, and it has to be remembered that westerners were being urged to ponder the fact that they claimed stewardship of a third of a continent.

Basically, this resilient sub-plot had crystallized from the interactions between governments and pioneer settlers in the west since 1829, but a fundamentally similar dialogue had been echoing around Australia and the late addition of federal participants enlivened the exchanges. In the most limiting of practical senses, the proximate source of the new scheme was

Canning the Outback

In 1906 government surveyor Alfred Wernam Canning (1860–1936) was despatched to under-explored country between Wiluna and Halls Creek. His objective was to determine its potential for overlanding cattle from the Kimberley to the southern regions, including the goldfields. Canning had already established a formidable reputation for long-distance Outback treks, following a three-year survey of the state's 1900 km (1175 miles) rabbit-proof fence.

Leaving Wiluna on 29 May 1906, he reached Halls Creek on 29 October without loss of men or camels, and his optimistic report convinced his superiors to send him back to equip the route. Returning with H.S. Trotman, he completed his gargantuan task in 1910 after sinking 52 wells (a number acknowledged to be 'native wells'), but the route fell into disrepair and was virtually abandoned. In 1929 he accepted a government invitation to go back to rehabilitate the run-down wells. The *Canning Stock Route* was in use until the late 1950s, when it was superseded by road transport.

the conscription of local expedients to secure the wheat belt, but the beguiling embroideries of state-federal relationships soon became pivotal. For example, in 1939 at an Interstate Conference on Water Supply held in Sydney, unanimous approval was given to this fossicking resolution:

> That this Conference is of the opinion that there are a number of schemes of water conservation, supply, irrigation, and hydro-electricity in certain States which are beyond the financial resources of such States, and recommends that the question of financial assistance from the Commonwealth on a basis to be determined by negotiation should be discussed at a subsequent Conference to be held with the Commonwealth representatives.

The war kept the Commonwealth and State governments fully occupied until 1945, but Canberra's influential Rural Reconstruction Commission was already broadcasting the views of its panel of experts. In its *First Report* (January 1944), the Commission observed that 'In the broad view of future agricultural development in Australia, irrigation and water supply must take a prominent place'. From the national perspective, irrigation projects could be said to have proven their value, and indeed it was held that under Australian conditions, even the supplementary irrigation of 10 per cent of a holding would significantly improve its viability. The *Report* ventured beyond that —

> As population increases the need for more irrigation will also increase and it is not too much to say that *in the long run water supply will be the limiting factor in Australian expansion. Australian agriculture will in time need all the water which it is possible to conserve.*

That unguarded statement was a godsend to harassed water managers, and westerners returned it in full measure in an appeal for Commonwealth funding. Furthermore, it must have been grasped that the appeal could also build upon a lingering ambivalence towards federation

Sir Russell Dumas (1887–1975), one of Western Australia's most distinguished engineers in public service. He was associated with the Public Works Department, the Metropolitan Water Supply, Sewerage and Drainage Department, the Ord River Project, the Comprehensive Agricultural Areas Water Supply Scheme and the Kwinana development.

Top: Scrub roller in the new wheat belt, c.1919; Battye Library 653B/2.

Lower: A similar contraption, 1914; Battye Library 51222P.

in the west — revealing arguments for secession had been made in the 1930s — and the political tuning-forks in Canberra had to take that into account.

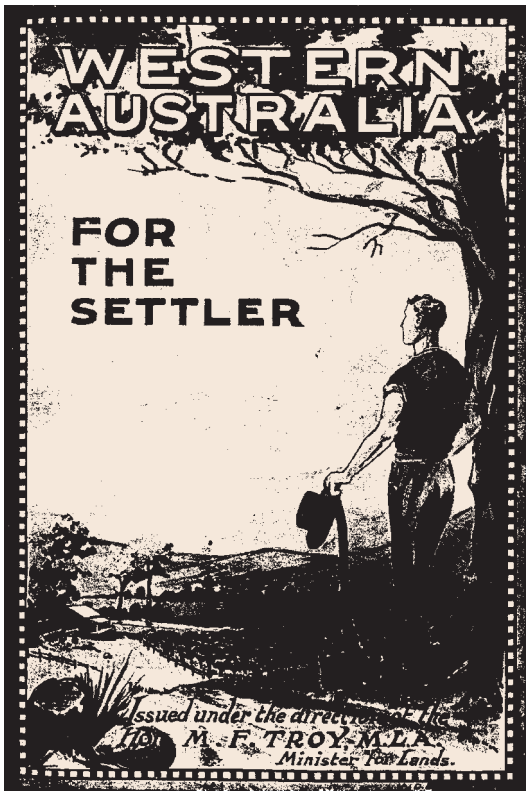
Although they would be eroded by over-use in succeeding decades, a number of the other props must have looked rock-solid in 1946: the critical and lasting value, national and state, of primary industries; a general strategic need to ensure a degree of dispersion or decentralization of the population; the particular need to develop safer water supplies away from the coast to prepare for wartime evacuations; and a yearning to tackle the embarrassing old discrepancies in basic living standards between Australia's rural and provincial regions and the capital cities.

The proposal, put in January 1946 by Minister for Water Supply A.R.G. Hawke, envisaged an augmented system based on pumping from the overworked Mundaring Weir–Goldfields Scheme and the Wellington Dam on the Collie River. It would serve farms and 35 townships. The wedge of land under consideration was enclosed by a line running in the west from Dalwallinu to Broomehill and Borden, through Northam, Beverley and Kojonup, and a second line from Dalwallinu through Merriden, Narembeen, Kondinin and Borden again, in the east. Both the Mundaring Weir and the

Wellington Dam would be raised, thereby increasing storage capacities by greater than three and about five times, respectively.

An honourable objective, no less so for its insertion at the end of the outline summary, was to 'provide a water supply service at the boundary of every holding'. Data on additional service reservoirs, improved pumping stations and other works were built in. Due emphasis was given to the needs of the gold-mining industry and the disadvantaged residents of the northern 2.4 million ha (6 million acres) of the 4.7 million ha (11.6 million acres) block under discussion.

The Commonwealth called in its appraisers. They mainly took note of economic, engineering, environmental and social factors, and on those grounds seemed persuaded by the plight of this northern sector. But they were only inclined to support improved supplies for the little townships, not the farms, in the long tongue of country extending from Northam through Beverley and down to Narrogin, Broomehill and Borden. They opined that parts of the wheat belt had been handicapped by low rainfall, high salt levels in the soil, and generally poor prospects for water storage. Extended reticulation might indeed offer the kind of 'water security' promised in the Western Australian document. That was the view. Reticulation was hardly an answer to the salting, of course, but that observation was not made — nor was the slip pursued.




WESTERN AUSTRALIA,

THE LAND OF GOLDEN OPPORTUNITY

FOR

EMIGRANTS. — EMIGRANTS.

EXCEPTIONAL FACILITIES OFFERED.

VAST AND FERTILE TERRITORY.

"There is a tide in the affairs of men, which, taken at the flood, leads on to fortune."—Shakespeare.

Napoleon Bonaparte's ideal of each individual being his own LANDLORD still fascinates, and the Nation's prosperity may be gauged by such a policy.

AVOID THE VISIONARY, BUT DO NOT NEGLECT SOLID FACTS.

OUR ENTENTE CORDIALE EXTENDS TO DESIRABLE SETTLERS.

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160 ACRES AS A HOMESTEAD FARM FOR £1. NO RENT.

1,000 Acres under RESIDENCE, from 10s. per acre upwards, 20 years' terms for payment.
A further 1,000 Acres under NON-RESIDENCE Conditions at similar rates.
GRAZING LANDS at from 3s. 9d. per acre.
GARDEN BLOCKS of from 5 to 50 Acres, at £1 per acre, payable in three years.

EASY CONDITIONS OF IMPROVEMENT.

HALF COST OF SURVEY PAID BY STATE.

FEE SIMPLE Granted if all Conditions are Complied with.

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FULL PARTICULARS MAY BE OBTAINED FROM

The AGENT-GENERAL for Western Australia, 15 Victoria Street, Westminster, London, and Under Secretary for Lands, Perth, Western Australia.

A modified proposal submitted in October 1946 was tailored to the Commonwealth's findings on intra-regional priorities. The revised estimated cost was £4.3 million, to be shared equally between the two governments. The total area included in the revised project was 1.7 million ha (4.1 million acres) and the total population to be served was reduced from 56,700 to 32,700. Yet the exhilarating first proposal retained its hold in the west. It would bounce back.

Felling a Karri tree — or, by modern environmentalist accounts, (the deceit of) pride before the (real) fall.

Development Imperative, 1950–1980

A state on the move

Against the vast backdrop of sun and space, West Australians are planning and working for big developments. Progress in the West to-day flows directly from the spirit and enthusiasm of the people, and from a most fruitful partnership between private enterprise and Government. West Australians have encouraged initiative. They have welcomed private capital. And their resources have been virtually doubled by stimulating the in-flow of private funds. They recognize that this is of vital importance in a huge State with limited population, limited financial resources — but unlimited natural resources. They see it as a national duty to accelerate the progress of this region, thereby creating a better balance between the development of Australia's east and west.

Of all the Australian people, West Australians are probably the most keenly aware that, with world population rising at tremendous speed, the empty regions of Australia must be developed in order to hold them. They are deeply conscious of a fundamental change in the centre of gravity of world affairs. They recognize that the Pacific Ocean and the Atlantic Ocean have been the two big sea masses on which important nations of the world have been based. Across these oceans most of the world's goods have been transported. But to-day, West Australians recognize a newcomer — the Indian Ocean, with the greatest market potential and the greatest political significance in history. More than 1,500 million people live within the orbit of the Indian Ocean, on which Western Australia is strategically located. By the end of this century, the number of people living within that orbit will have doubled. The strategic location of the West is therefore considered one of its major 'natural resources'— giving it an outstanding advantage for the development of trade with Asia and Africa. For this reason, Western Australia is encouraging rapid development in every field.

[Wieck, 1962]

It is not unreasonable to argue that in the long run the population which Australia can support will be limited by the available water.

[Munro, 1974]

III

Development Imperative, 1950–1980

War and Depression had generally strengthened the role of government in Australian affairs. In addition, even in Western Australia where sparky resistance could still be guaranteed, these crises reinforced a trend towards national integration.

Cat and mouse, the Commonwealth's champions promoted federally-co-ordinated national policies and the states manoeuvred to maintain their own agendas. As discussed in our earlier sections, Western Australian governments identified opportunities for enhanced regional development in the reports of Canberra's Rural Reconstruction Commission. The Commissioners' advocacy of increased investment in irrigation, water conservation and land drainage (in their eighth report, dated 11 December, 1945) could not fail to inspire confidence. Given the shared *frisson* of the recent Armistice, their pronouncements were bound to be interpreted as invitations —

> In the event of a real population pressure developing in Australia, circumstances would easily arise under which the development of the continent would ultimately depend upon the wisdom of the national policy in respect to water. *In this, the driest of the continents, the conservation and development of water resources should be an important item in national policy at all stages.*

Half-disguised issues of internal 'preparedness' were now linked moralistically, and more than ever before, to the belief that it was Australia's distinctive duty to supply food and fibre to a crowding world. Those sentiments helped to fuel an explosive growth in new water undertakings around the nation, beginning with the iconic Snowy Mountains Scheme in the south eastern States. Queensland's Burdekin Scheme is another example. For Western Australia it is the Ord River Project. As earlier discussions have shown, however, interpretations of the water management experience should not be confined to initiatory roles. It was also a consequence or close attendant of separately instigated pioneering in industrial and urban expansion.

The following north-south trek elaborates on these remarks and continues our exploration of the inter-relationships between water, land and community in the story of regional development.

EDNA and Ord

The history of the Ord River Project in the Kimberley is reasonably well pitched in the context of a compulsive nationalistic and imperialistic attention to the economic development of Northern Australia — unkindly labelled the 'EDNA' syndrome. Zealots might argue that flirtation with EDNA is as old as European settlement in the west. That may be so, but some of the most ardent declarations reverberated through the interwar years, and they were linked to a number of speculative proposals in the 1930s. These notions envisaged targeted investment and immigration from Britain and Europe, a range of private and public enterprise controls, the settlement of a community of returned soldiers, and the creation of new colonies, including a plan for the settlement of Jewish refugees.

As we have seen, the Western Australian government moved more cautiously into the Kimberley in the early 1940s. Its preliminary field inspections and research analyses were noted in the eighth report (1945) of the Rural Reconstruction Commission. Deliberations of this senior body could promote, retard or halt momentum in several spheres, and the following extended analysis is warranted on that score alone. There is another justification. The Ord Project would be pilloried in subsequent decades, when casual apportioning of praise and culpability betrayed a dearth of historical context, a conjuring of selective Altzheimerism.

The Commissioners were conscious of the prevailing ignorance about the chances for irrigation in the far north, and lamented the absence of international benchmarks: while established British and French ventures in the Sudan, for example, dealt with a broadly similar climate, that hardly carried over into the specific environmental, social and political parameters. The Ord nevertheless suggested good prospects for a serious trial of large-scale tropical irrigation.

The Commissioners also felt obliged to cite useful precedents for state-federal partnership in giant water projects: in Australia, the co-operative management of the River Murray offered the obvious reference — albeit sadly and rather oddly taken-for-granted; and in the United States, a 'much advertised' come-lately Tennessee Valley Authority had been attracting international interest.

Enormous difficulties were presented by the Kimberley's long dry summers and by the irregular incidence and quantity of its monsoon rains. Under existing technologies, freakishly high evaporation rates ruled out dryland (or non-irrigated) agriculture focussing on valuable commercial crops. Rainfall and temperature peaks in December–March produced a discomfort level that was considered virtually prohibitive for 'European' (i.e. white) labourers. The report mentioned a £1.5 million proposal then before the Western Australian government. The intention was to insert a multiple-purpose reservoir to provide irrigation facilities and hydro-electricity for new farms and industries; western soil experts had already advised that 26,000 ha (65,000 acres) were irrigable. An established deep-water harbour (at Wyndham) was perceived to be one advantage, and the region's relative proximity to Asia was mainly viewed in its problematical strategic context and only secondarily in the light of exciting economic prospects.

Experience taught that resolutions of project 'feasibility' might turn on

Dithering with EDNA

Most Australians realize that the emptiness and primitive stage of development which characterize the north of Australia are a reproach in the eyes of the world. It is known that much of this area has many disadvantages from both agricultural and sociological aspects, but these are in fact the normal problems of such regions and Australia has made few and relatively insignificant attempts to solve them … *Australia would be in a much better position to face the assembled nations in conference if she were able to state unequivocally that she was committed to a scheme of this kind as a genuine endeavour to utilise the empty North.*

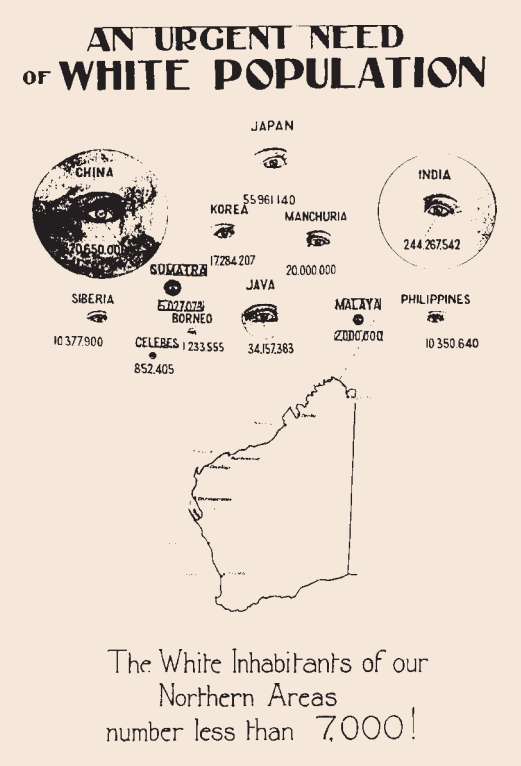
On the other hand the defence aspect of future developments in Northern Australia is of significance in this matter. The very emptiness of this region constituted an obstacle to attack from outside during the recent war, and was possibly its main safeguard.

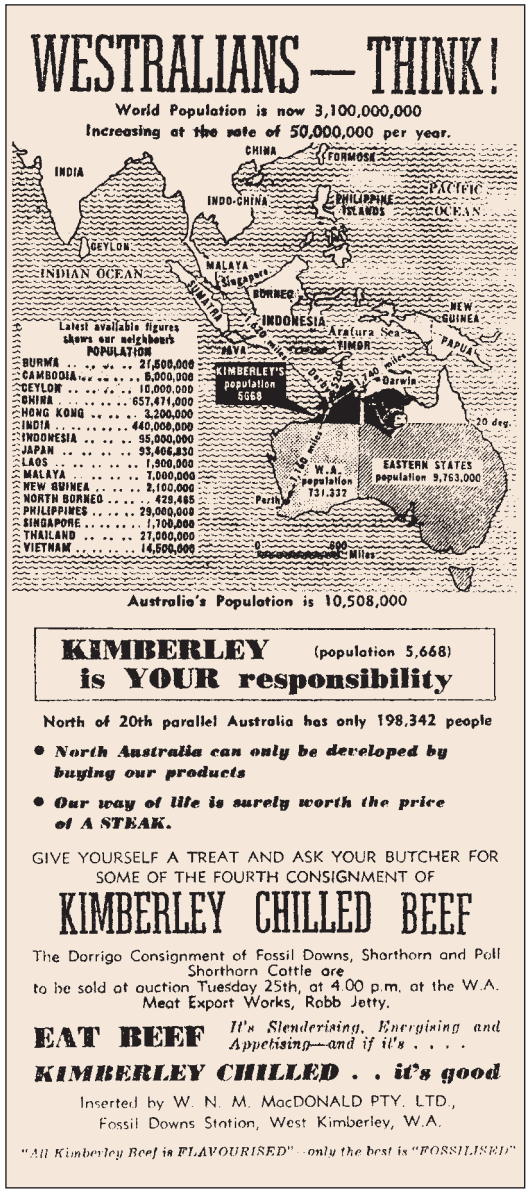
[Eighth Report, Rural Reconstruction Commission, 1945, p. 59]

6

Left: A geography of paranoia: the Near North and the Western Third. From Stuart, 1923.

Right: Near and Nearer Norths, from the West Australian, *24 September 1962.*





orchestrating rather than on reconciling assorted engineering, scientific and economic calculations. In this case, as well as being mutually responsive, these formulations had not progressed beyond the novitiate or hopeful stage: there was still a clutter of elusive 'preliminary' analyses.

In 1945 the leading questions roared too loudly to require any special underlining from the federal Commissioners. What to grow? How to dispose of the produce at commercial rates of return? The Commissioners plumped for fuzzy answers, which was about par for the time.

> Many types of vegetable crops and tropical fruits could be grown but the markets open to them would be mostly local and therefore very limited, unless the mining industry developed anew or some secondary industry formed an economic location in this part of Australia. Rice and certain other grain crops could be produced if there were reason for expanding their production.

Australia's rice production was then concentrated in the south east, in the Murrumbidgee Irrigation Area, and combined economic and environmental costs might recommend a gradual transfer to the Ord. Cotton had been touted for the Kimberley before World War I, and its candidature was still strong, but the Commissioners were wary of its notorious susceptibility to pests and world market fluctuations. That seemed to leave them with a clear option, a retreat to one of the more familiar *raisons d'être* of water schemes in remote locations: '*The use of the area in conjunction with the cattle industry seems to offer most promise*' — chiefly by means of large irrigated fodder reserves and supplementary grazing blocks, managed in tandem with the Wyndham meat works to 'top off' or 'finish' the region's beef cattle.

Mumbling ifs and buts and maybes, the

Commissioners gave the Ord proposal a small tick. Their provisos included further advice from Defence authorities, dam engineers and soil scientists, and the dispatch of Australian agronomists to North Africa. There was less buck-passing over the need to advance applied research activities in the region, but it seemed to be thought that enigmatic strategic considerations would ultimately hold the key: 'Those responsible for national planning must decide whether the development of Northern Australia by this and similar projects is purely an internal business matter or whether the element of national defence enters into it.'

One needs to peel away the deceiving insulation of two generations of dizzy change to appreciate these preoccupations. It was one thing to bear arms in a European war half a world away, and quite another to contemplate similar engagements much closer to home — in what Australians were being schooled to call their 'Near North'. Subsequent events built a forceful argument for a re-evaluation of tropical Australia. In the public mind, upheavals in China, Indonesia, the Malayan and Korean peninsulas, Vietnam and neighbouring territories would be added to the shocking record of Japanese belligerence — and naturally, many Western Australians, Queenslanders and Northern Territorians felt entitled to point to a very adjacent regional focus of anxiety.

Much of the sparring, prevarication and well-meaning confusion of the 1940s and 1950s was probably inescapable in an evolving federal system. But the Ord chapter would become a saga rather than a growing pain. In February 1949 it was moved beyond the gleam-in-the-eye stage. The federal government was asked to provide financial assistance for a mixed, £4.3 million livestock and cropping proposal which quietly comprised a scheme for the Ord. Canberra only agreed to co-operate in the provision of improved road and watering services.

A joint (Western Australian-Commonwealth) Kimberley Development Committee was appointed to report on the potential development of the state's northern sector. Its recommendations backed increased research and experimentation. Further representations were made over the next few years, and in 1956 the state produced a new submission focussed on the Ord and costed at £11.5 million — 'a charge against a national effort to encourage settlement in our northern areas.' The strongest response from Canberra came in 1957 in the form of a £2.5 million grant for development programmes above latitude 20° south; the conditions called for specific proposals.

This gesture was often ridiculed as puny in the west, and it netted only a few submissions for harbour works and transport facilities. But the wider issue of northern development was being exploited in federal electioneering, and a bidding war between the competing political parties produced the customary extravagant promises. The successful campaign of the Menzies conservative coalition had promised a doubling of its first grant, and interest in the Ord had been drummed up by western newspapers, but the Western Australian government was still to prepare attractive and plausible proposals.

Even its modest applications under the initial grant now seemed less persuasive and therefore, according to Graham-Taylor's (1988) provocative account, a firmer Ord proposal represented the only chance if the leading objective was to prise the full £5 million from Canberra's grasp before the expiry date of 30 June 1963. Perhaps Graham-Taylor is a little unkind to western decision-makers. Though admittedly imperfectly understood, the Ord remained the better researched option and in the prevailing climate the alternative of 'missed opportunity' was on the whole politically unpalatable in the west. Canberra was under no obligation to supply ignition.

Menzies Pilates the Ord

… this is, after all, your business'

If we were spending the money ourselves and of our own choice, we would, I think, like to have a good deal more information as to the problems of transport and marketing. It is one thing to feel reasonably satisfied that certain commodities can be grown under irrigation. It is, of course, quite another to determine whether they can be profitably grown. But we have come to the conclusion that this is, after all, your business. You have the immediate responsibility for developments in your state; we have esteemed it our duty to provide some financial assistance.

[R.G. Menzies to Premier David Brand, 24 August 1959]

Frontline experience: Court *versus* Davidson, 1963

'North-West Minister Court said yesterday that ill-informed critics with a short-term outlook would not deter the Government from the task of developing the North.

He was replying to criticism of the Ord River project by Dr B.R. Davidson, a visiting lecturer in agricultural economics at the W.A. University.

Mr Court said Dr Davidson was apparently a member of a small band of politicians and economists who believed in a Melbourne-Sydney economic axis.

Dr Davidson had displayed dangerously defeatist thinking and had been seriously misleading in his references to estimated crop yields on the Ord.

Backroom theories were no substitute for front-line experience or the pioneering spirit that conquered problems instead of backing away from them.

With advice like Dr Davidson's, W.A.'s wheatbelt would still be awaiting development.

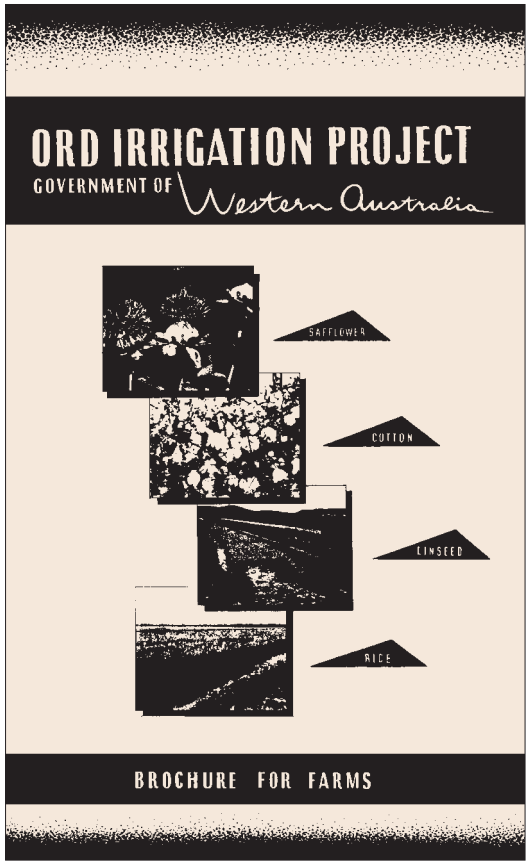
N.G. Case

Dr Davidson's two main lines of criticism — defence and economics — had been based on fallacies.

He had said that Northern development was not justified on grounds of defence because invaders would prefer to take over developed areas — but this had not been true of undeveloped West New Guinea.

"Here, as in other aspects, Dr Davidson's theories rest on a flimsy material base." Mr Court said. "He ignores the fact that world opinion will find us morally unjustified in holding the North if we do not use it …"'

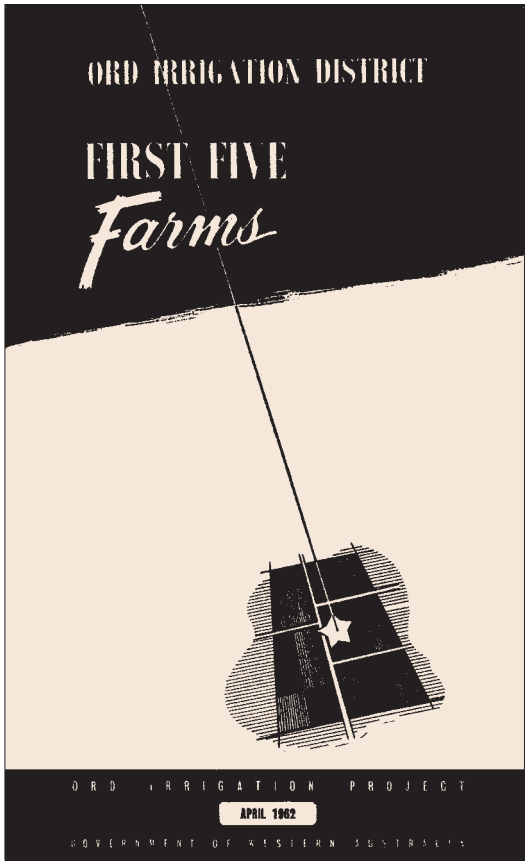
[— And Davidson was also said to be hopelessly out on the question of cotton yields and returns; from the *West Australian*, 19 October 1963]



A request for approval of an Ord Scheme was made in August, 1959. Robert Menzies had been reasonably well advised, but his costly Pontius Pilate response — 'it is, after all, your business' — would echo down the years. The west's proposal concentrated funding on the construction of a diversion dam and on preparations for the arrival of the initial group of farmers. The dam was ready in July 1963; the first five settlers were chosen in April 1962 and by 1965 30 subdivisions had been allocated under the opening stage of the scheme. The approximate total cost of this phase, including the preparation of the farms and the building of the new town of Kununurra, was £8 million.

No confident solution had been reached on the question of selecting commercially and agriculturally viable crops. Pencilled in, as it were, as participants in a research exercise which should have been a *precursor* to their investment, the pioneers struggled with pests, weeds, isolation and high aspirations — both their own and those of a large fraction of the national population: state boundaries were being transcended by armchair frontiering. The availability of a generous federal cotton bounty influenced western authorities to recommend that crop to the new farming community. There were problems with the determination of appropriate subdivisional arrangements and land grading standards for irrigation and drainage, and pest control amplified the financial and psychological load.

Concurrently, the state government forged ahead with a request for further Commonwealth assistance to complete the project. It argued that the planned main dam would protect the existing diversion dam from floods and silting; that cotton, linseed, sugar cane, rice and safflower were 'proven' suitable; that cropping would stimulate the regional livestock industry; and that the scheme would 'generate a



All Ords: project evaluation, 1964

If from a national public point of view it is considered —

a) that most Asian countries are frustrated in reaching their social ideals by economic problems;
b) and that aggression originates ultimately in response to some frustration …

then the inevitable conclusion is that Australia has to do all it can to prevent those countries from having the obvious argument: 'If you Australians do not use those natural resources, why can't we use them for our increasing and hungry population?'

There is a strengthening belief that something has to be done to counter the possible claims of the over-populating Asian countries to the usable but unused land in the North of Australia; a development of the usable land by an irrigation scheme such as that proposed for the Ord River would do something to counter those possible claims.

[From the abstracted report on Secondary Benefits contributed by C.A. Cannegieter, as presented in *Ord Irrigation Project … A Case for Financial Assistance*, February 1964, p. 29]

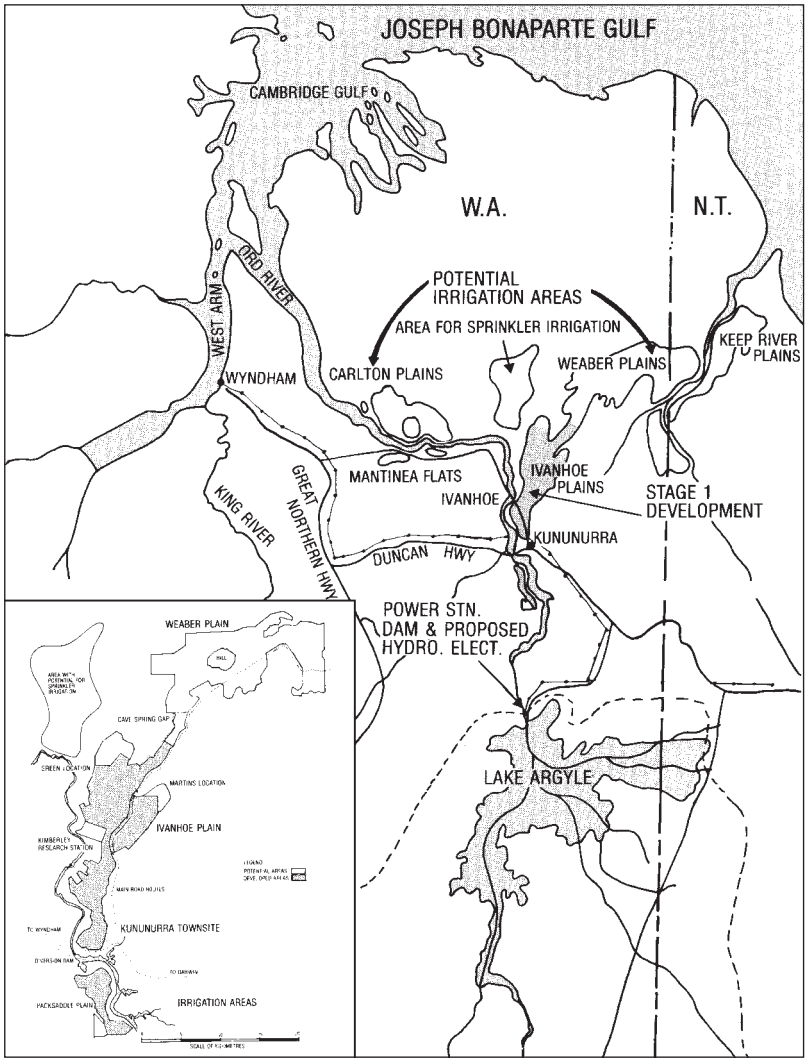
stable population of from 10,000 to 20,000'. Modest beginnings in a remote corner of the continent were readily broadcast as prefigurements of an incremental exploitation of state-federal relationships, and lively discussion ensued after the new case was submitted in February 1964.

Although they frequently wavered, successive Western Australian governments repeatedly subsidized and re-launched the phantom vessel, and withstood every rebuff from its only possible sponsor. Cotton and beef continued to provide the main hopes, and astute lobbying from the west would soon ensure a three-year extension of the cotton bounty after its intended expiry with the 1968 harvest.

Like so many other big ventures in this era of intoxicating developmentalism, the Ord Project was partly the product of a collective act of faith and mightily assisted by its energetic espousal by a pugnaciously determined state politician. Victoria had Sir Henry Bolte. In Western Australia the larger-than-life champion was Sir Charles Court, centrally placed as Minister for North-West and Public Works from 1949 to 1971, and later as State Premier.

On 1 November 1967 the federal government agreed to approve financial assistance worth over £48 million, roughly evenly divided between a loan and a non-repayable grant. Critics continued to point cynically to poor economics, political cowardice and opportunism — northern development had become a crucial election issue — but economic rationalism had yet to achieve sacrosanct status and related attempts to debunk 'alarmist' concerns about regional security failed to make a dent.

By 1971 estimates claimed that the project had swallowed $40 million and that a further $34 million would be needed. The main dam was ready for commissioning in June 1972. Cotton yields and market prices began to disappoint and resistances to DDT and other standard applications meant that insect control measures could account for about half of each farmer's total costs. Beef



From the undated promotional pamphlet,* Ord River Irrigation Area. Kununurra, Western Australia, *published by the Western Australian Department of Agriculture and the CSIRO.

Hanging by a thread … cotton on the Ord, 1963–76

Season	Total area cropped (ha)	Area under cotton (ha)	% under cotton
1963/64	1,344	752	56
1967/68	5,538	4,849	88
1971/72	5,785	3,888	67
1975/76	3,361	nil	nil

Source:
Ord River Irrigation Area Review, 1978

Argument for the Drys: B.R. Davidson, 1969

Irrigation is only one means of increasing agricultural production. Better varieties of crops, new and improved types of fertiliser and insecticides have caused the yields of crops to increase rapidly in recent decades. Better strains of livestock and animal husbandry practices have increased the output of meat, milk and wool, and new pasture species have enabled larger numbers of livestock to be carried on the same area of land. Between 1947 and 1967 Australia's agricultural output increased by 93 per cent; the additional output from Irrigation Schemes contributed merely 13 per cent of this increase…

[*Australia Wet or Dry?*, p. 2]

and sorghum also looked less promising, the crippling handicap of high freight charges for relatively small volumes was at last conceded, and the Ord's new pioneers complained of poor co-ordination between on-again, off-again state and federal authorities.

Prospects brightened again in the later 1970s with reportedly better solutions to the insect problem; improved bulk handling facilities; the steady replacement of cotton by a diverse range of crops including multi-purpose sugar cane (its potential uses included ethanol, pulp and paper), rice, hay and fodder grains, fruit and vegetables; plans for a hydro-electric scheme to serve the far north and north-west; and local resurgence in the mining industry.

At 30 June 1978 public expenditure on the project was fast approaching $100 million. Only six farmers remained, and they were said to be battling hard. As for the predicted spin-offs or 'multiplier effects', there had been no appreciable boost, and the wider region remained sparsely inhabited. And yet a pulse was still discernible. The vision was now emphatically national: no parochial outlier, but rather a very nerve-end, the Ord had become fixed in our geographical imagination. When it is not moving mountains, faith can make a good fist of resuscitating frontier-style expectations in a shrinking world.

Environmental Problems and Opportunities

Hi-ball 'dozer clearing Jarrah in the Denmark area, 1952; Battye Library 51213P.

The Ord example is representative of a number of initiatives taken by Australia's postwar governments to stimulate the development of selected regions. Typically, the approach favoured a concentration of investment in certain localities and enterprises, and usually entailed reinforcements or modifications according to reviews of progress. Alternatively, scatter-gun policies simply sprayed government largesse hither and yon, except when catering to localized pork-barrelling, and Western Australia was not spared those practices either.

From another perspective, the 'seeding' philosophy illustrated in the Ord exercise underlined both tradition and innovation. It shows three historical strands: i) an elaboration of the trial-and-error procedures common to settlement expansion since the early nineteenth century — witness the implicit acknowledgment of the role of field testing by pioneer families; ii) manipulations, over three decades, of the dialogue between federal and state partners; and iii) the growing significance of scientific and social scientific contributions. In nominating *environmental problems and opportunities* as the heading of this section, my intention is to bring together various facets of the water story under a single theme. It picks up the same three strands and finds that this conveniently stereotyped developmental era was actually the opposite of uni-dimensional.

The commentary opens with a sketch of the overshadowed contribution of water management to a fresh mining boom which commenced in the early 1950s. It proceeds with an outline of the subtly supportive role of water management in three other aspects of development history: the retention and elaboration of the great farming belts; the foundations of rapid suburban and industrial expansion in the Perth metropolitan district; and the recognition and remediation of land and water degradation.

7

Man taming the earth: from an advertisement in the* Western Mail, *1950

Consolidating the Farming Frontiers

The most evangelical of its postwar champions were inclined to elevate water as the *sine qua non* of regional and indeed of national development. They sidestepped or failed to appreciate the complexities of the development process. In the twentieth century the most vital resources have proven to be human needs, ingenuities and investment capacity, and even in the driest of the inhabited continents the importance of the water element could be exaggerated by unqualified references to the effects of its managed application to subhumid tracts. As the proponents of economic rationalism flushed out by the Ord venture declared with vehemence, the great northern effort might have turned a better profit elsewhere.

Prodigious water investments in the drier areas might be neglecting authentic environmental ones: rather than enforcing expensive interventions in poorly understood ecological conditions, it might be better to devise closer adaptations of the imported production systems. But the development imperative had appeared in so many guises: it was an effective transmitter of the sonorous claims of national security; it barracked for the can-do of gung-ho modern engineering; and it buzzed with all the whisperings of a collective conscience which was sincerely confused about 'wasted' opportunities — and especially about 'empty' or even emptyish space. And certainly, the development imperative resonated with unusual effect in Western Australia.

Yet in the cultivation and livestock farming sectors, progress over these 30 years depended more often on consolidating old gains than on pushing out the settlement frontiers. It reflected a host of refinements — better crop and grass varieties; improved rotations, strains of livestock and types of fertilizer; more effective clearing, cultivation and harvesting equipment and practices; the discovery and correction of trace element deficiencies, especially in lighter soils; more efficient handling and transportation facilities; greater resort to pesticides, herbicides and weedicides; and a growing if still insufficient recognition of conservation values and approaches.

Water management's conspicuous role should not be divorced from this wider context of change. The following discussion is confined to a few broad and specific contributions.

First, the Modified Comprehensive Water Supply Scheme was completed in 1961–62 at an estimated total cost of £10,270,000, £5 million of which came from the Commonwealth. A case was made in 1960 for extensions which would take the coverage up to the original 1946 boundaries. The estimated cost was £17,484,000, for a total area of approximately three million ha (7,600,000 acres). Canberra sent off another rejection slip and the state government allocated £50,000 annually to connect the worst-off townships to the existing mains. Among the first to benefit were residents of Ballidu, Dalwallinu, Kojonup and Pithara. A reduced version was approved in 1965 for 1.5 million ha (3.7 million acres) of farmland and country towns, and over the next three decades similar state-federal negotiations produced a pattern of supply which resembled the hopeful 1946 picture.

The documents accompanying the

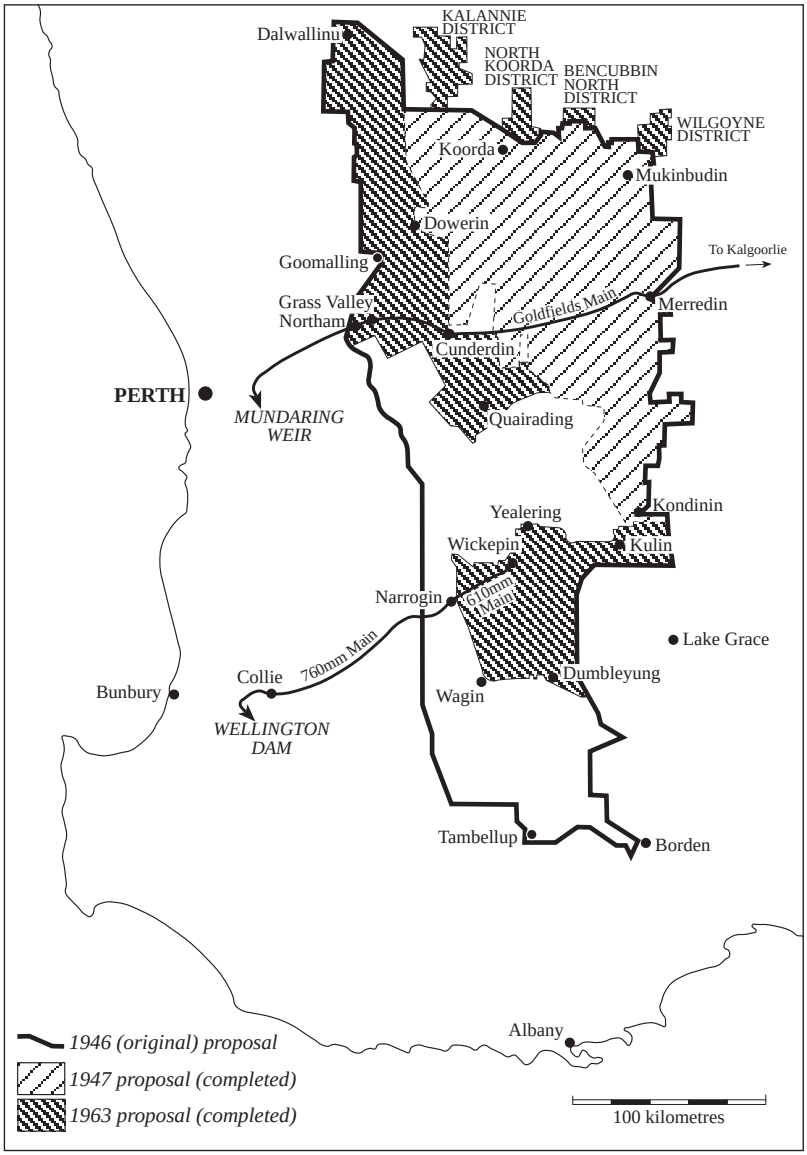
submissions acknowledge the function of this governmental partnership in promoting a logical sequence of settlement, from the partial dependency of trial-and-error pioneering to a phase of self-reliance via the current *stage*, 'which really amounts to development and consolidation of the areas which have proved capable of cultivation and closer settlement.' While begging questions about the allocation of responsibility for regional testing between settlers and government advisers, it implied an engagement in *planning* and that was more pertinent. Serious loan applications are considered stiffened by such whiffs of reasoned action. If the uncited historical record lent only a little substance, no matter.

But for today's readers, the submissions themselves do allow authentic glimpses of the detailed texture of support already funded. What was largely required in the 1960s, apparently, was a move towards a stable or mature 'stage' marked by civilized amenities for rural families, together with further safeguards from dry season traumas for the increased numbers of stock.

The scope of change — a justification of new assistance — was generally indicated by statistics relating to the amount of land cleared in the wheat belt as a whole: the total of 5.3 million ha (13 million acres) in 1946 had grown to 9.3 million (23 million acres) in 1959; similarly, in the project region sheep numbers had increased by 77 per cent to 3.2 million. There were about 600 government-constructed water tanks throughout the state in the late 1950s, including 150 in the Scheme Area. Most were small affairs, harvesting natural rainfalls and usually uncovered — and therefore subject to the sorts of dependency they were intended to combat. Boring and well sinking had disappointed many farmers, and while enterprising 'artificial' catchments had challenged the contemporary limits of ingenuity, they suffered from the same disadvantages as the more orthodox facilities.

The artificial types were represented by two curiously labelled categories. *Bitumen catchments* were simply consolidated earth catchments which had been sealed with a bituminous mixture. Efficient but expensive (£1,200–£1,500 per acre), some were employed for country town supplies. The *roaded catchment* only became significant after 1950. Commonly, graders formed a series of 'roads' or corrugations about 7.3 metres (24 ft) wide to direct water into an earth tank; from there it might be pumped into a larger storage. Ordinary earth catchments performed badly during the typically light but frequent winter rainfalls of the region, whereas the roaded versions tended to respond quite well to those welcome events. This type of land-sculpting seems to have been partly based on the older 'rock catchment' concept. It was found to be suitable for small town supplies, and the work was occasionally contracted out to local farmers.

Second, the continuing improvement of drainage and irrigation methods added new agricultural acreage to the state's complement, and extended or stabilized existing areas. New storages seemed to be warranted by rising water demand in the



Watering the wheat-belt: the presentation and re-presentation of the* Comprehensive Agricultural Areas Water Supply Scheme, *from 1946.

A roaded catchment, 1970s. By courtesy of Malcolm Howes.

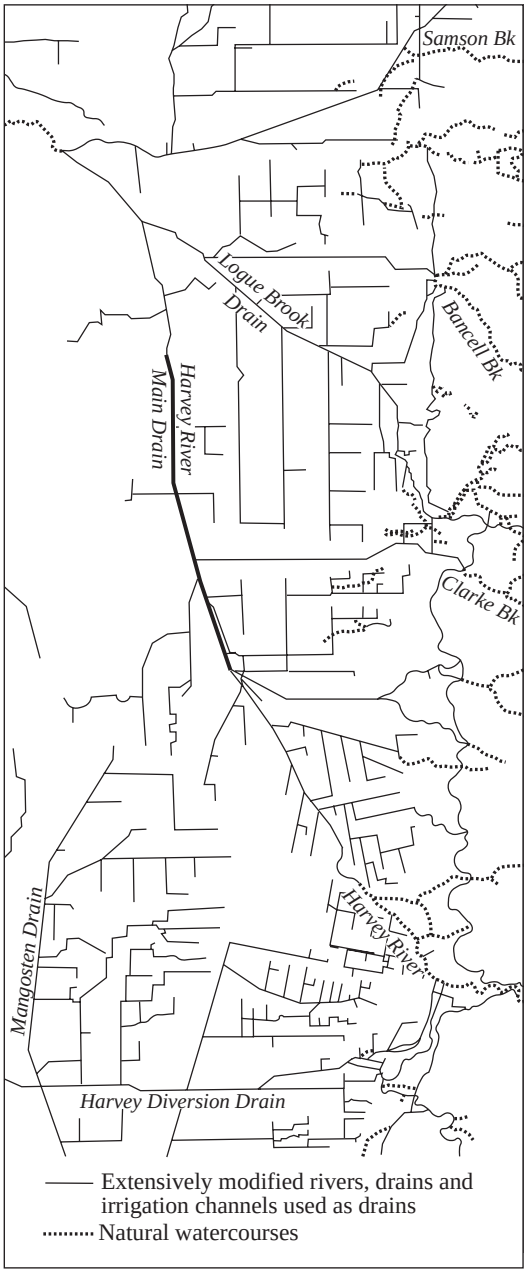
Harvey and Waroona Irrigation Districts during the 1950s.

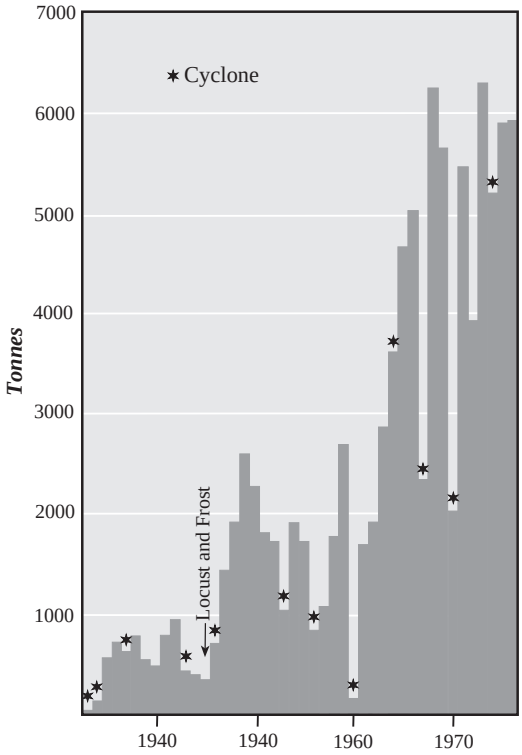
In the case of the former, competing alternatives were the raising of the existing dam on the Harvey River and the construction of a new dam, either downstream of the original or at Logue's Brook. The decision favoured Logue's Brook on cost and efficiency grounds, and because of its proximity to irrigable land between Wagerup and Yarloop. Logue Brook Dam was officially opened in 1963, just in time to avert stringent water rationing. A little further north, successful Waroona irrigators had also been edging towards a rationing regime through the 1950s, and when that eventuated the Harvey path beckoned; an earth-fill dam was completed at Drake's Brook in 1966.

Thus, each intervention in the natural system led inexorably to others. And so it continued. A series of alarming seepage episodes demanded remedial measures for the Drake's Brook Dam over the next few years. In addition, Harvey farmers were then losing about 25 per cent of their supplies through evaporation, seepage and wastage, and the dilemma had opened old sores. Government expert Hugh Oldham had knocked back local proposals for a fully piped scheme in 1915, and that penny-pinching response was now coming home to roost. Work was commenced on a piped system in the late 1970s.

Understandably, given the predominating climatic cues and the comparative absence of large rivers, flood control efforts were seldom noticeable on local government agendas outside the metropolitan region. For over a century, such tasks were usually classified as categories of 'public works' requiring engineered 'structural' interventions. Typically, although requests from its local government partners often instigated activity and the trend towards cost-sharing arrangements became more pronounced over the years, the state government determined the nature of the work and assumed responsibility for its supervision.

South of Harvey, severe flooding hit the Collie district in 1963 and 1964, exposing the inadequacies of river improvement works. During the later 1960s the Collie River was enlarged and cleared to increase its flow capacity. This did not eradicate the problem, but it brought a useful 2.7 metres (9 ft) lowering of the flood level.





Left: Local irrigation networks, showing the manipulations of natural rivers and the insertion of artificial water routes.

Right: The fluctuating rise in banana production in the Carnarvon district, to the late 1970s, showing the impacts of cyclones and other natural hazards. Adapted from Jarvis, 1979.

In the north west, Carnarvon irrigators had been contending with variable rainfalls and river volumes, summer cyclones, and salinity related to Gascoyne River bores. During the 1960s an extensive levee was erected to protect the town. A wellfield was developed by the Public Works Department upstream of the promising banana, fruit and vegetable plantations to supply them with groundwater, and in the 1970s annual production values averaged $6 million, from only 500 ha (about 1,200 acres). Producers came to draw equally on government and private efforts, and were alerted to the problem of overuse between river flows, which might be separated by up to two years.

Slowly at first, then with mounting urgency, it was being realized that politically-acceptable planning processes could no longer rely on any kind of single-faceted solution, and that Western Australians wanted to see more government recognition of the democratic principle of 'public participation' in the design of programmes for the development and protection of their own districts. Sober doubt replacing the inebriation of ambition; civilized restraint slackening the clinical vice of development? Hardly. Not yet, anyway. First, there was the small matter of another exceptional burst of mining activity which placed new premiums on environments which former generations had found useless and intimidating.

Mineral Watering

The spectacularly successful quest for minerals added an arresting new volume, rather than merely a new chapter, to the history of exploration in Australia. At the outset the familiar list of heroic treks and lonely prospecting was of course richly augmented, but even by the end of the 1960s it was being overwhelmed — by the exploits of big science, bigger technology,

and colossal financial capabilities and appetites.

All that herculeanism could not cancel out the universal need for water. And while it might be supposed that the new order could afford to be comparatively dismissive, the historical record advises differently. Thanks to a number of signal achievements, the water mark lost very little of its old significance, but there is still a danger that it will be obscured by obsessive attention to the exceptional evolution of the mining industry *in toto*. Water management was threaded through all phases of that evolution: it was integral, not incidental, to the industry's innovative engagement with regional environments.

The multi-faceted history of Australian mining continues to invite us to move beyond the established economic, political and social interpretations to examine relatively neglected features. Certainly, more consideration could be given to administrative, aesthetic, community health, environmental, financial, legal, scientific, technological and other perspectives on Australian history. That conviction obviously extends to the appraisal and management of water resources, but I do not venture further comment on the availability of this wider research potential.

The roots of the state's modern reputation as a mineral stockpile can be traced to successful drilling for oil in the 1950s and to much earlier periods of exploration and exploitation, including the original golden era, but from a global standpoint it was the 1960s and 1970s that produced the real Thunder Down Under. The new booty included bauxite, diamonds, mineral sands, natural gas, nickel and petroleum, but the example of iron ore mining is acceptably illustrative of the special demands and responses tagged for this section.

The unprecedented speed, scale and monetary cost of most of these new activities forced a change in the state government's attitude towards resource exploitation and regional development. Its engagement could be as close as ever and might also rework the old principle of collaboration with local producers, but with less reliance on investments in hands-on, day-to-day operations to guarantee infrastructural support. Astonishing concentrations of iron ore were located in

Taking the Plunge: water controversies in the 60s and 70s

… the fact that the stage as set by Nature is gloomy and forbidding does not mean that the people of Australia cannot enact a lively and successful play on this stage. Nature's double curse [i.e. extreme variability of rainfall and consequent streamflow over time and space; generally low average rainfalls and streamflows] does not mean that Australians should throw up their hands in despair. Rather it presents a challenge to the Australian people to show how difficulties can be overcome by a nation with a high standard of scientific and technological education…

Surely then, if the youth of Australia will take an interest in Australia's water resources development problems, they can confound the pessimists who have said that the limit of Australia's population, at the present standard of living, is twenty million people, and prepare the way for future development to a nation of fifty, or even perhaps one hundred million …

[Munro, 1974, p. x]

If Australians persist in expanding the area under irrigation they are simply squandering the nation's resources. The present-day Australian is a poorer man than he would have been if the resources used in irrigation had been invested in dry land farming, and the future Australian will be poorer still if a policy of expanding irrigation at the expense of dry land farming is continued.

In terms of her existing population, Australia has an ample supply of water in the form of rain and a far higher area of irrigated land per head of population than any other highly developed country in the world. It is the conservation of water for uneconomic irrigation schemes, rather than allowing the water to flow harmlessly into the sea, that has wasted the nation's resources.

[Davidson, 1969, pp. 244–245]

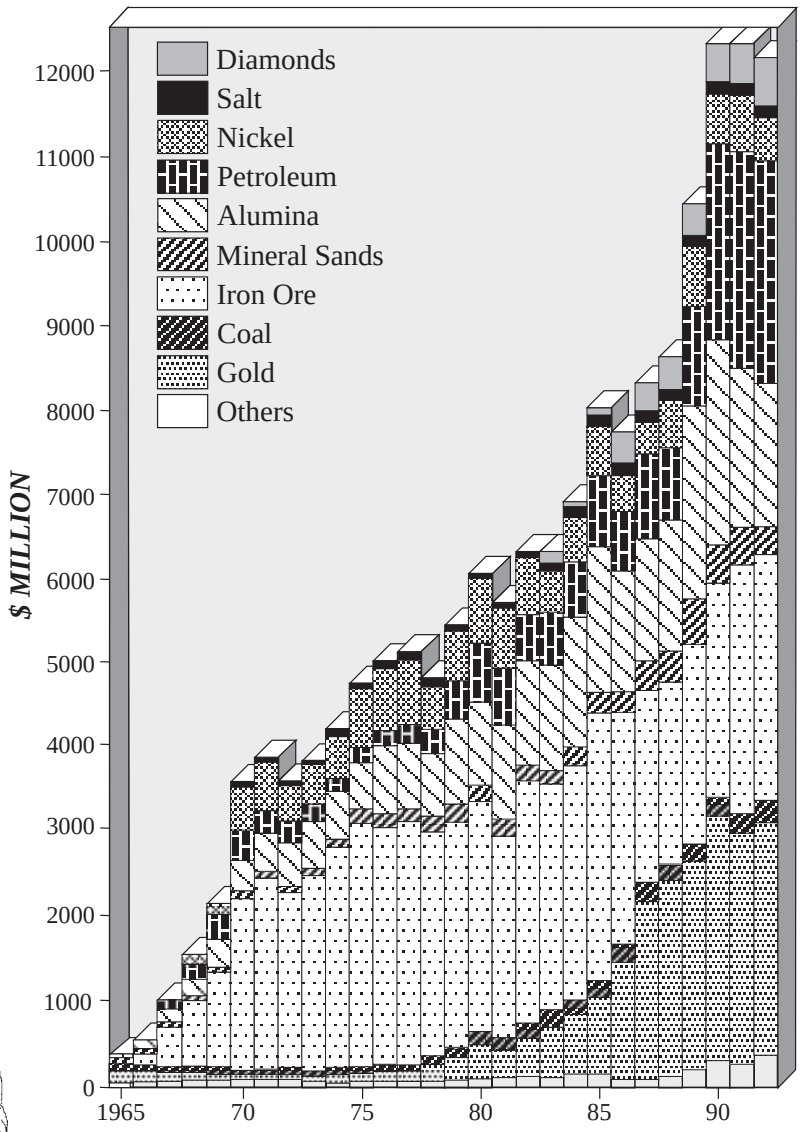
the sparsely populated pastoral district of the Pilbara. As with other booming mineralliferous regions in this period, the necessary capital came from huge consortia which were prepared to mine and in a limited way process the ore, and to build their own settlements and transportation links.

The Hamersley Iron company soon had mines at Paraburdoo and Mount Tom Price, with port facilities at Dampier. Cliffs Western Australian Mining worked at Pannawonica and shipped from Cape Lambert. The new productive region they created was to be administered from Karratha. At the inception, a desalinization plant at Dampier power station and Miaree Pool on the Maitland River provided sufficient water, but plans for rapid expansion needed the assistance of the State's Geological Survey Division and Public Works Department. The companies footed the bill for a major investigation which led to the tapping of groundwater from the Millstream aquifer, with pipelines to Dampier, Cape Lambert and the new town of Wickham. On completion in 1972 the total costs were $22 million.

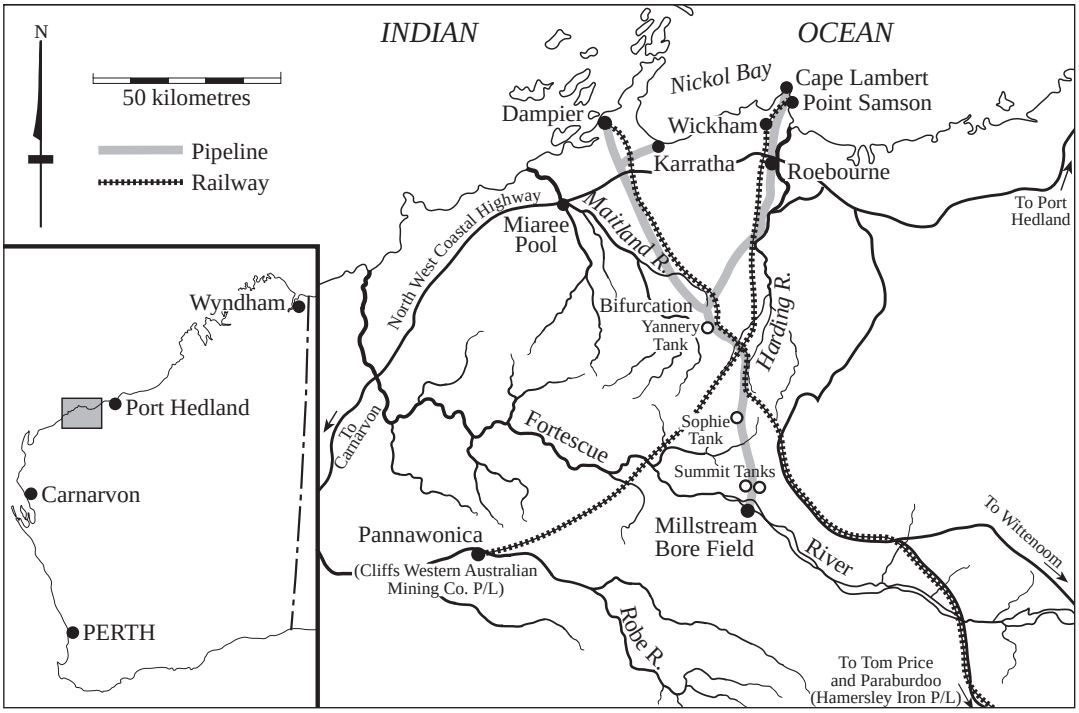
The annual rate of supply from the Millstream was exceeded only by that of the Goldfields and Agricultural Water Supply Scheme, and such startling comparisons, together with threats of an increased demand from the nearby North West Shelf Gas project, helped to promote a proposed dam on the Harding River south of Roeburne. The $28 million cost would be met from federal and state funds, and by

Lang Hancock, arguably the most prominent of the modern diggers, champion of the Pilbara and of full-blooded development.

This is a Spooner caricature, by courtesy of the artist. (In his **Wake Up Australia**, *Hancock roared 'Capitalism Means Life – Environmentalism Means Death').*



The rush that never ended: main components of Western Australia's annual mineral production, in millions of dollars.



The West Pilbara water supply system. Adapted from Le Page, 1986.

Woodside Offshore Petroleum Pty. Port Hedland, a little further north, was supplied by pipeline from bores in the Yule, Turner and De Grey Rivers.

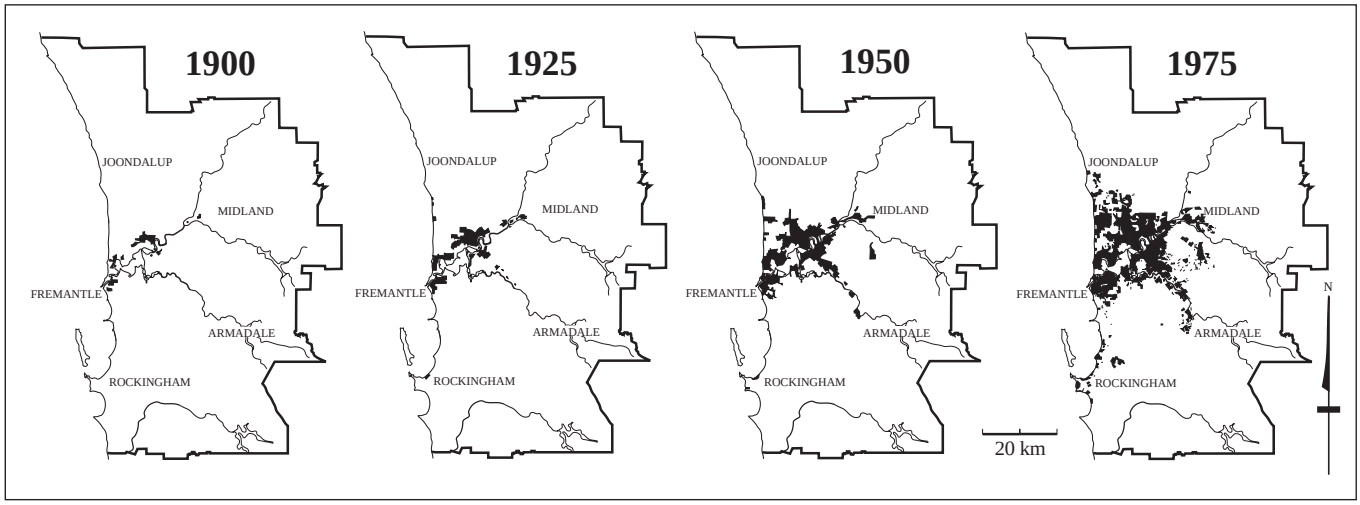
That transgresses into the mid-1980s and avoids some historic disputes. The Millstream venture roused protests from environmentalists and local Aboriginal communities, and the main outcomes were the formation of a new national park and designs for an elaborately regulated *conjunctive* (or combinatorial) harnessing of the region's two chief surface and groundwater facilities. This advanced management strategy involved adjustments of fine balances — between, on the one hand, surface reservoirs experiencing extreme evaporation rates, and on the other a vulnerable aquifer which was thought to function like a vast roofed tank, and clearly offered vital drought security. On each count — financial, political, social, technological — the development of the bustling, hustling Pilbara was pointing to a different future for the state's water specialists.

Perth and the Swan Coastal Plain

In 1952 the state government and the Anglo-Iranian Oil Company (much better known later as 'B.P.') agreed on the construction of a port and oil refinery on the site of a small holiday resort about 40 km (25 miles) south of Perth. It was a foretaste of a rolling transformation of the metropolitan region. The agreement stimulated the growth of the Kwinana complex which included iron and steel works, an alumina refinery, the production of industrial pipes, chemicals, cement and fertilizers, and other manufacturing activities. And Kwinana would be a dominant consumer of water.

Prefacing the deal, however, were important decisions to ensure a greatly increased water storage for Perth. In 1951, Minister for Water Supply and future Premier David Brand promised new storages at Mt Yokine, a large bore at Attadale, a diversion weir at Kangaroo Gully to increase the flows into the Canning Dam, and a new major dam on the Serpentine River. Additionally, sewerage, water treatment and drainage works would be stepped up over much of the city. The confidence expressed in these gestures obviously assisted the Kwinana agreement; in fact, the required water supply extensions were commenced before the initial character of the complex had been formally determined.

Brand would make further significant contributions. It was in the nature of things for water resources initiatives to lead or



A representation of the expansion of urbanization in the metropolitan region, 1900–1975.

closely accompany key development decisions by the government of the day. And it is no accident that a number of the state's most prominent politicians identified with or actually completed apprenticeships in the high profile water, agriculture and regional development ministries connected with so many of the issues narrated in this book.

The Serpentine scheme was completed in 1961; it played its part in the processes of industrialization and metropolitan expansion. Within two years, Premier Brand was putting his weight behind a long-festering proposal to separate the Metropolitan Water Supply, Sewerage and Drainage Department from direct government control. Country Party members were concerned about the implied favoured status of Perth's water users, and they objected to the notion of a separate Board with similar borrowing powers to those of the State Electricity Commission. The views of the Brand administration prevailed and a seven-member board with local government representation assumed control in July 1964.

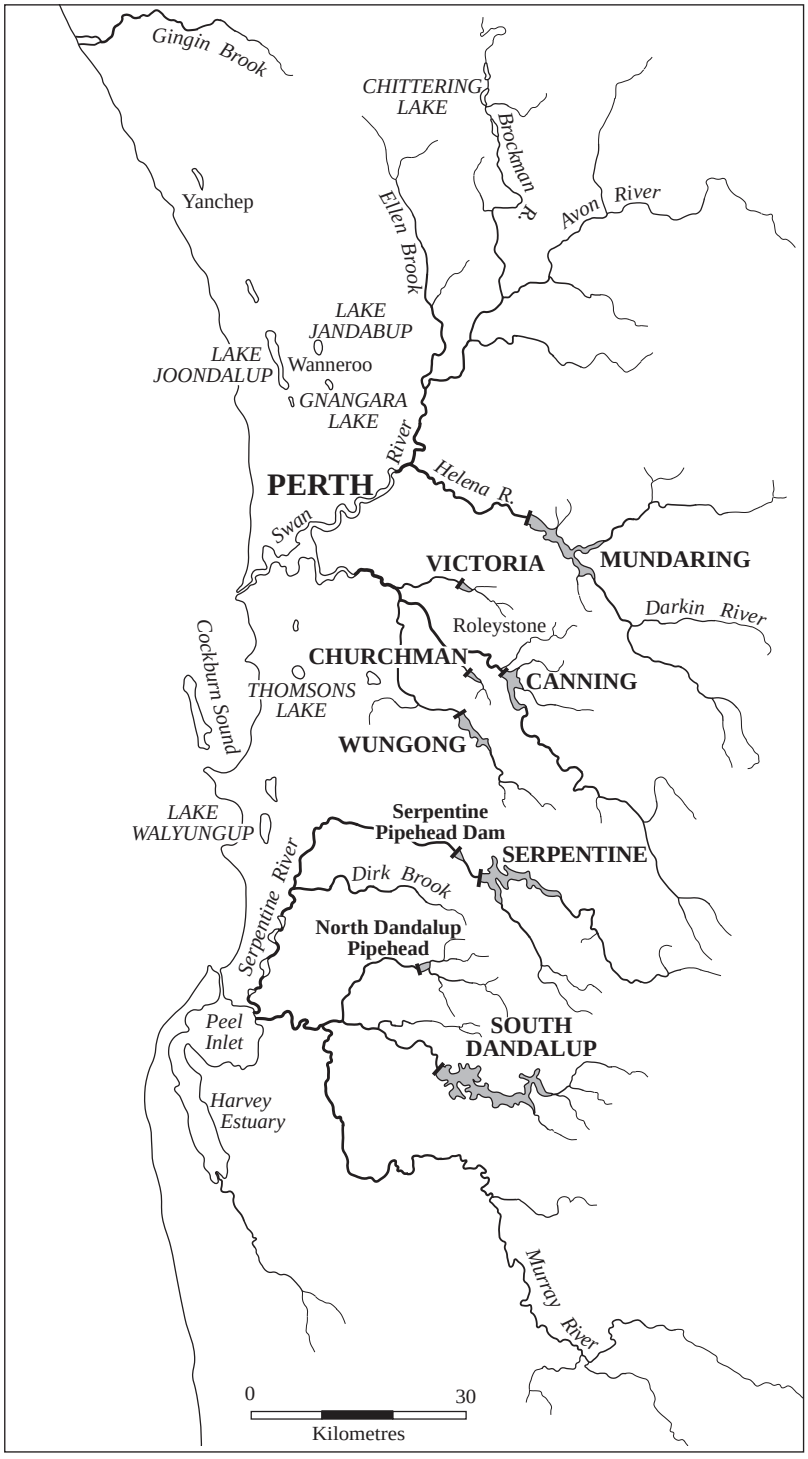
The economic boom was just under way, and the board would be under the whip to meet spiralling demands. Pessimists berated the heavy dependence on surface water supplies. Others noted that, for many years, those supplies had been usefully complemented by shallow wells and deep bores, and that cities and entire production regions in the United States and elsewhere were being supported by groundwater. Those considerations finally convinced the government to approve the creation of a hydrogeology section in its Mines Department. W.A. was on the up. For some of its leading water people, the way to go was clearly down.

Kwinana was also one of the triggers for a review of metropolitan planning culminating in the highly regarded *Stephenson-Hepburn Report* of 1955 (more properly the *Plan for the Metropolitan Region, Perth and Fremantle 1955)*. Its recommendations would influence planning legislation and metropolitan design over the next 40 years.

The Report's many valued points included, firstly, the notion of a growth pattern centred on a number of well-provided and self-contained communities linked by a good road network to workplaces and a system of open spaces; and secondly, the expectation that local communities would have responsibility for devising their own adaptations of the overall planning concept. Unfortunately, its discussion of ecological contexts was thin by today's standards. In particular, the nuanced economic and environmental values of groundwater mounds and their partly linked wetlands were neither explained nor assessed.

Elaborations over the next decade set out practical suggestions for guided 'corridor' growth, and a well-regarded *Corridor Plan* was promoted in the late 1960s and early 1970s. The young city was in fact unusually advantaged by the presence of massive groundwater reserves well within its expanding metropolitan fringe. Fortuitously, the reservation of wedges of open space between the growth corridors — very welcome in itself, naturally — gave a good measure of protection to the main

David Brand (1912–79), long-serving Premier of Western Australia.



Metropolitan region: major reservoirs and rivers.

The Increasing Primacy of Perth, 1901–1981

% total W.A. population resident in Perth

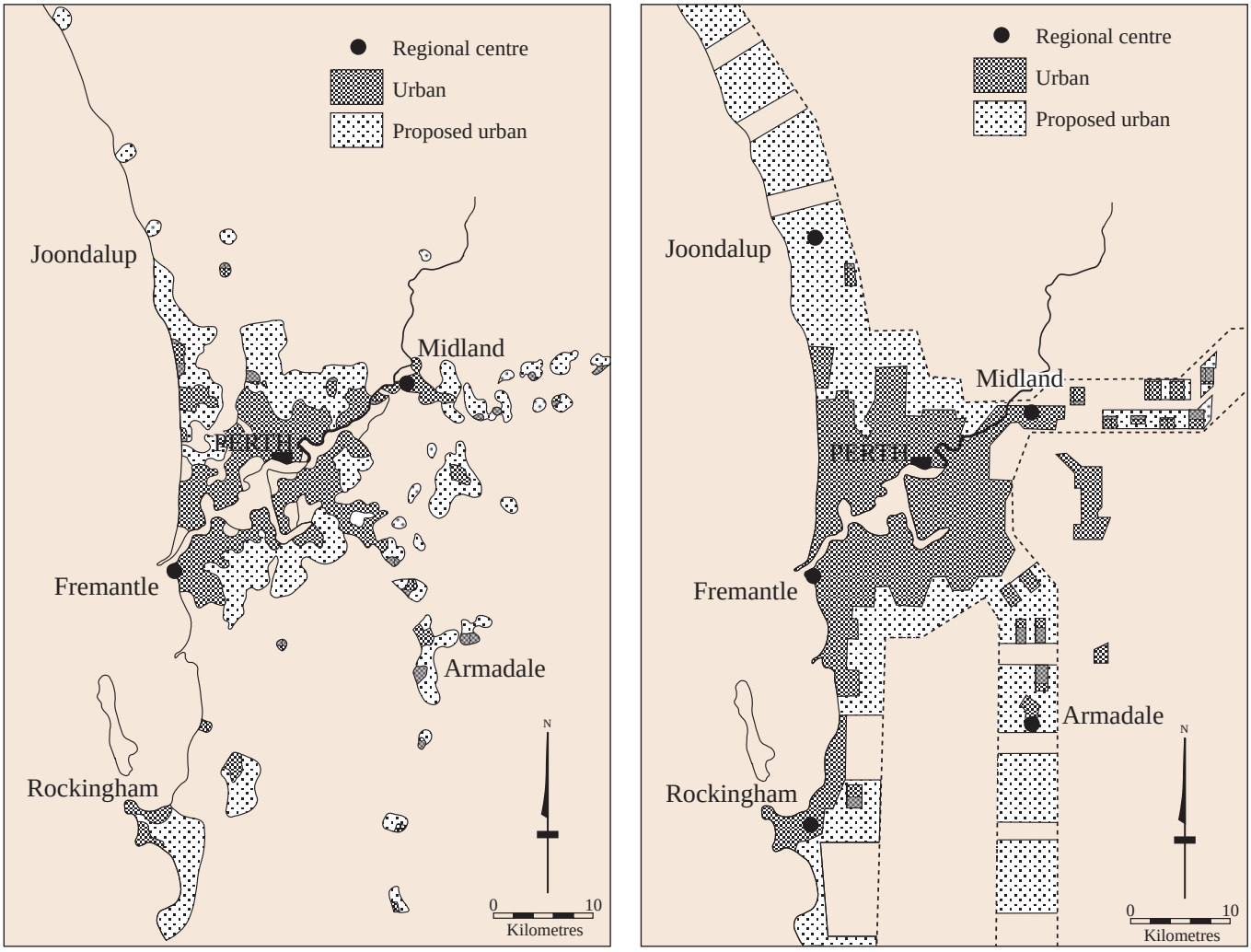
1901	**15**
1947	**55**
1948	**62**
1981	**63**

Source: official censuses, as cited in *Australians. Historical Statistics*, Fairfax, Syme and Weldon Associates, Broadway, 1987, p. 41; the pre-1961 data exclude Aboriginal Western Australians, and the actual metropolitan shares of the state total were larger than shown.

groundwater mounds to the north and south of Perth, and arguably prolonged the lives of associated wetlands on the central coastal plain.

A landmark study in state water planning emerged from a joint Metropolitan Water Board–Public Works Department initiative in 1973. It is usually referred to as the *South West Regional Water Planning Study*. No public report was released, but the co-operative experience and the adoption of a long range regional perspective were seminal. So too were the main observations and findings regarding dryland salinity, demand management, private water development in the metropolitan area, the importance of recognizing the interaction of water issues with other social, economic and environmental themes, and the conjunctive use of groundwater in the Perth supply system.

Perth's two main groundwater sources were the *Gnangara Mound* and the *Jandakot Mound*. The first was very favourably located to serve market gardeners on the city's fringe and to supply high quality drinking water as the urban population expanded towards the north. It is a large area, cresting at approximately 75 metres (245 ft) above sea level, from which the water flows west towards the Indian Ocean and east into Gingin Brook and the Swan River. The mound also supplied a number of wetlands with euphonious titles, including lakes Gnangara, Yonderup, Nowergup, Joondalup, Jandabup, Goollel and Mariginiup, and Coogee Springs. The Jandakot Mound is smaller and crests at only 26 metres (85 ft); its water flows west to the Ocean and partly to the Swan and Canning Rivers in the north-east. Related wetlands include lakes Thomson, Bibra and Yangebup. Both mounds were rapidly incorporated into the city's supply system and had to be factored into the design of water management strategies to take Perth into the next century.



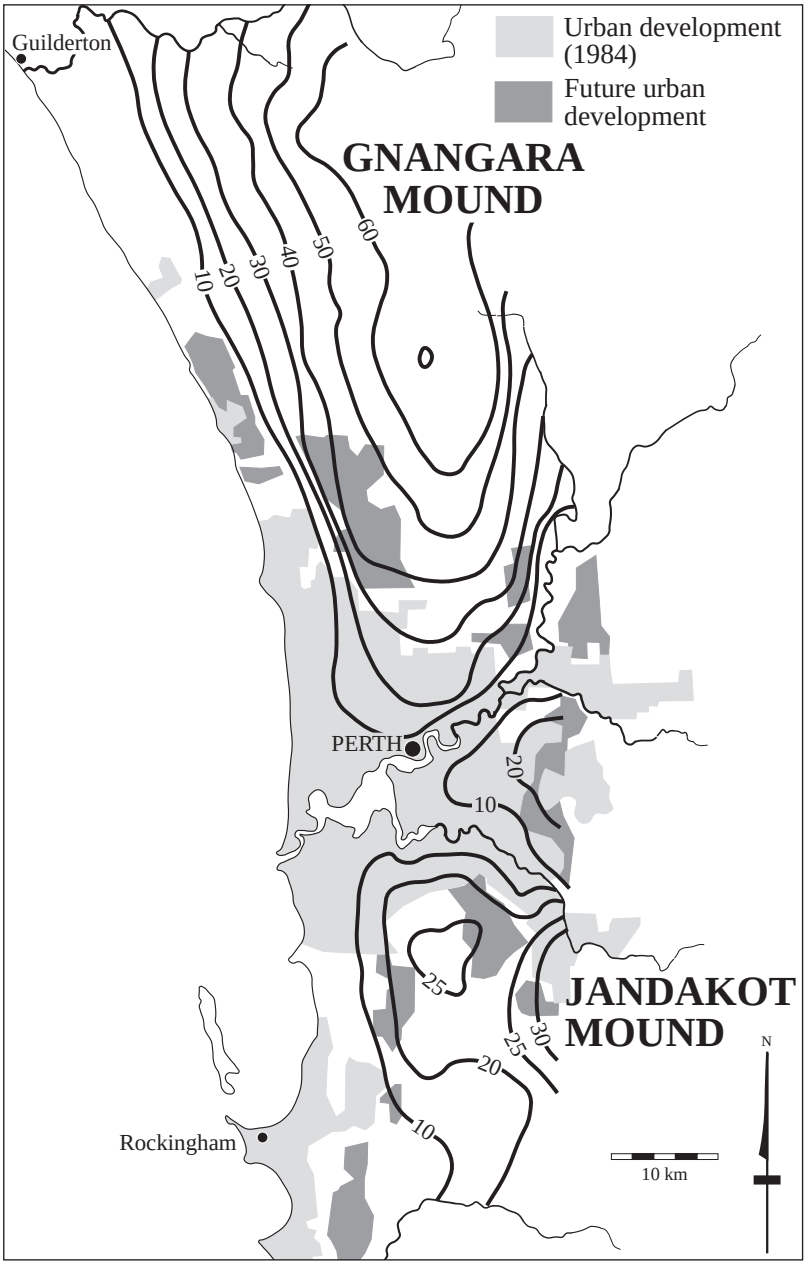
Left: The Stephenson-Hepburn Plan for Perth, 1955.

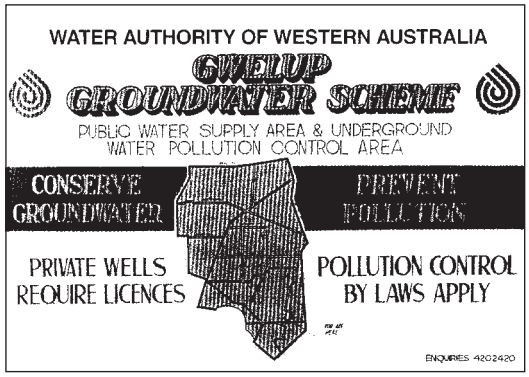
Right: Perth's 'Corridor Plan', 1970.

By the end of the 1970s there were fears that community interests in development and environmental protection had become poorly synchronized; indeed, there had already been a number of collisions. And Perth's old dependence on groundwater had become quite pronounced. During the drought of 1975–77, when strenuous efforts were made to curb reticulated (scheme) water consumption, the result was an overall reduction of 45 per cent; in 1975, groundwater contributed 16 per cent of the total metropolitan (scheme) supply, and by 1977 the proportion had risen to 49 per cent. In 1980–81 the groundwater share had fallen to 40 per cent — still unusually high due to drought conditions, it may have attested to a continuing confidence in the resource.

Confidence or over-reliance? Normal inventory methods could not compute the effects of the popularity of small 'backyard bores' (not the garden gnomes; and notice the ghost of colonial Perth), but it was estimated that they could be credited with roughly 25 per cent of total groundwater consumption in 1981. Amidst the growing concerns about the likelihood of over-exploitation, there were also anxieties about the threat posed by leakages from septic tanks and by industrial pollutants. About one-third of Perth's residential properties had septic systems in 1980, and the risk of direct contamination from leakages increased with the predominance of private bores. Enhanced environmental protection measures, it was urged, would cope with this problem and with the management of industrial wastes.

In the interim, it was hoped that the improved planning of metropolitan expansion might deal with encroachments on the key groundwater areas, or otherwise provide for advanced multiple-use controls. Pursuit of the latter ideals turned contemporary thinking towards the kinds





Groundwater mounds and the threat of urban expansion. Water table contours are in metres. Adapted from Webster, 1989. The availability of accessible, fresh and shallow groundwater below the metropolitan area distinguishes Perth from the other Australian capitals. Ease of access is a two-edged sword, however. The potential for pollution of the resource from activities on the surface increases with the extension of urban development onto the principal groundwater mounds, as shown on this map; and the independent harvesting of the resource by householders and other users complicates the essential procedures of monitoring and regulation.

Elegant vineyards grace the landscapes of the Swan Valley, and just as gracefully acknowledge the growing importance of groundwater in the wider metropolitan region. All a bit of a turn-up for British traveller-novelist Anthony Trollope, who had sagely pronounced in 1872 —

> ***It is hard, too, to believe that a country should be so prolific in grapes as this is without some result. I will not take upon myself to say that I drank Western Australian wine with delight. I took it with awe and trembling, and in very small quantities. But we all know that the art of making wine does not come in a day; — and even should it never be given to the colony to have its Château This, or Château That, its 1841, its 1857, or 1865, or the like, — still it may be able to make raisins against the world.***

of 'interconnectedness' best appreciated in refined ecological conceptualizations. The separation of natural resource agencies and associated political portfolios began to look indulgent as well as anachronistic. As in the rest of Australia at this time, when the pennies began to drop the required reforms were virtually bound to be placed on parliamentary agendas. But the process was speeded up by intensifying community concern about the twinned themes of land and water degradation.

Controversially, since there was a range of causes, bauxite mining had been publicly implicated in the spread of the fungus disease *Phytophthora cinnamomi*, the leading

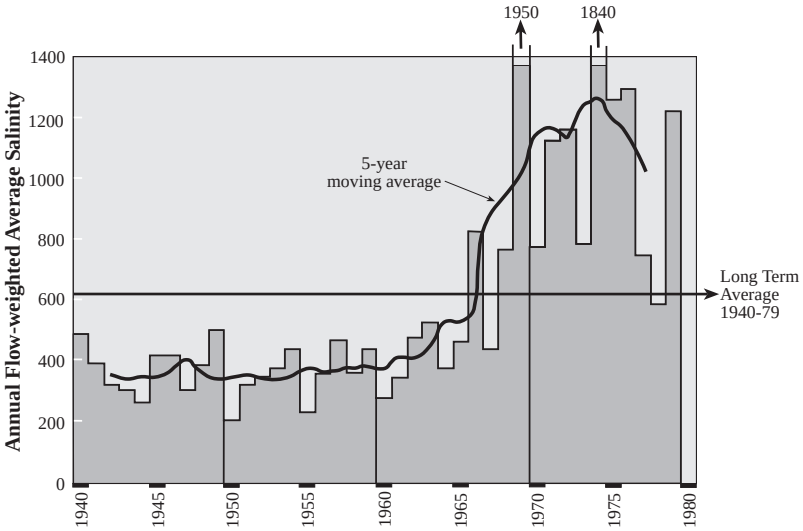
contributor to 'dieback' in the Jarrah forests which protected the catchments. The effects of the resultant thinning of the forest cover included rises in groundwater levels, and an increased risk of salinized surface soils with implications for river water qualities. Interpretations of salinity in Perth's Mundaring Reservoir pointed to the cumulative effects of extensive clearing in the early years of this century, and in this regard the most visible policy response was the exclusion of mining and the introduction of clearing controls in the catchment during the 1970s. More grist to the mill of a flourishing environmental movement.

Throughout Australia, the clamour over increasing salinity was then insisting that managers be made more accountable for the consequences arising from diminished quantities and qualities of water. The inheritance of predominantly anthropocentric (or human-focussed) assessments was under challenge.

Turning to Salt …

Western Australian geographer Arthur Conacher recently proposed a definition of 'land degradation'. He believed it was best seen as referring to 'alterations to all aspects of the natural (or biophysical) environment by human actions, to the detriment of vegetation, soils, landforms and water (surface and subsurface, terrestrial and marine) and ecosystems' (Conacher and Conacher, 1995, p. 3). Though it still begs a few questions, as he realizes, at least it emphasizes human culpability and keeps the water issues in context. Objectively, the statement also reinforces the view that those themes date from the distant beginnings of human occupation — that is, from long before 1829.

It is the aggravation of the processes of degradation after the late nineteenth century, and then especially after World War II, which taxes modern communities with problems that are unprecedented in scale. As a sub-set of the suite of degradation types, salinity cannot travel without its companion adjective, which is to say that the process occurs naturally, and that the biggest management issues arise with *increased* levels — in this case, increased to the point of disrupting situations valued by human communities.



Increasing salinity in the Kent River since World War II.

Salinity is measured in total soluble salts (milligrams per litre). Regionally, the problem is also being intensively monitored by the use of satellite imagery and electromagnetic recording.

The highly publicized environmental crusades of the 1970s promoted intensive re-evaluations leading to the adoption of new attitudes towards conservationism in Australian parliamentary and bureaucratic circles. But the several examples of increased salinity indicate that advances in science and technology, whether influenced by or only marginally related to the environmental movement, forced similar openings for changes in government policy. That was also true in Western Australia, where important strides were being made towards a more thorough monitoring of regional variations in natural precipitation, the rhythms of streamflow, and the changing qualities of surface and groundwater sources.

Commonplace salts are found in varying amounts in soils and waters throughout the state, and 'salinity' itself merely refers to a measure of their concentration. As it was generally understood in the later 1970s, *increased* salinity was associated with interactions of three main factors: the relatively high water storage capacities of deep soils; significant contributions of salt from natural rainfall; and the abilities of native tree covers to use water. Salt may be easily flushed from shallow or porous soils, or by heavy rainfall. Where rainfall is low and water movements are restricted by deep soils, even though the roots of the native vegetation may take up the bulk of the rainfall, its imported salts tend to remain in the soil.

Imagine, so the argument now runs, a region that is variously lightly wooded or

A salinized patch in the western wheatbelt, 1997 (author). Scenes such as these have received widespread publicity over the past decade, but increasingly, the spectre of salinity is haunting urban Western Australia as well as the countryside. The evidence is there in rising water tables and deteriorations in water quality and in battles to retain the civilizing 'amenities' — cf. the old hopes for the Comprehensive Scheme in the early postwar years — of public parks, gardens and recreation ovals. Sometimes naggingly pronounced, it is there in the crumbling foundations of buildings, including many private homes. Salinity is holding up a powerful mirror to the aspirations, attitudes and actions of previous generations, declaring the need to recognize the full combination of social, political, financial, legal and other considerations along with the scientific and technical facets. It mocks the confident self-image of those who look instead to quick technological 'fixes'.

quite densely forested at the time of the first European incursions. Although that region is impressively stable in geological terms, the natural salinity levels of its soils reflect distinctly marine origins in some past era. Those characteristics are enhanced by another simple fact: for aeons, its rainfall has been largely derived from air masses which have passed over the Indian Ocean. Furthermore, until the nineteenth century the region had not felt the impact of an advanced, commercially-orientated society. Then — quite suddenly, in ecological terms — it is cleared for agriculture, rural settlements, mining. The primeval accumulated salts are destabilized, released.

For Western Australia, the (disputed) proportional loss of woodland and forest cover since the commencement of European occupation was put at between 31 per cent and 43 per cent in the early 1980s: let us say about one-third of the 'immediate pre-European' tree cover had been cleared by the end of the period reviewed in this section. Large areas of the wheat belt had been reporting soil and water salinization, and related production losses had become severe in the 1970s. The ancient hazards of water and wind erosion could be validly set down to a combination of factors including poorly adapted cultivation and grazing practices. But the principal reason forwarded for the hallowed development imperative turning to salt was the widespread removal of the tree cover.

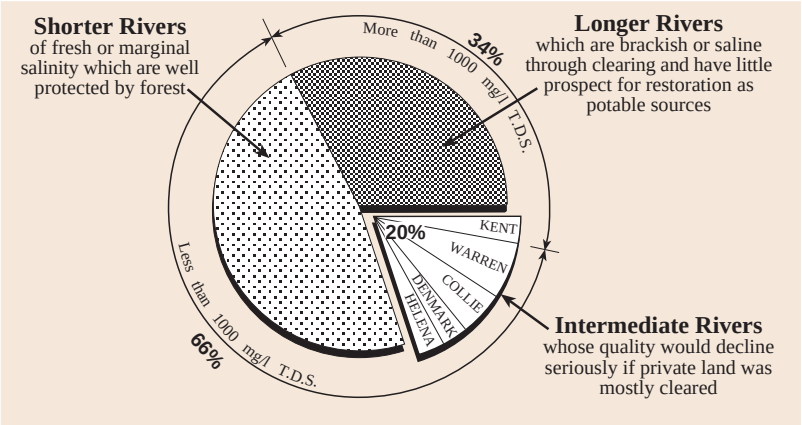
Salt was an old enemy in the west. Drilling for artesian water had often located it; goldmining companies and condenser operators grappled with it on a daily basis; pioneer wheat farmers ruefully reported it throughout the interwar years. A Royal Commission on the Mallee Belt and Esperance Lands (1917) had identified it as a factor in frontier farming. W.E. Wood, Inspecting Engineer of the Railway Department, ascribed the salting of locomotive water supplies to the clearing of local catchments by agriculturalists: that was in 1924, and a few years later he also commented on the introduction of salts in rainfall. Respected soil scientists L.J.H. Teakle and G.H. Burvill outlined the same underlying ecological mechanisms in a series of publications between the 1920s and 1950s.

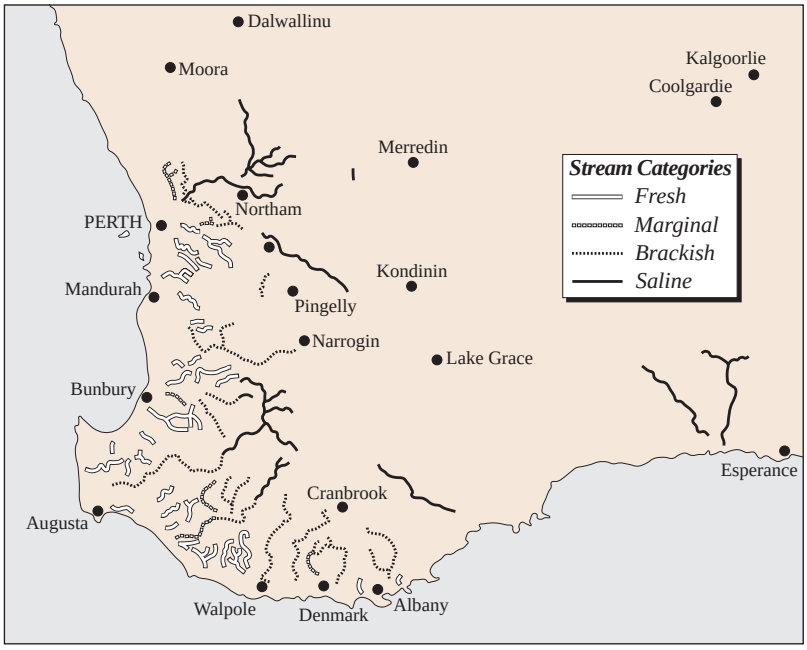
During the 1950s and 1960s the Public Works Department lobbied against political moves to throw open parts of the Mundaring catchment for development: *it was already well developed*, for water supply. Intensive monitoring had established that natural regrowth and tree planting had repaired the damages resulting from a speculative venture into disastrous

White-Out: Salinity in WA, 1955–1990

Year	Estimated area affected (ha)
1955	73,500
1974	167,300
1985	300,000
1990	443,000

Source: Dröge (1991).





Top: Simplified categorization of the effects of salinity on south western rivers.

Lower: Simplified distribution of stream salinity in the south west.

ring-barking in 1904. The intention had been to increase runoff into the reservoir, but it also increased general contamination and salinization. Convinced by the weighty data, PWD executives also argued for tighter land use controls, continuing public ownership, and forest protection for those catchments it envisaged as likely candidates for future water harvesting.

Internal memoranda show that their public service brief was alternately described in aggressively moralistic or hushed strategic tones, and recourse to technocratic self-righteousness was less common than their critics have assumed. Catchment protection and bureaucratic citizenship ran together; that seemed to be the line. Politicians who prattled about substituting modern water treatment facilities for the locking up of good land knew nothing about a collective international experience which gave top priority to the protection of virgin catchments and saw water treatment as an expensive last resort, notably for older countries where the best chance had been lost centuries ago. That kind of thing. It was also pointed out that the conventional water treatment so naively cited did not eliminate the salts anyway.

And thus salinity — 'the most vital factor', according to a 1956 memorandum — became a formidable weapon in the struggle for extended catchment protection and enhanced Public Works Department influence.

The argument might win the day where the paramountcy of water use was barely challenged. Where the clout of mining and timber milling was applied, a clash with the opposing 'multiple use' principle, then gaining support throughout Australia, was on the cards.

The ecological matrix spotted by pioneer settlers and by Wood, Teakle, Burvill and their colleagues became convincing when improved monitoring of environmental change in the favoured south west added river degradation to the gruesome litany of degradation categories. Since the rivers acted as natural drains for wide areas, river salinization measurements were reasonably valid indicators of regional environmental health, while on the local scale they drew special attention to the declining ecological status of the watercourses themselves. These injured streams were not only intrinsically valuable, a fact that was not lost on influential environmentalists: several were (actually or potentially) useful contributors

Salinity and Sacrosanct Catchments

In Australia and in W.A. in particular, where water supply could be the factor that will ultimately limit the population and development of the State, catchment areas should be preserved in their entirety.

Any demands for the alienation of land on the catchments adjoining the metropolitan areas should be resisted on the score of increased salinity alone, and regardless of all other factors, as a rise in salinity could jeopardise existing supplies for posterity.

[Internal memo from the Engineer, Goldfields Water Supply, to the Acting Director of Works, 18 September 1956; Public Works Department.]

to water harvesting schemes for the metropolitan and country districts.

As it matured into the 1970s, the main interpretation of river salinity drew simple distinctions between three groups: short rivers with timbered catchments and low salinities; longer rivers with heavily cleared catchments and brackish or saline waters; and an intermediate group.

The first included the Canning, Brunswick, Deep, Donnelly, Harvey, Serpentine and Shannon rivers. It was chiefly associated with the relatively high and intermediate rainfalls of the Darling Range, almost fully protected by State Forests, and with generally low levels of soil salinity except for the inland margins, where the salt remained fixed by a good tree cover. The second included the Avon, Blackwood, Frankland and Murray rivers, which extended well inland to privately-owned, extensively cleared agricultural tracts with saline soils. That poor condition could not be redeemed in the short-term. The intermediate group of rivers therefore offered the management target.

Their catchments include some of the implicated inland soils and partial salinization had occurred in the rivers because of a limited amount of clearing. But the situation was not considered lost: if clearing on private land were halted, the problem could be contained. The principal streams in this group were the Collie, Denmark, Helena, Kent and Warren.

Between 1976 and 1979 the state government finally agreed to place bans on clearing practices in these intermediate areas, and the Public Works Department purchased a number of farms in the Collie catchment to reduce the movement of salts into Wellington dam. The confrontations between the government (or its bureaucratic agencies) and the farmers were often bitter: more than a million hectares (2.5 million acres) were affected by the bans, and 262,000 ha (650,000 acres) had already been cleared, largely on private properties. The landscapes of Western Australia had always reflected the changing relationships between governments and people, and the results of the tipping of a delicate equilibrium were bound to be very stark. Farmers in other catchments reacted sharply to the bans, and proceeded to head off the contagion of unwarranted interference by accelerating their own clearing programmes.

The joint message from ecology and history was that this collision of interests would produce no winner. Not the best of verdicts, as the state prepared to celebrate what Burvill's (1979) fine collection of agricultural essays introduced as '150 YEARS OF DEVELOPMENT AND ACHIEVEMENT'.

Change, Inc., 1980–1998

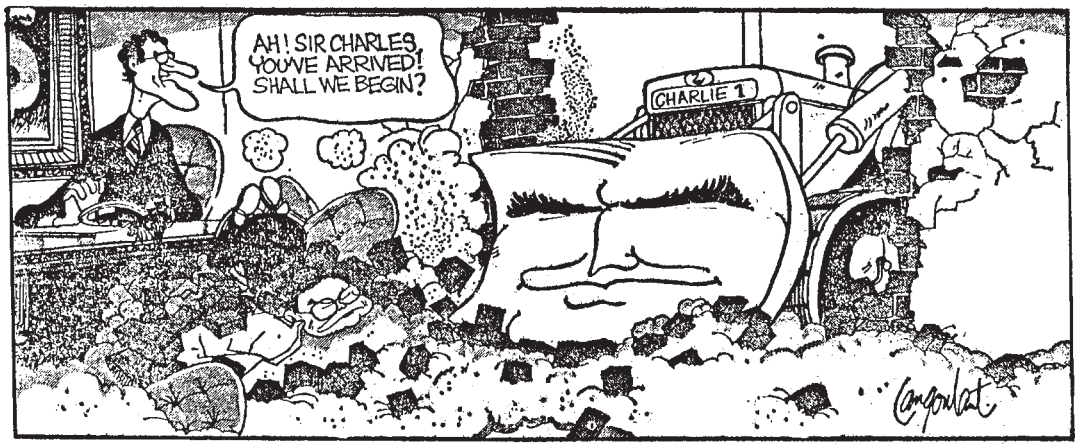
IV

Change, Inc., 1980–1998

Modern communities often look to their history writers to produce unambiguous identifications of any number of 'beginnings' and 'ends'. By training as well as by personal inclination, most of these writers are closely engaged with intricately woven processes of evolutionary and revolutionary change which defy the crudities of chopping and slicing: history is no salami. A fairly broad consensus has emerged, however, on the importance of certain developments at federal level during the mid-1970s. They introduced a missionary critique which proceeded to scorch and scarify public sector management in each of the states.

It had not exactly achieved cult status by the early 1990s, but its influence was then widespread. Every state experienced savage excoriations, wrenching upheavals. Each exhibited its own twists and turns of the Australian story; its own lists of winners and losers according to the peculiarities of the local milieux. A new 'management culture' made such an aggressive entry that it struggled to command the depths of loyalty and affection inspired by the systems it displaced. As the demand for 'forward planning' for the new century produced a rallying focus, it promised to measure the worth of the new structures and procedures.

The first part of this final section is therefore concentrated on the introduction of modern water management reforms. The second outlines some of the deliberations on strategic planning for metropolitan and non-metropolitan Western Australia.



PM Malcolm Fraser (with John Howard recumbent) greets, or is rather confronted by, Charlie Court.

From Langoulant,* Daily News, *19 June 1981; by courtesy of the artist.

Reformist Impulse

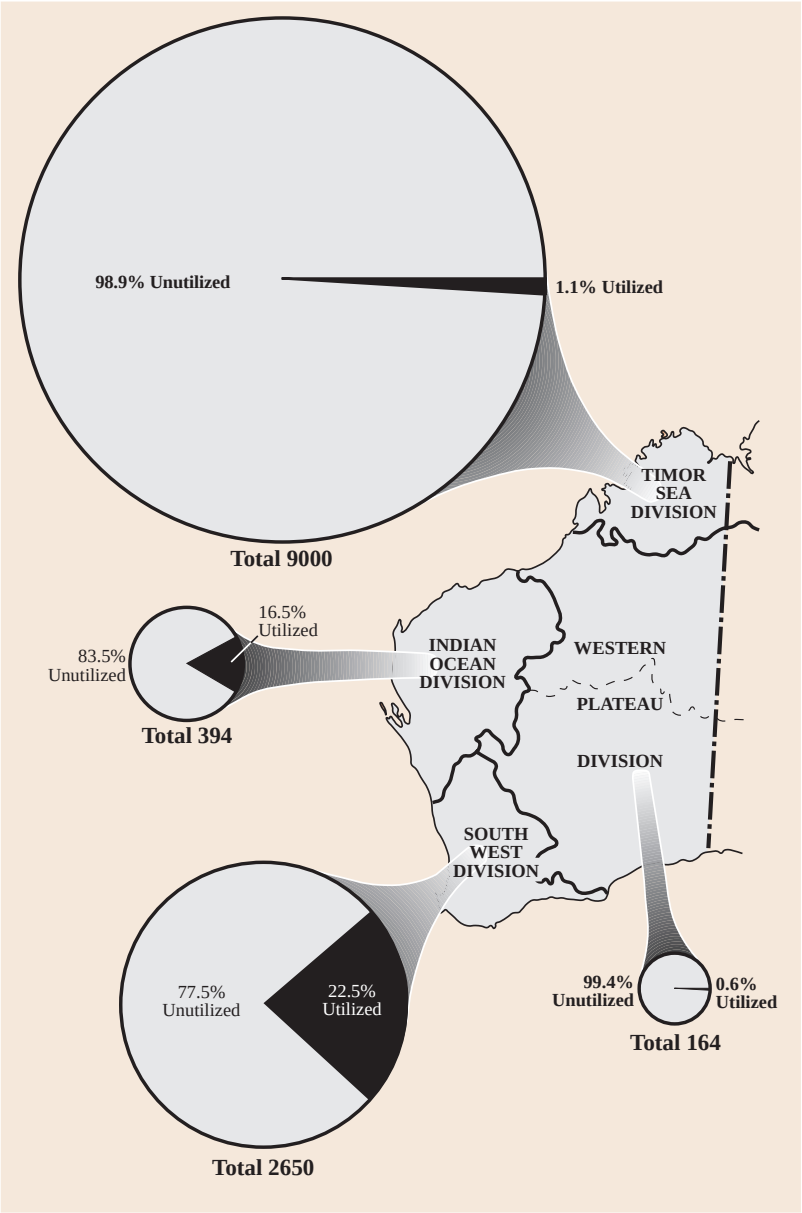
If there was no precise 'beginning' for this new era, the context and recommendations of the federal Labor government's Royal Commission on Australian Government Administration (1974) probably served the most significant notice. As I have explained in *Watering the Garden State*, '*MDB*' and *Plains of Promise, Rivers of Destiny*, recent British and American moves were influential and our state administrations had been moving down the same track as their Canberra counterparts: 'comprehensive corporate management' and the achievement of greater 'accountability' had penetrated the bureaucratic lexicon. In the water sector (increasingly referred to as the water *industry*), the trend was away from heroic or 'developmental' orientations towards a more 'mature' phase associated with retreats from big construction.

Key events ensured that water issues were prominently positioned on political schedules. The financial costs of the Brisbane floods of 1974 were eventually set at $200 million. Losses in national agricultural production from the continental drought of 1982–83 amounted to $1.5 billion. The average annual cost of flood damage in New South Wales was said to be $25 million. Salinity was terrorising every state, and the salinization of irrigated land was cited as one of several negatives against the investment of further public funds in irrigation storages.

Placed under renewed scrutiny, Australian water management was found to be burdened with a number of handicaps, which Sewell, Handmer and Smith (1985) concisely entitled 'yesterday's myths'. Our water planners had been very fundamentally constrained, it was urged, by five incorrect public notions: that water was a 'free good', God-given as it were; that it could be managed in isolation; that 'the desert can be made to bloom'; that 'social values will not change'; and that 'water management is mainly a technical matter'.

The effects had included insufficient, unrealistic water charges; the establishment of single-purpose agencies or local bodies for irrigation, water supply, flood control, power development and so on, with only tenuous links between them and scant appreciation of the role of water in broader economic and social planning strategies; expensive new constructions for dubious gains; a comparative neglect of non-traditional demands on water, such as those of recreationists; and the standard pre-eminence of engineering and hydrological perspectives, at the expense of expertise from economics and a range of earth science, biological science and social science specialisms.

Both the printed record and individual recollections generally support these observations for many areas of Australia, while insisting that they are overdrawn and



Generalized map showing the availability and utilization of W.A.'s divertible water resources (millions of cubic metres per annum).

8

do not have universal application. When they were variously noted in the 1970s and 1980s, another view was added, *sotto voce*. There was undoubtedly a belief in political circles that the country's water managers enjoyed a trifle too much independence from government — that some re-organization was required to guarantee the kind of accountability that would come from closer compliance with government policy.

Approaches to water management stemming from these evaluations emphasized such considerations as the adoption of 'comprehensive', 'integrated' planning with inter-agency, interdisciplinary and multi-disciplinary perspectives incorporating social, economic and environmental concerns. They also stressed the overdue recognition of water as an economic good and the contingent requirement that pricing policies and the like be reviewed. Much greater attention would be paid to environmental factors and to water demand management, as opposed to demand-response strategies. There was an acceptance of the value of public participation in improving the definitions as well as the solutions of problems. And they favoured the replacement of local government areas and other 'artificial' territorial frameworks with natural units such as river basins as the primary bases for environmental and social monitoring, and in strategic planning designs.

Some of these analyses and recommendations were relevant to the situation in Western Australia during the early 1980s. At that time, the Public Works Department was still responsible for the collection of water resources data, the development of irrigation supplies, and the supply of all towns outside the metropolitan area, except for company mining towns in the Pilbara and the south western towns of Bunbury, Busselton and Harvey. The Metropolitan Water Authority continued to exercise jurisdiction for Perth and its vicinity. It shared responsibility for local groundwater investigations with the Geological Survey Authority of the Mines Department, which remained the chief groundwater body for the state. The Departments of Forests, Agriculture, and Conservation and Environment were closely involved in water resources development projects and with problems connected with water yield and water quality. An overview of all of this activity was gained by each organization through involvement in, and representation on, the Western Australian Water Resources Council.

The tendencies reported in our previous section had confirmed that the unqualified ambition of the pioneering era could no longer be sustained, and that heightened sensitivities to financial, environmental and social parameters called for the adoption of *holistic* approaches and sophisticated corporate planning frameworks. The first unequivocal expression of the changing mood was the telescoping of the Metropolitan Water Authority and the country water supply functions of the Public Works Department. The merger began formally on 1 July 1985 and the new body was entitled the *Water Authority of Western Australia*. It assumed comprehensive responsibility for basic supply, water resource assessment and planning, irrigation, floodplain management, and wastewater treatment. The state's Water Resources Council was retained as a source of independent advice to the Minister.

The Public Works Department had launched a *State Perspective* programme focussed on water resources in 1982. It was to run in conjunction with a related national study, *Water 2000*, conducted under the auspices of the Australian Department of Resources and Energy. The overall objective of the surveys sponsored by this programme and published by the state's Water Resources Council was to re-insert water resource matters more definitively into the enveloping context of community interest issues — and thereby to recommend on planning *orientations* rather than policies. In detail, this work built upon earlier ventures, including the 1973 *South West Region* exercise and specialized metropolitan studies. A great deal of

information-gathering enlisted new projections of supply and demand, and a concerted effort was made to present an array of comparatively 'accessible' material for public consideration.

In spite of some neglect in academic circles, water had never occupied the preposterously low 'utility' end of the hierarchy of public attention, and the efforts outlined in this section helped to ensure the special status of the resource in a sparkling new age of development — as evoked, for example, in Premier Charles Court's enthusiastic presentation of his state as 'The Land of Movable Mountains'. Before the end of the 1980s, *State Perspective* analyses had established the crucial role of water issues in the continuing development of the south western region, which was then accommodating some 90 per cent of the Western Australian population and clearly deserved priority consideration. Specified key themes accentuated land use problems and their connections with groundwater and salinity. They were followed by the need for improved interaction with National Park managers and an involvement in wider recreation planning; the management of floodplains and water yields in forested catchments; increased attention to water allocation between competing urban, rural and environmental uses; and the more influential managerialist stance on financial accountability.

Acceptance of multi-dimensionality was one thing. The eccentric vocabulary of corporate managerialism, with its calls for mission statements, performance indicators, professional development requirements, proactive and reactive modes and all the rest, was sometimes considered ludicrous and alienating in the predominantly technological culture of water management. Yet the water sector was being relentlessly refashioned to cope with the kinds of multi-skilling now demanded, and much of the opposition was muted or redirected. If proponents of the new wave were occasionally reviled and feared as dangerous cranks, the technological mind needed no convincing that the function of a crank is to produce revolutions! With growing urgency, interdisciplinarity was progressively written into individual résumés as well as into in-house induction programmes and activity patterns. Specialization was not simply to be diluted, but the voguish medium nurtured richer *blends* with predominating flavours of adaptability and uncertainty.

That, essentially, was what was meant by the talk of a 'culture change'. In the late 1980s, few aspects of Australian life were immune. Any state of movable mountains was bound to produce supreme tests of professional integrity, tolerance of uncertainty, employable adaptability. They would crop up with alarming frequency during the water managers' involvement in the contest between environmental conservation and rampant development.

Throughout the nation, government agencies suffered epidemics of merging, scrapping, reconstituting, re-skilling, re-briefing and re-ranking. Hallowed conceptions of the public service vocation were ignored or gracelessly devalued. At

Crowding the Water Management Agenda, 1987

Commonly cited water-related issues —

1. land use: agriculture — water consumption, salinity, land degradation; industry — water consumption, water pollution; mining — water consumption, disrupted surface drainage and groundwater systems, water pollution; urban development — water consumption, catchment disruptions, water pollution; forestry — loss of vegetation, salinity of soils, rivers and reservoirs, soil erosion; other — constraints on water resource development imposed by competing land uses
2. water consumption — allocation equities; health questions; industrial and power requirements
3. impacts on water quality — broad-ranging and specifically located (or 'point-source') pollution; sedimentation; salinization, eutrophication
4. biological/ecological systems — flora and fauna conservation; wetland protection including groundwater relationships; fish management; roles of national parks and other reserves in catchment management
5. watercourse management — flood mitigation and control; sedimentation; in-stream uses
6. recreation — maximizing river-based opportunities; interactions of recreation and water supply demands
7. reservation of amenity and cultural heritage — compliance with national and state 'heritage' documentation and listing regarding rivers, riverscapes and significant catchment sites.

Source: adapted from Australian Water Resources Planning Committee, May 1987, pp. 3–4.

first, the attendant instabilities were counter-productive. Change itself seemed to have become addictive in some quarters. In return, critics charged that 'management' had been reduced to a synonym for undifferentiated 'change' — that is, with no substantive purpose other than disruption. That helped to draw a heavy veil of dismay and disillusionment across the genuine accomplishments of these transitional years. Later, it would be concluded that some of the positive outcomes included greater appreciation of the primacy of policy implementation and community involvement, and a renewed inclination towards inter-agency co-operation.

With the end of confident developmentalism, Western Australia braced to join the rest of the country in wrestling with the nervous nineties. Issues arising from urbanization and environmental degradation received remorseless publicity. The state's Environment Protection Authority and the mega-department of Conservation and Land Management *('CALM'*, a merger of authorities responsible for forests, national parks and wildlife management) quickly moved into prominence. But the messages on multi-dimensionality had been received, and it was soon evident that the reform process had not after all eradicated the old predilections for inter-agency jousts over territory, influence, and funding. Whatever its accredited fields of care, water management's historical centrality simply accumulated more significance. That was to be graphically declared in tense discourses over widening conservation themes and the provision of adequate water supplies for coming generations of metropolitan and non-metropolitan residents.

An Australian Heritage Commission had been established under the Whitlam and Fraser federal administrations in the mid 1970s. Its lofty aim was to create a process of broad consultation leading to the production of a national register of places that had been invested with special natural, cultural and social values. The imagery became blurred over the next decade, but the seeds were already sown: resource management agencies were encouraged and sometimes directed to work harder at defining and protecting those inscribed values. Perhaps too much of this was running on the spot, but the process stirred up local interest and served another notice on the surviving mono-functional technocrats. Federal initiatives are so often blunted by unimpressive timing, and that has been exacerbated by inadequate liaison with the states.

National surveys of land degradation and water resources drew mixed, sometimes hesitant responses around the country in the 1970s and 1980s, and much the same could be said of federal *World Heritage* initiatives leading to the creation of the first large and truly 'national' parks. Under the federal constitution the states had retained control of the fundamental natural resources, and each state claimed the advantage of unique legacies of hard-won lessons which presented too many opacities to outsiders. The trend was irresistible, however, and in fact there were tentative moves towards the achievement of national environmental 'standards'.

Futures

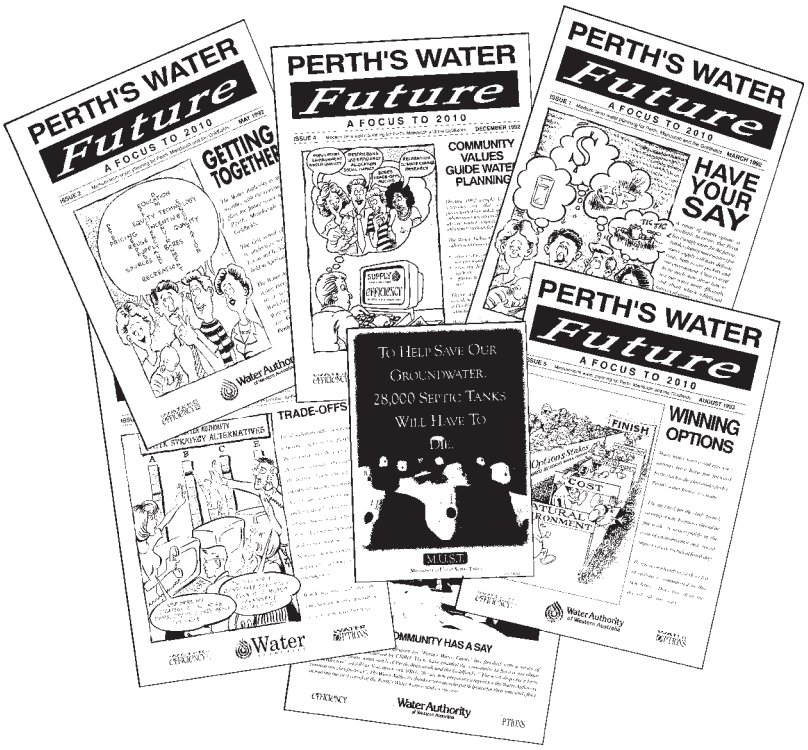
As the management policies and monitoring practices of each state became more exposed to national scrutiny, so the pace of organizational reform quickened. But that weights the federalist line. The rest of the interpretation finds unbroken trajectories at the state level.

The formal and informal educational thrust of the modern environmental movement clarified the special appeal of the peculiarly isolated third of a famously isolated continent. Biological complexity in the west had exhibited stunningly impressive adaptations to a range of arid, seasonally arid and Mediterranean environments — with erratic rainfalls, common yet still largely unpredictable droughts, and generally poor soils.

If the rich word 'settlement' implied transactional negotiating processes (as in disputes, business agreements, etc.), then western environments were only now having *their* say. Natural fauna, flora, soils and water resources had all been adversely affected by the European invasion. When that international buzz word 'sustainability' entered Australian discourse it had suggested new ambiguities. Alarmists now claimed that the *status quo* was actually a destructive vortex. Saner critiques recommended new management strategies to build a more satisfactory dynamic that was actually worth 'sustaining'.

According to a Department of Agriculture statement in 1988, the estimated annual cost of the state's land degradation problems exceeded $600 million. And in its various capacities water was deeply implicated, primarily or secondarily, in each of the cited types of degradation. A Select Committee of the state's Legislative Assembly decided to underline the achievement of *ecological* sustainability 'within the context of catchment plans'. It also advocated, amongst other things, a wider acceptance of the need to plan for the inevitability of drought visitations, greater attention to revegetation, especially reforestation, and improved efficiencies in rural production to reduce the pressure on natural resources.

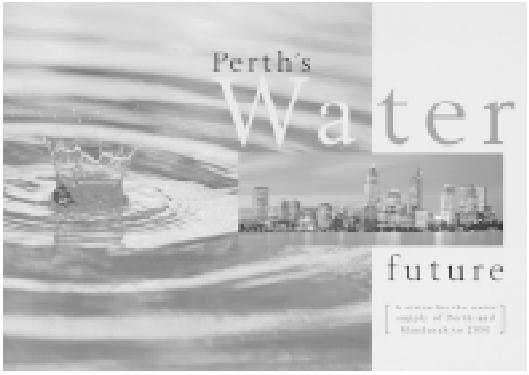
Recovery and rehabilitation were said to be dependent on new and revivified partnerships between government and



Canvassing community opinions: the new era.

people, incorporating better recognition of community initiatives, the design and research of development and education programmes, and the need for financial support and freshly tailored legislation to match the circumstances.

In terms of the main processes of deterioration, only about 30 per cent of the state's total agricultural area was considered 'stable'. The extent of salinity was predicted to increase relatively slowly in the drier east and quite rapidly in the wetter south and south west. Soil erosion and other stubborn environmental problems meant that about 20 per cent of the state's pastoral country was in poor shape. Compared with the exceptional



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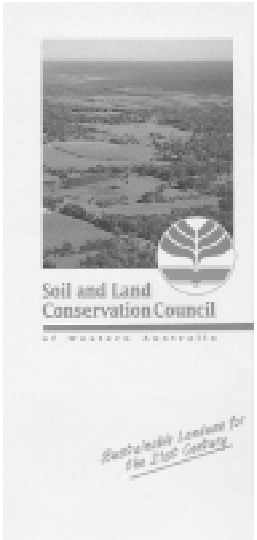
Movable Mountains?
Land Degradation Costs, 1988

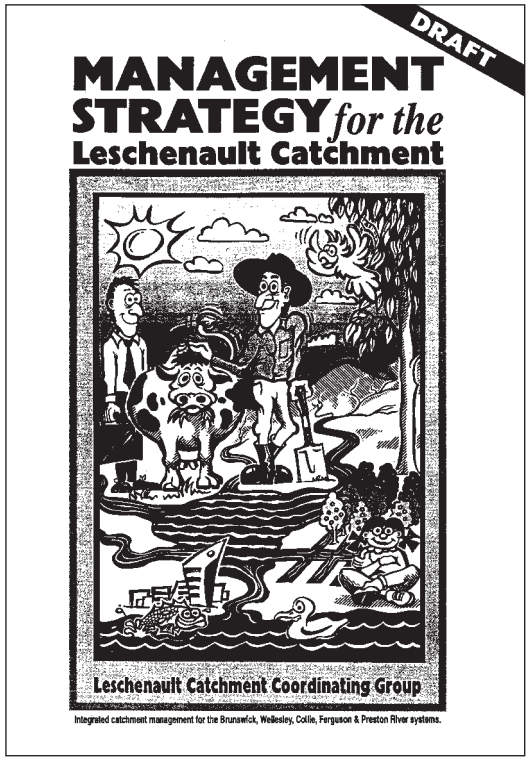
Type	Area affected *(ha)*	Estimated annual cost *($ million)*
Dryland salinity	2,880,090	1014
Waterlogging	1,800,000	90
Water erosion	750,000	21
Wind erosion	50,000	21
Soil structure decline	3,500,000	70
Subsoil compaction	8,500,000	153
Water repellence	5,000,000	150
Soil acidification	375,000	5
Vegetation decline in the rangelands	19,600,000	37
TOTAL COST		**$609 million**

Source: Department of Agriculture, Situation Statement, and *Final Report of the Select Committee on Land Conservation*, W.A. Legislative Assembly, 5 December 1991. Note that the estimates for dryland salinity were slightly updated and include almost 2.5 million ha of 'potentially' affected land; that there were 1.3 million ha under pasture which were said to be experiencing waterlogging in average years; that the estimate for wind erosion is qualified as 'variable'; and that the totals for the rangelands include 7.3 million ha affected by wind and water erosion. Note also that subsoil compaction, water repellence and soil acidification had received far less publicity — and less attention from specialist researchers, too. Satisfactory control measures had still to be devised.



continuity of the Aboriginal presence, the European invasion had occurred in the blinking of an eye (more appropriately, the cracking of a rifle). The speed of the transformation and the ignorance of initial conditions meant that the ecological consequences of the imported development imperative would never be fully reckoned.

No other Australian state exceeded the west in its number of rare, threatened and extinct species. More than 1,000 (15%) of its recorded flowering plants, principally (80%) in the south west, were listed as threatened or rare, and some 100 had become extinct. About 8 per cent of the 140 (presumed, 'pre-European') species of terrestrial mammals were also considered



extinct. Most of the mammal extinctions had occurred since World War II. The sorry overall picture is more reliable than the itemized statistics, but they are indicative. The information stung the consciences of environmentalists who were then beginning to exercise political influence, and helped to place the west in its national and international perspective.

The official adoption of an answering, state-wide conservation strategy would instruct specialist water managers to liaise with other experts and with the public in framing and implementing 'integrated' programmes of stabilization and rehabilitation. The resulting focus on catchment units was perhaps the best proof of an improved grasp of the ecological significance of the water factor. But regularly quoted inventories concentrated on land degradation and seldom distinguished a few emerging problems which were of singular importance in the west. Much of the value of two-thirds of the wetlands of the Swan coastal plain had been obliterated or severely affected by draining, filling, pollution and mining. And to the $600 million annual losses in agricultural and pastoral production had to be added the notional costs of stream salinization (approximately $41 million yearly) and of restoring the 'eutrophic' or

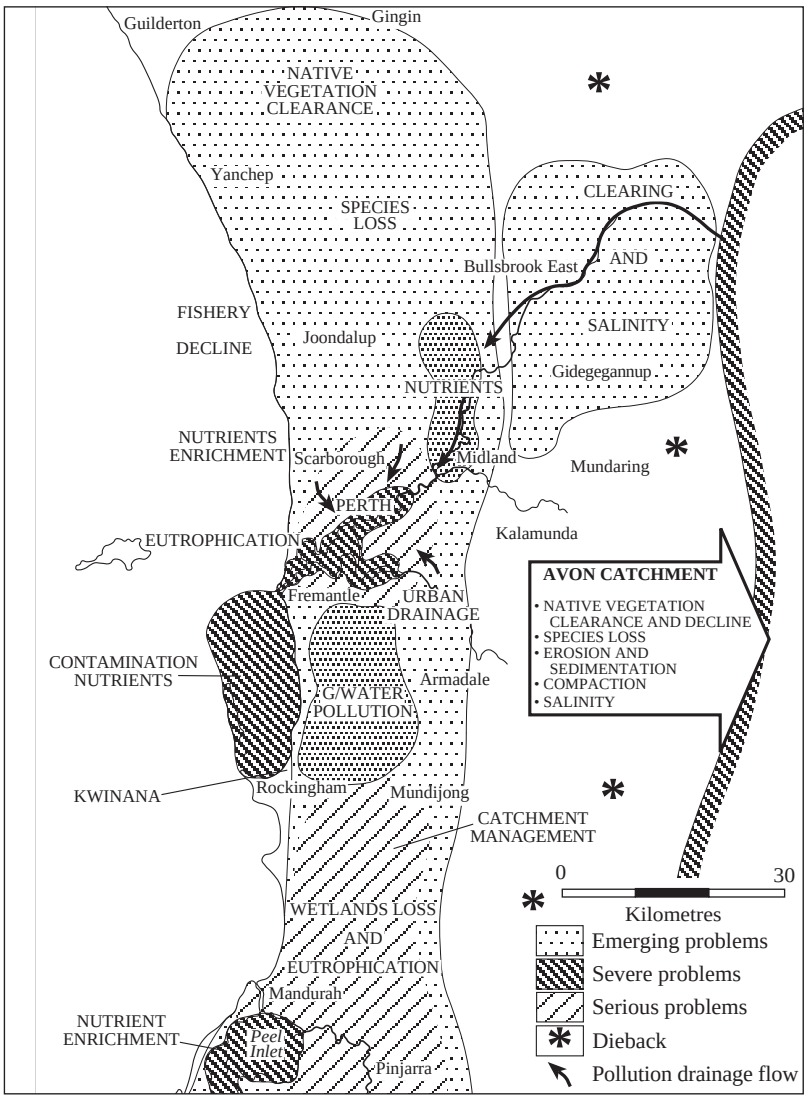
nutrient-clogged Peel-Harvey system ($100 million).

In the latter cases, the problems were partly related to clearing activities and the application of agricultural fertilizers. Elsewhere, industrial contaminants had been responsible for the degradation of coastal and estuarine areas. True to our interdisciplinary times, therefore, the water management field could not fail to become less exclusivist by the day. 'Context' had always had the edge; now it was chic to admit it. Much of that came down to a better-honed *sense of place*, as George Seddon's (1972) eloquent depictions of the Swan coastal plain had recommended.

The attendant debates should have exposed the populist reductions of the historic water theme to water supply alone. They should have brushed aside the absurd notion that the technocratic tradition of public service was best continued by the production of a few more monuments to old-time civil engineering. The new water game not only recruited adaptable players — here as leaders, there as supportive team members — but conceded that the management task should be *everyone's* duty and right. It recognized that the great age of heroic construction seemed over, throughout the western world. In Western Australia, there were even some fears that siltation was shrinking the capacity of Lake Argyle behind the Ord River Dam: the storage volume might decline by 40 per cent over the next century. And the modern game plans often gave equal or more weight to questions of water quality, to reconciling fiery controversies over allocation and pricing policies, and to revising legislation which no longer addressed current needs and expectations.

So, the culture of water management was opened up as never before to social science perspectives; but the list of new skills had the potential for exponential growth. The emergent maze increased the strain on existing institutional patterns. Here, there is only enough space for a short detour to two samples: first, the efforts to improve river management, partly independently but also in response to federal initiatives; and secondly, some effects of the combined influence of two unlikely bedfellows, economic and environmental issues, in fresh approaches to water management in irrigation districts.

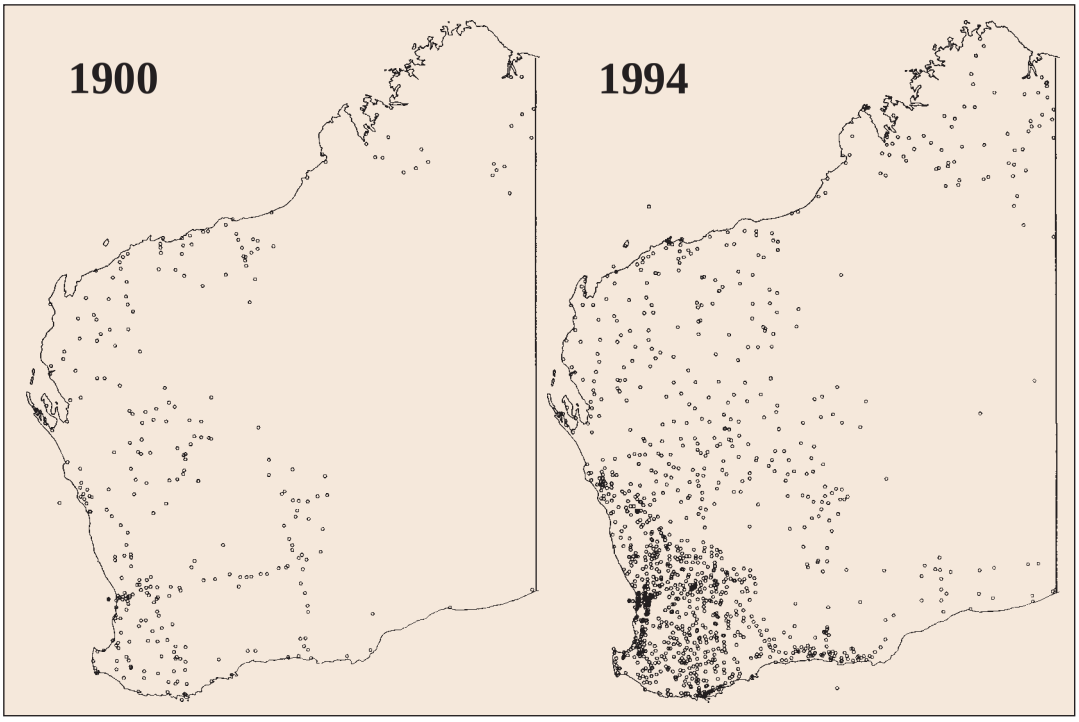
In December 1992 the Commonwealth government introduced a 'Monitoring River Health Initiative' to develop a national approach to the problem. Imported from Britain, the main idea was to fund a procedure based on the use of river-living

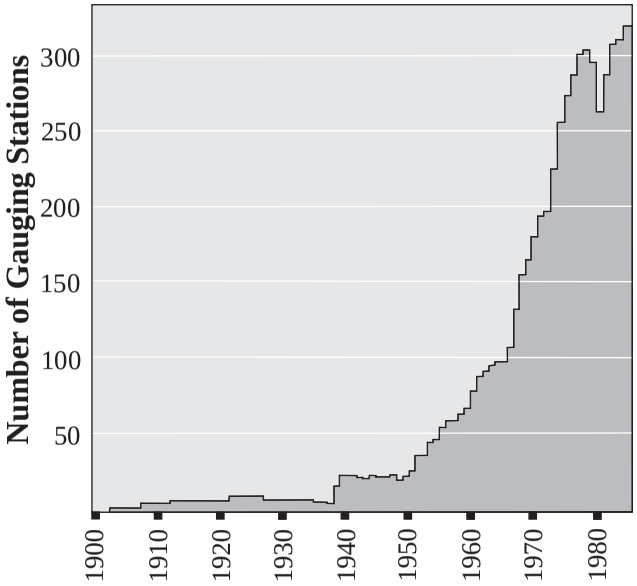


The Swan Coastal Plain and some of its emerging environmental problems. Modified from Singleton, 1992. Dieback is by no means restricted to the jarrah, though that notorious problem is emphasized here by Singleton: the process is also very apparent in parts of the coastal plain.

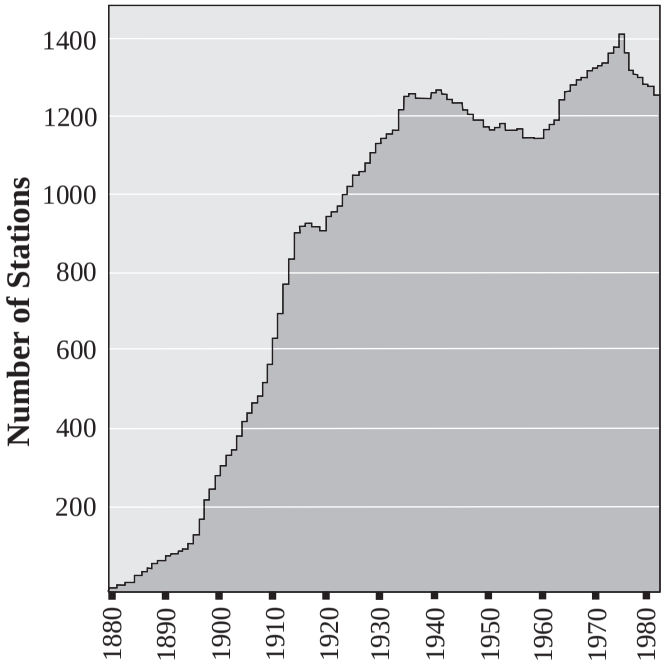
The successful British 'RIVPACS' (Riverine Invertebrate Prediction And Classification Systems) approach to river health encouraged the selection of some 1500 reference and monitoring sites around Australia, shown on this map.

Improvements in the state's coverage of environmental monitoring operations: basic meteorological sites, 1900–1994.

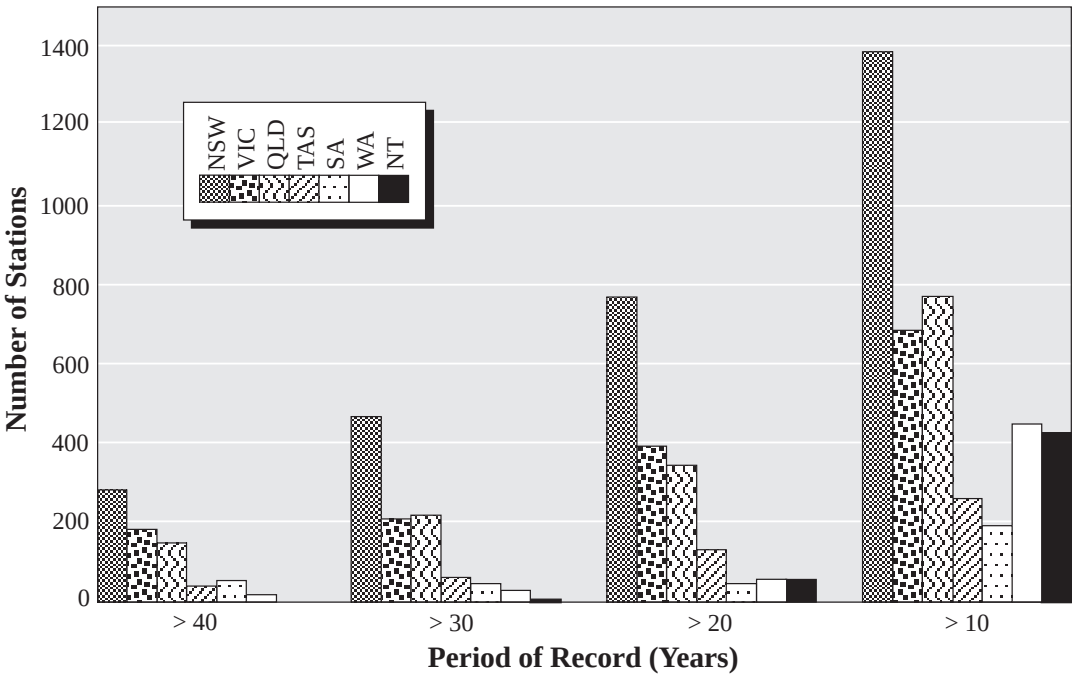




Growth of the state's stream-gauging network, reflecting the major advances made in the design of the data collection network and in the corresponding quantity and quality of statistical information since the late 1960s. Stream–gauging commenced in earnest under 'the Chief', C.Y. O'Connor, in 1897— on the Canning and Helena Rivers, in connection with plans for the Goldfields Water Supply Scheme. The formation of the Australian Water Resources Council in 1963, and the inception of Commonwealth financial support for monitoring in 1964–1965, provided the main turning points for Western Australia.



The increasing number of 'daily read' rainfall gauges in Western Australia, from 1880. The first modern **pluviograph** *or continuously recording rain gauge was introduced to Perth in 1946, but large quantities of reliable pluviograph data only became available after the commencement of a Public Works Department programme in the 1970s.*



Inter-Australian comparison of the number of flow measurement stations operating in 1983. Given the huge size of Western Australia, and its problematical regional diversity in rainfall and streamflow characteristics, it was not as well served as other states.

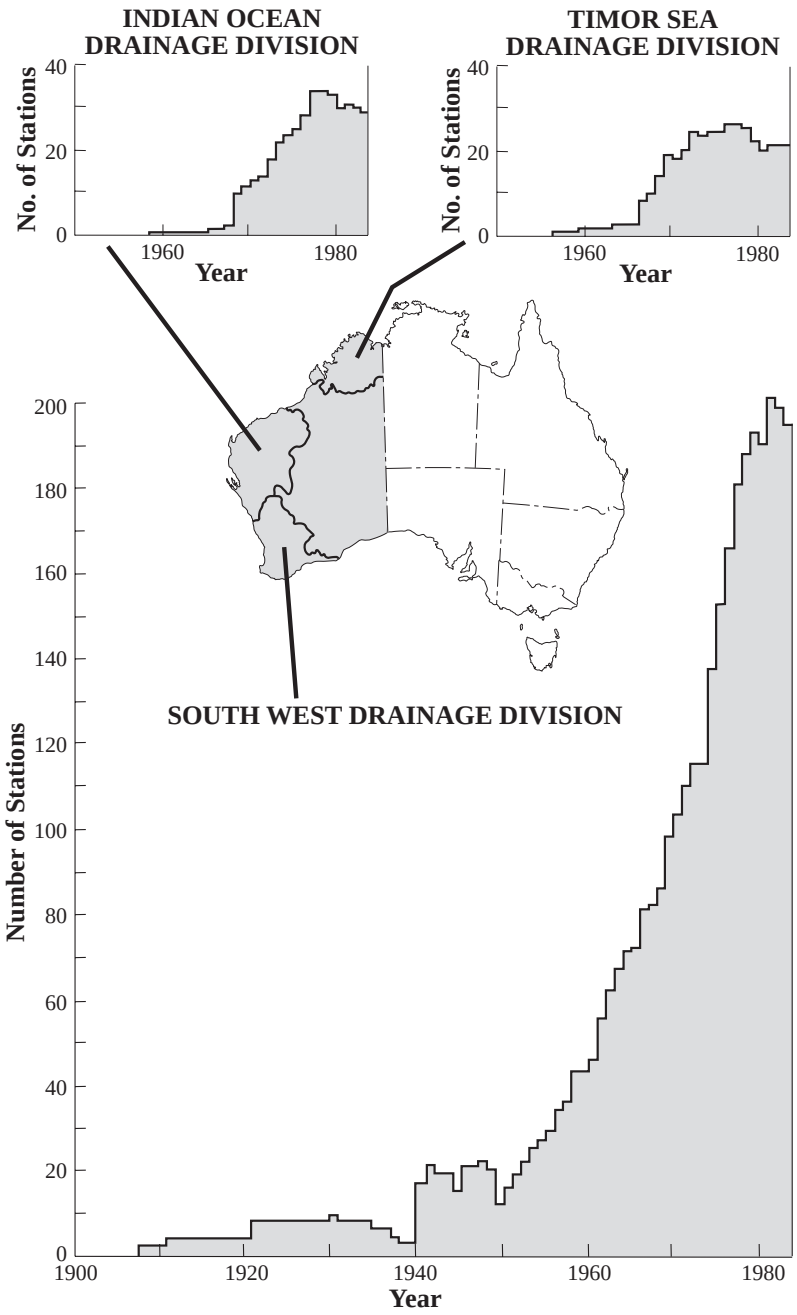
organisms as biological indicators of the health of aquatic systems. That would also help in determining the 'environmental flows' (as opposed to those harnessed for human communities) which would be required in each situation to maintain a well-functioning river ecosystem. The immediate result was a national River Health Programme. Other initiatives called for the identification and protection of wild and scenic rivers: inevitably, the enveloping framework affirmed the goal of *Ecologically Sustainable Development*, which might have achieved the status of a motherhood concept if it had not been left undefined, unidentifiable — a fate which is more often reserved for rogue fathers.

In their implementation, these programmes promised to knit a closer spatial texture into the states' management practices, and they uncovered a number of deficiencies. Fishermen, bushwalkers, campers, pastoralists, farmers and loggers had been saying for years that every river had its own personality. Now it was claimed that each watercourse probably had its own scientific fingerprint, too. If that was to be established there could be no substitute for painstaking analysis. Even if the methods were everywhere much the same, for management purposes the results were best evaluated along with an appreciation of proven local characteristics. Information bases were usually found wanting, and not only for scientific and technological measures: for example, too little was known about the various human demands which had scarred and trained the rivers since pre-European times.

Again, the push towards the integration of land and water resources management stressed the *interdependence* of rivers and their catchments, and simultaneously challenged the legacies of fragmented jurisdictions. Who, then, was to blame? Who was to pay? Could rivers be managed without managing their catchments? Could anything be done without 'managing' the catchments' human communities? Was it necessary or possible to re-organize administrative, political, legislative, ownership and other divisions and chains of command, so that they conformed to the natural units governing the river's behaviour and 'health' status? Even in the far south west, which was considered well-researched, Western Australia's managers became contracted to a copiously enriched documentation on most fronts.

The utopian challenge was to establish and protect *both* human and natural values, neither of which could be expected to be fixed for all time. Perhaps that was still too much to ask. Certainly it demanded even greater investments in interdisciplinarity and in the design of outreach programmes to invite the wider public into the change process.

Another restructuring was produced to speed the process. In January 1996 a



Generalized regional differences in the streamflow record. Note that these graphs do not distinguish the proportion of data considered 'adequate' for reliable management calculations. Even in the south west division, incomplete data sets were significant during the 1940s, 1950s and early 1960s. Monitoring was usually initiated later in each of the other two divisions, and the variation in the number of stations with reportedly adequate records was particularly marked in the Timor Sea division.

WATER AND RIVERS
COMMISSION

Water and Rivers Commission was formed from the merger of the Water Resources Division of the old Western Australian Water Authority, the Western Australian Water Resources Council, the Waterways Commission, and the hydrology and groundwater resources branch of the Department of Minerals and Energy.

Its declared function was to manage surface and groundwater resources, including rivers and estuaries, with a focus on the protection of environmental values and on the allocation of water for various uses to support sustainable development. Farming, mining and manufacturing interests were represented on the Commission's board, the relatively straightforward water services responsibilities were to be confined to a new water corporation, and the Minister for the Environment noted that there would be an obligation to give due attention to environmental, cultural, economic and social interests. There could be no plainer endorsement of the departures mapped in our previous paragraphs.

My second example is similarly indicative of a mixture of state and nation-wide movements. Australian governments were casting off their historic roles as resource developers. The insistent preference for 'Management' was intended to signify both a pulling back from the perceived extravaganzas of their predecessors and a candid admission that making do with existing assets made no more sense, where those assets were either running down or ill-adapted to the rapidly changing requirements of modern communities. Gradually, regardless of political colourings, governments became committed to supporting a range of rehabilitation programmes and associated institutional reviews at a time of escalating demands on their limited treasuries. Irrigation schemes, all too easily billed as the favoured offspring of wild-eyed patriots, tunnel-vision engineering and ambitious politicians, had been earmarked by economists and environmentalists over a number of years. They were obvious candidates for review in the reformist climate of the 1980s and 1990s.

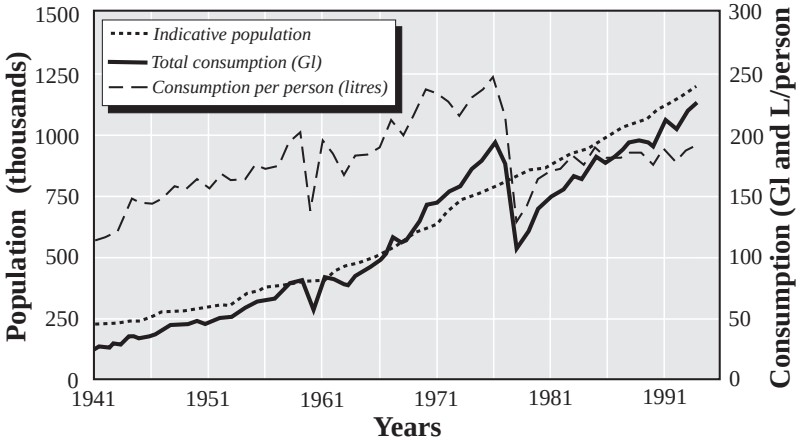
The new catch-cries were improved economic efficiency, less state regulation, more self-reliance, and more accountability from the irrigators themselves. The probing of salinization and waterlogging issues encouraged government specialists to recommend water allocation and water pricing changes to reduce wastage and generally maximize water use efficiency. 'Environmental flow' conceptualizations attacked the ingrained emphasis on narrower 'extractive' uses. At the same time, water agencies themselves were not immune to political commands that they be at least self-supporting, if not actually

profitable. And their pricing had to be shown to be 'economic': overt or hidden subsidies would not be tolerated.

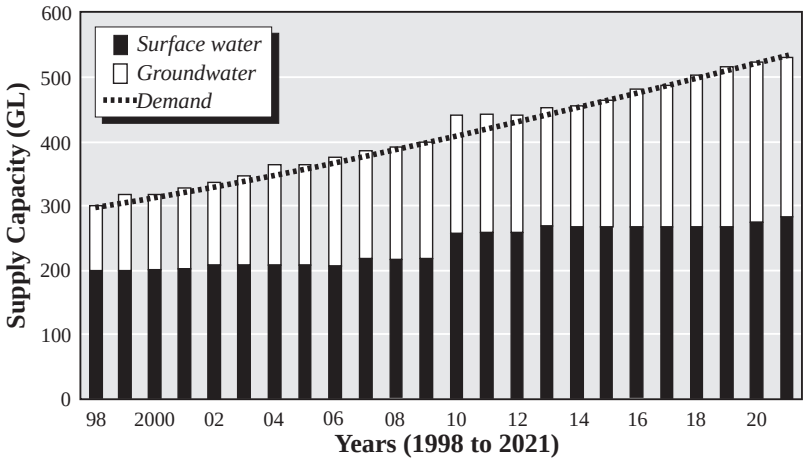
Bruce Davidson and others had anticipated the main essentials, of course, 30 years earlier. But as it took hold, the new mood became quite radical — for instance, it was patently more accommodating to a projected 'privatization' of community assets, and that would have dumbfounded the first pioneers. Seen in this light, the attempts to convert allocation and pricing policies built an interesting transitional platform. Each state conducted its own experiments, but some had an across-the-board national appeal. For instance, the idea of *transferable water entitlements* encapsulates the ruling intentions and points to the level of difficulty.

Inherited allocation and pricing models tied each water *right* to a particular parcel of land. Yet rights and *needs* seldom coincided, even on the compact, standardized blocks of most early schemes. Water needs might vary widely between different kinds of irrigation enterprise. Historically, when some irrigators had chosen to exhaust their full 'right' that might have constituted overwatering, whereas others with different enterprises and abilities to pay might have been in a better position to make use of the surplus. Under newly-trialed regulations, this hallowed land-water nexus was broken and transferability became possible. There could be local water trading. Theoretically, the increased flexibility would foster the evolution of a more rational system which maximized the economic benefits and minimized the environmental damage.

This surprising solution was fraught with administrative and legalistic tangles. For example, where western irrigators were dependent on surface supplies and the basis of allocation was the rated area of land, in reality allocations varied with the amount of water available in the scheme — so that the entitlement was to a share of the available supply, and not to a specified volume. Supplies varied over time and in that regard schemes also differed from one another; furthermore, they could be said to differ in terms of longevity. Pricing should reflect all of these factors. Early recourse to auctions, plain and simple, was sometimes considered an abrogation of public duty — and with so many unknowns could obviously backfire on those government bodies which retained the brief for fiscal



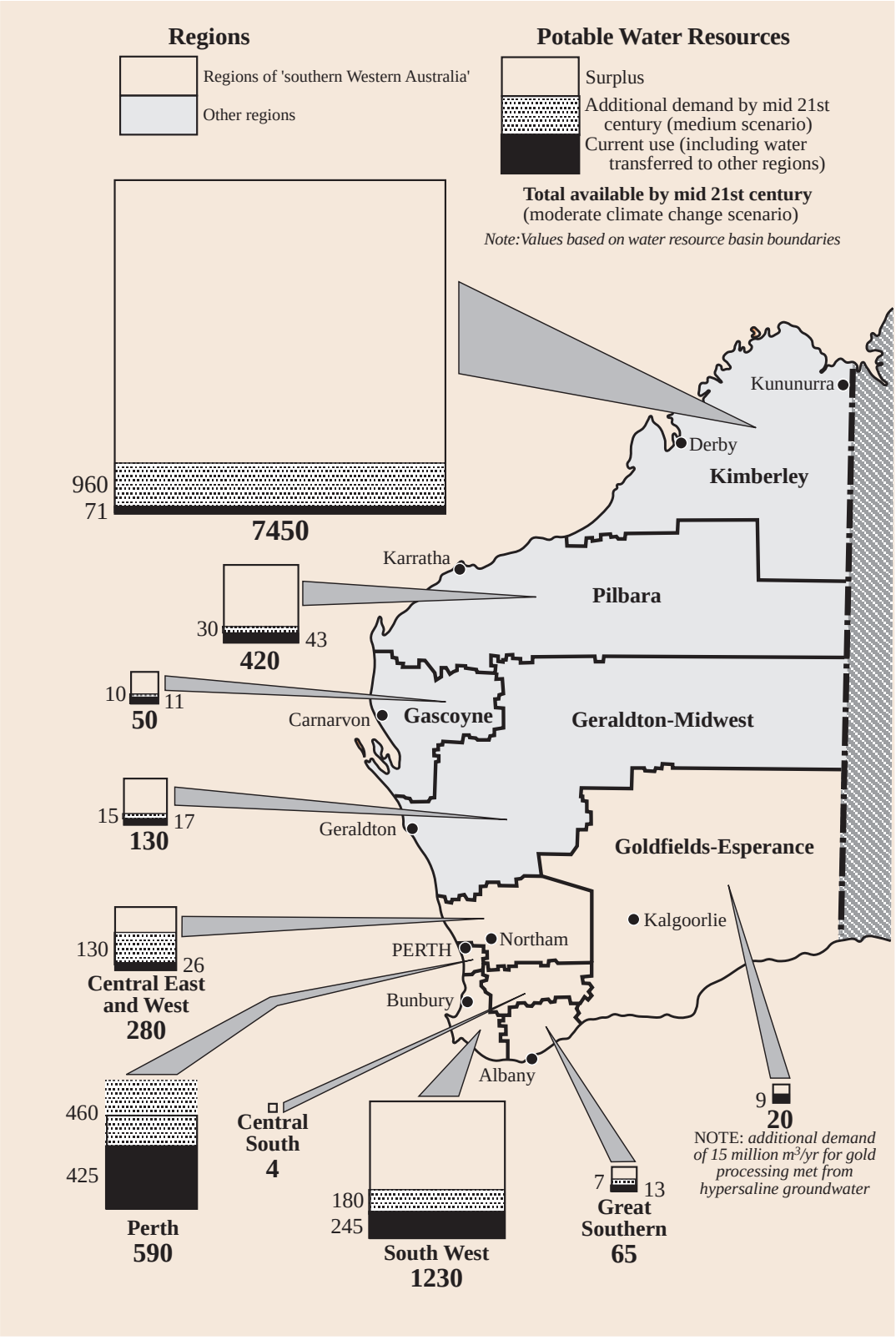
Perth metropolitan water use, 1941–mid 1990s. A trend line indicates population growth. Water restrictions were imposed during the later 1940s and 1950s; more stringent restrictions were required for almost two years in the mid-1970s and this, with the subsequent introduction of 'pay-for-use' excess water rates, produced the significant decline in water use which is picked out on the diagram. The more recent rises occurred despite the increase in the use of* private *bores for gardens.



A perspective on Perth's water futures, showing a potentially increased reliance on groundwater. 'GL' = gigalitre: that is, one thousand million litres or one thousand megalitres.

responsibility, environmental monitoring and so on. All of that was further complicated by the extension of the flexibility principle to include a leasing option for short or lengthy periods. Pilot runs offered the wisest route.

Transferable water entitlements were touted as a market mechanism which would direct water to those who valued it most. What if a *government body* saw an opportunity to participate (compete) in order to effect a restructuring for the benefit of the Western Australian public as a whole? That scenario might very well arise where a strong case was made for the transfer of water from irrigation areas to urban consumers. Again, groundwater



A perspective on regional water resources, distinguishing between current and predicted demands. Perth's predicament and apparent 'importing' options are suggested. The unit employed is millions of cubic metres per year. Adapted from Western Australian Water Resources Council 1988.

supplies, uniquely significant in Western Australia, were clearly less amenable to orthodox legal reckonings and posed special questions: how, then, to implement transferability in districts of *conjoint* surface-groundwater use? Effective trialing therefore had to address an array of situations, from the older irrigation districts in the south to Carnarvon and Broome in the north.

These ramifications did not present insuperable obstacles, and in the mid-1990s the principle was continuing to garner support. With one exception, the debate had been too nuanced to appeal to the community at large. I have alluded to the hypothetical situation in which a transfer is made from rural to urban consumers. In the public imagination, *the* water issue was the constantly nagging tension over future metropolitan supplies. Good progress was made towards earthing that anxiety during the 1980s and 1990s.

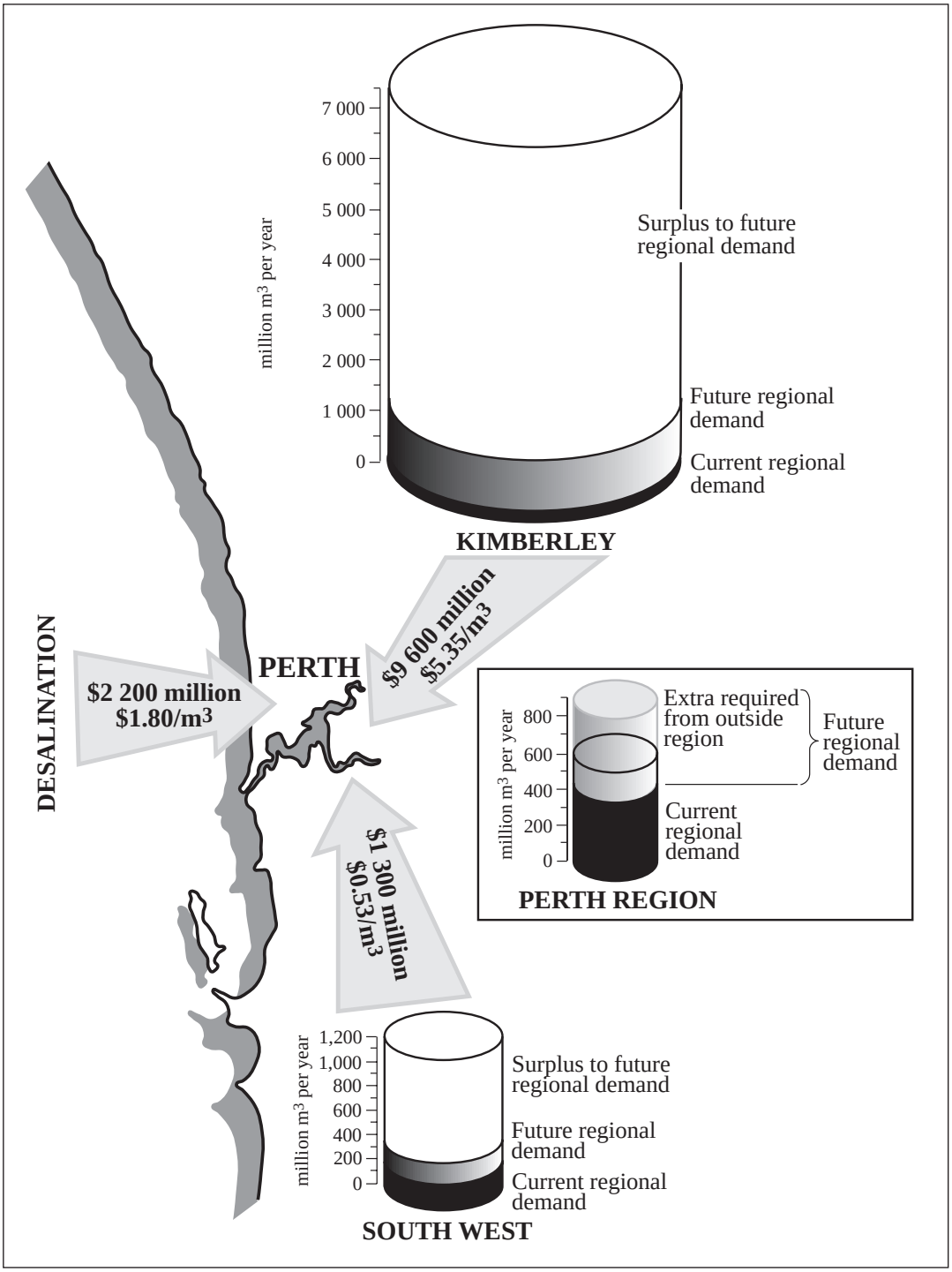
The first big initiative came at the end of the 1980s. At that point, Perth's residents had become familiar with periodic water restrictions and there had been growing concern over scientific speculations on the drying effects of the puzzling Greenhouse Effect in the south of the state. But the Water Authority's sources development programme had been well primed to cope with Perth's anticipated growth into the first decade of the new century; similarly, water efficiency had been very actively encouraged by the Authority, and it sought community participation in open reviews of its programme every two years. The anxiety remained, and the State's Water Resources Council was directed to investigate long-term options. Its report, *Water for the 21st Century* (1988) offered the following robust findings —

- despite the strong growth in demand, and allowing for climate change, southern Western Australia did have 'viable future supply options';
- the known water resources within the wider south west region itself were sufficient until the middle of the next century;
- the central issue was not availability, but cost;
- increased water use efficiency could be expected, and that would extend the margin of safety over a lengthier period.

Perth's Water Supply Options, 1988

Source	**Annual yield** (millions of cubic metres)	**Cost** ($ cubic metre)
1. Forest thinning	29	0.05
2. South West sources	810	0.53
3. Moore subregion	110	0.54
4. Excess drainage	40	0.30–0.55
5. Brackish water	37	1.00
6. Wastewater re-use	43	0.70–1.70
7. Sea-water desalination	>500	1.80
8. Kimberley tankering	>300	3.30
9. Pilbara pipeline	210	4.90–5.10
10. Kimberley pipeline	870	5.35

Source: WAWRC, *Water for the 21st Century* (1988). Note that this ranking is only by cost. The determined standard yield required of the legitimate options was 300 million cubic metres, which was the estimated additional supply needed for the region by 2050. Wastewater sources were not intended for domestic purposes.



Water supply options for the Perth region, on the basis of a predicted need for an additional 300 million cubic metres annually. Adapted from Western Australian Water Resources Council 1988.

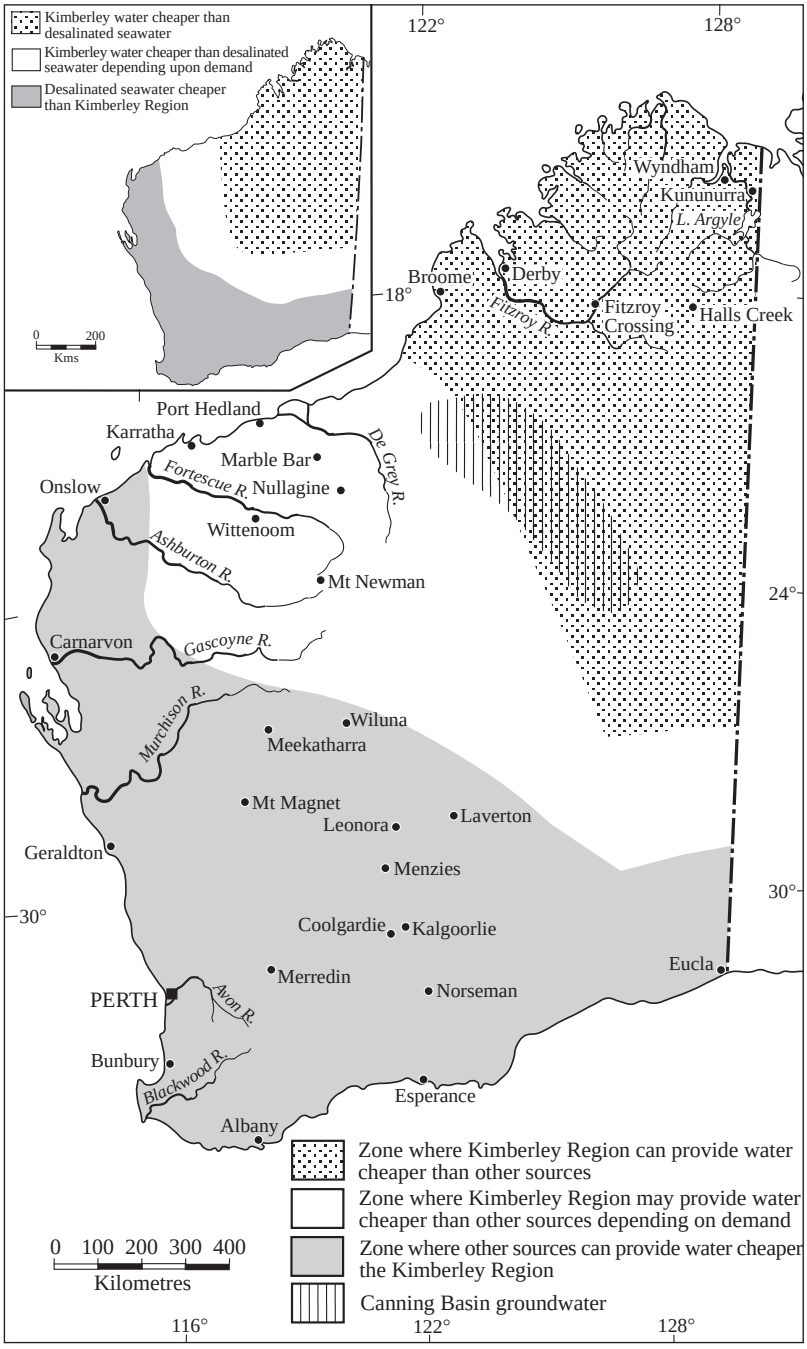
The report addressed the leading ideas which had been attracting comment, but cast its net still wider. *Sea-water Desalination* was an obvious candidate because the supply was close and virtually unlimited. Its unit cost was set at about $1.80 per cubic metre, and that provided a convenient upper limit against which the other options could be measured. It was largely rejected on the grounds of cost and because of prohibitive energy implications, but was ranked second overall. A notional *Kimberley Pipeline* was ranked last. It was more costly than the desalination option, more sensitive to variations in demand, and required a large energy input (because it would be pumped).

The best option was entitled *South West Sources*. It offered both low cost and large volume, and would only fail to meet requirements under the worst combination of climate change and demand growth. One

qualification was that a transfer of groundwater from the Moore subregion north of the city might provide a supplementary supply. Other suggestions included strategic *forest thinning* (to increase runoff into reservoirs), which seemed 'unproven' environmentally; and the increased use and re-use of *brackish water* (desalinized), *excess drainage water* and *wastewater*, which would probably not compete for some decades on economic grounds.

The goldfields had maintained their historic link with the metropolitan system. They could be supplied from existing sources and from saline groundwater, unless they experienced another amazing boom. In the latter event, their best options were freshwater from the west (supposing the saline rivers question had been answered) and possibly sea-water from the south. Although Perth, the leading market, was located outside the economically competitive range of the prospective Kimberley river sources, they might eventually be tapped for irrigation and mining developments in the Pilbara as well as in the far north.

Earlier government publications had tried to defuse excited speculations on the towing of suitable Antarctic icebergs to moorings off the coast, and that issue was not revisited in *Water for the 21st Century*. The verdict had been that, with current technologies, there were too many unknowns and the grand theatrical gesture was bound to be too expensive. Yet assignment to the science fiction category might even be twisted to serve as stimulus in the driest of the inhabited continents, and the dream went on. Generally reassuring, almost all of this, and rather more than



Water supply 'cost preference zones', comparing the harnessing and transportation of potential Kimberley region supplies with other options for Perth. Adapted from Western Australian Water Resources Council, 1988.

steady-as-she-goes therapy. On the contrary, as the vanguard statement in an earnest public information drive — acknowledging a new, Australia-wide rhetoric of open government and appeals for a de-mystification of technocratic expertise — it had tackled populist remedies head-on. Into the early 1990s, community participation was more assiduously courted in a carefully stepped progression from information-sharing to debated options and the determination of funded policies. Echoing the battles over environmental issues in the

***Large-scale catchment management at West Dale, 60 km west of Beverley. By courtesy Alcoa Pty Ltd. And* Western Australian Journal of Agriculture.**

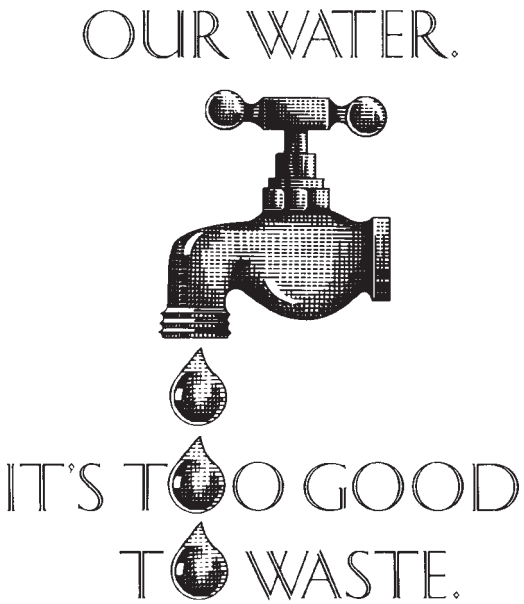
1970s and 1980s, this approach was becoming representative of a fairly standard expectation across the government sector.

The water discourse retained a certain aura, but the state's other managers had taken the same route or were preparing to do so. Whatever the theme — town and regional planning, national parks and conservation areas, resort development roads, power — the government's desire for a stronger partnership with the community was repeatedly declared. One excellent example was an energetically tailored three-year programme which led to the publication of well-crafted documents on *Perth's Water Future* in June 1995.

The familiar concentration on the big issues of development in the south west therefore extended a century-old regional preference. Historically, this can only be seen as assertion, not inertia. Aptly, the strategy focussed on the full regional panoply — officially, the Perth, Mandurah, and Goldfields and Agricultural Areas water supply system. It was then serving a total population of over 1.2 million; the total was expected to grow to 1.7 million by 2011, and possibly to 2 million by 2021.

Total water consumption was reflecting this expansion and a generally increasing community and industrial usage, despite a number of efficiency drives. That meant that the existing system would be fully utilized by 1997–98 and would require augmentation in the early years of the new century. It was broadly envisaged that some 86 per cent of the additional capacity up to 2010 would be supplied from groundwater sources. Thereafter, surface water might be drawn from the south, requiring a new dam at Harvey; but by 2021, groundwater would still be furnishing half of the total supply.

Perspective



Government and people were still locked together in debates over water resources. That had been so under Governor Stirling and under Premier Forrest, and on through all the years of wheat frontiering and irrigation pioneering. The relationship was often uneasy, no matter what the context, but in the water discourse the dialogue over critical needs tended to subdue other concerns. Potential for disputation naturally grew with the gradual emergence of a modern pluralistic democracy, and as economic, environmental and social issues generated a range of interpretations and aspirations.

Whereas the immensity of the water challenge usually dealt the primary tasks to government managers, its very complexity and of course its expense demanded tenacious public consultation. The detailed record underlines a persistent input from individuals and district communities, not only in the implementation of policies but also in the elucidation of problems and opportunities, and in the creation of solutions.

Some of that engagement was conducted at the most intimate of local scales which my account has shunted aside or disguised: nineteenth-century discussions on the multiple roles of wetlands and the contentious juxtapositions of wells and cesspits, then those ingenious condensers on the goldfields; later, the collaborative development of rock catchments and roaded catchments, and the introduction of drought-evading crops and crop-rotations. In comparison, subsequent events on the Ord and in the Pilbara seemed so remote and so emphatic in scale as to exclude community participation, but not so. Both attracted public controversy: the first at national and international levels as well as within the state; the second provoking influential reactions from the west's environmentalists.

Success has many fathers, but failure is usually a bastard. When development was found to have overstepped the mark and there was culpability to apportion, past and present governments received their share — that is one of the more comforting constants about politics — but if joint enterprises are to continue to function, partners are well advised to sign on the bottom line together. Governments may have prepared the way for regional overloads and indiscriminate tree clearing, but they were often urged to do so by their electorates. Furthermore, there is ample evidence of instances in which government managers have failed in their efforts to dissuade private property owners from clearing large tracts of vulnerable country — that was pointed out in an earlier section on the south west rivers.

In all of this turmoil, one of the most profound and most Australian of dilemmas was that both partners dealt with stressful conditions of *environmental uncertainty*. From the beginning, that has necessitated a fair amount of trial-and-error. The unavoidable corollary is that the development orientation which dominated

most of the state's recorded history of water management contributed priceless lessons about an environment which had been utterly foreign — an environment which seemed to put on fresh layers of significance, again in distinctively Australian fashion, with every decade. It led to and repeatedly reinforced an early concentration of effort on the south west. But in addition, if the great agricultural, pastoral, mining and metropolitan regions are the products of that learning process, then clearly their perennial transformation still offers instruction.

Western Australia's water specialists graduated from township wells and ditches to a defensive shoring-up of early frontier gains with a peppering of holes and tanks and reservoirs. Then they moved on to sophisticated environmental monitoring procedures employing computerized rainfall and river gauging devices, and electromagnetic testing of salinized country. Ultimately they achieved the maturity of a more richly informed conservative position which counselled against quixotic investments. The capital and the country towns became more respectably 'sanitary', but in that regard isolated Aboriginal communities still required special assistance in the 1980s and 1990s.

On several occasions, water management institutions had been refashioned in an effort to increase their responsiveness to contemporary state and federal contexts. In the 1990s as much as in the 1890s — and indeed in the 1930s and at every other critical juncture — practical water management ideas were transmitted from the specialists' camp into the public arena. Schools and community groups were deluged with literature, sprayed by water experts. And water's irrepressible ubiquity was finding so many openings — from ideas for the redesign of household appliances to the planning of new subdivisions, with a view to reducing water use and maximizing groundwater recharges. Water management's part-natural, part-constructed inclusiveness was also bringing a reverse flow of ideas — notably from community-based *Landcare* operations which had been delving into the mysteries of 'integrated catchment' planning.

Some of the most recent developments were the products of a mixture of national — and to a certain extent international — influences, and responses at the state level. For example, in 1994, a 'COAG' meeting (of Australia's premiers and the Prime Minister) agreed to cooperate in the implementation of a strategic framework for improved efficiency and sustainability in water management around the country. The required package of measures would address the economic, environmental and social implications of 'future water reform'. But the resulting focus on water allocation and tradable water entitlements soon became officially attached to a National Competition Policy, and one of the intentions was that, if the specified reforms were not in place by the end of 1998, 'defaulting' states would not receive the payments otherwise due to them under the terms of that policy. This decision stimulated a flurried combination of moves to ensure the necessary advances — in applied water science, to give greater assurance that the base data and fundamental understandings were correct; in the promotion of cost recovery principles and commercialization; and to remove inherited legal obstacles to the reconciliation of market and property rights with 'public trust' matters, such as environmental sustainability.

Uncertainties still abounded. That situation had been as endemic in the western third as in the rest of the country. But there was great hope, surely, in the recent trend in water management, which was undeniably away from the seductive development imperative towards a more adaptive yet vastly more guarded mode. One important if only vaguely defined component in that increased elasticity was claimed to be a greater 'accountability', which could be taken to imply the superiority of political over technocratic responsibility and expertise.

As usual, however, the record finds more continuity than change. For every C.Y. O'Connor and Russell Dumas there was a John Forrest, a David Brand or a Charles Court behind the scenes. The argument should be over the quality of the music, not about who calls the tune. A point had been reached when Western Australians felt entitled to expect lasting improvements in composition and execution.

Glossary of Terms, Expressions and Abbreviations

The following selections are offered to assist readers through the minefield of accessible scientific, technical and specialized historical literature which addresses the Australian experience of water management. Some are adaptations of common water sector terms and expressions previously included in my '*MDB*'. *The Emergence of Bioregionalism in the Murray-Darling Basin*. Others have been extracted and modified from recent management publications produced in Western Australia. The list has been tested with students at Monash University.

abstract to withdraw water (e.g. from an aquifer)
acidity see soil acidity
aesthetic arguments for conservationism refers to protests made on the basis of an appreciation of the beauty of the environment
afforestation deliberate planting of trees, usually in treeless areas or where the tree cover is sparse
AHD Australian Height Datum, a reference level which is approximately the same as mean sea-level
alluvial river (water)-borne
aquifer a water-holding underground layer of rock which is sufficiently porous to allow the movement of water; yields water to springs and wells
artesian bores tapping groundwater confined under sufficient pressure to force the water to the surface (under sub-artesian conditions the natural pressure is insufficient; pumping may be required)
artificial recharge refers to means of deliberately adding water, usually to groundwater reserves and wetlands

bank (river) margin of a river
bioregionalism an array of modes of thinking in the fields of resource appraisal, planning and environmental management, which focuses on a recognition of ecological integrities and therefore accords a central role to the utilization of natural units, including river basins
bluebush variety of saltbush, roughly the colour of sage and widely considered good sheep fodder
bores see wells
burning-off deliberate and systematic destruction by fire of unwanted land cover, including remnant plant material such as spent grasses and straw subble on cultivated land; normally with the intention of improving or maintaining productivity

cartography map-making, map-drawing
catchment the surface area from which runoff flows to a river or any other collecting area or reservoir, such as a groundwater aquifer or wetland
civic action independent engagement in decision-making, seeking an expression of responsible citizenship
civics theory of the rights and duties of citizenship
clear felling complete removal of tree cover
Closer Settlement government-sponsored intensification of settlement in older-settled districts; commonly included the repurchase and subdivision of large freehold properties
conductivity the electrical conductivity of water is a measure of the resistance of that water to electrical current or electron flow; used as an indication of the amount of dissolved salt
confined aquifer an aquifer confined between an upper and lower layer of relatively impermeable material
conservationism originally, a belief in the careful management or use, but wise-use of resources for the benefit of future generations as well as the present; later, applied more specifically to principles of 'preservation', with far more emphasis on the cessation of development
contour banking creation of small linear mounds across slopes — i.e. following

specified 'contours' or lines on a map which connect points at the same altitude

corporate management a major thrust in the desired organizational reform of Australia's private and public sectors; emphasizes the drafting of comprehensive plans and explicit goal-setting

cotton bush another variety of saltbush, roughly reminiscent of cotton; considered good livestock fodder

creek generally in Australia refers to any seasonally inundated channel of variable size and shape, but locally the implication is that it is considered smaller than a 'river' or 'stream'; elsewhere, refers more specifically to a narrow coastal inlet or sometimes the tidal estuary of a river, so that *salt* water is implied

CSIRO Commonwealth Scientific and Industrial Research Organization

cultural refers to ways of living

cultural landscape patterns of settlement and types of land use which mirror current and past ways of living

'cultural purposes' statement of water management aims to maintain natural, historical and sacred values which are the focus of scientific research, education and related cultural attention

dam a structure placed across a slope or river valley to store runoff or stream flow and allow it to be diverted for water supply use or released in a controlled manner for downstream use

decentralization government initiatives to counter a perceived over-concentration of population in the major cities and provincial towns

desertification a wide range of natural and human-generated processes associated with the serious deterioration of the productive capacities of regional environments; salinization, soil erosion and soil exhaustion are peculiarly significant contributors

development imperative a national preoccupation with material progress dependent upon resource exploitation

dieback refers to the poor condition exhibited by native trees over large areas; the major visible symptom is a dying-back from the crown, though some diagnoses locate the problem in the roots; principally ascribed to a variety of ecological disruptions

discharge areas or zones localities in which upward-moving groundwater appears on the surface of the soil

discharge the volume of water moving past a chosen point in a channel or stream; discharge rates are measured per units of time (e.g. megalitres / day)

dispossession theme applies in Australia to the taking of land from those who were (presumably) its first human owners, the Aboriginal communities

diversion mainly refers to the development of a water resource to harvest some or all of its divertible water

divertible water the average annual volume of water which, using current practice, could be removed from developed or potential sources on a sustained basis at rates capable of serving urban, irrigation, industrial or extensive stock uses; does not include minor sources

drainage interceptions and removals of excess water by artificial or natural means

drawdown the decline in water level due to abstraction

dry farming a suite of methods introduced to maximize the available rainfall in the drier districts of wheat belts; originally included a heavy reliance on the well-timed planting and harrowing of the soil during a lengthy fallow period to improve weed control and the retention of water and mineralized nutrients; carried to the extreme, it was sometimes implicated in widespread soil erosion

dryland salinity salting of non-irrigated land; commonly caused by hillslope clearing which produces a rise in water tables because of the increase in the intake of rainfall

'Dust Bowl' refers to episodes of severe environmental deterioration in the USA during the 1930s, triggering widely-publicized 'dust-storms' which removed vast quantities of invaluable top-soil

ecological a description of the science of the natural relationships of organisms to their environment

ecological arguments for conservationism stress the need to recognize and protect natural integrities and interdependence

economic rationalism a compelling

inclination, dubbed 'fundamentalist' by its harshest critics, to stress the supremacy of the profit motive

ecosystem a community of interdependent plants and animals together with the physical environment which they inhabit and with which they interact

edible scrub most often refers to the incorporation of naturally-occurring shrubs and trees into the feeding regime on pastoral holdings

empirical testing trial-and-error methods employed on farming and grazing properties, especially but not only in the pioneering phases

environmental pertaining to the natural and / or society-modified milieu

environmental degradation decline in the quality of natural resources, frequently but sometimes extravagantly ascribed to human activities

environmental determinism view that the environment controls the pace and direction of human activities

environmental impact statements detailed descriptions of environmental effects of proposed developments; also known as environmental impact assessments

environmental impacts see above

environmentalism ideology and practice deriving from a deep-seated concern for the environment

ethical arguments for conservationism insist on the recognition of the natural rights to existence of all elements of the creation, including humans

Eurocentric in Australia, a bias towards white or European-centred ideas and attitudes, to the exclusion of other cultural legacies

eutrophication enrichment of a water body with nutrients: natural eutrophication refers to the natural nutrient enrichment that results from deposition of organic material, leaching from soils, etc.; cultural eutrophication refers to nutrient enrichment that results from human activities (e.g. fertilizer, run-off, industrial effluent, sewage outfall)

evapo-concentration the increase in the concentration of dissolved substances in a waterbody due to evaporation

evapo-transpiration the combined effect of transpiration by plants and direct evaporation

evaporation basins the employment of natural and artificial depressions as reservoirs for the receipt and disposal of unwanted saline water

evaporation rate measurement of the loss of moisture

'extensive' irrigation the early profligate watering of grassland and crops on broad acres, in contrast to the subsequent tightly regulated and smaller-scale applications

extraction zone area within which wells can be used to extract groundwater for diversion; may be separate from recharge areas for confined aquifers

fallow the resting of land for a season or more: see dry farming

feral animals hitherto domesticated animals which have succeeded in establishing themselves in natural, semi-natural and modified environments, usually at considerable environmental and economic cost

field sciences centred on actual observation and survey as well as upon laboratory experiments; grew rapidly after the publication of Darwin's *Origin of Species* (1859) supplied momentum with a theoretical proposition

fish trap (Aboriginal) product of the intervention of indigenous water managers to deploy rocks and small makeshift (rush, etc.) dams to manipulate the hydrological system in such a way as to farm fish and eels in rivers and swamps

freehold signifies permanent private ownership of land

geo-hydrological studies of the nature and behaviour of groundwater; also referred to as hydrogeological

gigalitre one thousand million litres or one thousand megalitres; expressed as 'GL'

grazier rural producer engaged in commercial livestock farming; often but not always differentiated from 'pastoralist' by the implication of a somewhat smaller scale of operations

groundwater sub-surface water in a saturated zone of the soil and / or a geological layer; see also aquifer

groundwater area (GA) in WA, an area proclaimed under the Rights in Water and Irrigation Act (1911) in which private groundwater abstraction is licensed; within the Perth–Bunbury Region, groundwater areas were defined under the Water Authority Act (1984) for the protection and

management of the resources; those identified as major scheme supply sources were protected as Groundwater Reserves or Public Water Supply Areas

gullying process of erosion associated with the concentration of run off (see below) and the creation of deep gashes in the land surface; the channels thus formed may remove large quantities of soil

habitat the particular type of environment occupied by an organism or organisms

hydro-geological see geo-hydrological

hydrographic records accumulation of statistical and other data representing stream behaviours over time

hydrological description of the study of surface water and groundwater

hydrophytic refers to plants whose habitat is water or very wet places

impermeable non-porous, not allowing water through

infrastructural support (for pioneer settlers) especially with regard to the provision of transport and credit facilities, marketing advice, agricultural research, etc.

'inland sea' in the Australian context, the great geographical conundrum of the nineteenth century: the notion that an immense body of water (and possibly a mysterious, advanced civilization) would be discovered in the centre of the continent

interception refers to rainfall caught and held on the leaves of trees and vegetation before reaching the ground and returned to the atmosphere by evaporation

lake basins that are permanently inundated; cf. swamplands

land degradation essentially, a decline in the quality of soils and land cover commonly caused by human activities; but this cannot be divorced from the effects on climate, landforms (see topography) and hydrology

land ethic insistence that a moral-ecological dimension puts limits on society's freedom of action in and with the natural environment

laser-grading employment of laser-guided technology in the surveying or re-surveying and re-profiling of land to ensure more efficient drainage and irrigation

leaching removal in solution of soluble salts and minerals by seepage of water

leases contracts permitting the occupation of land for prescribed periods under certain conditions

locks enclosures made in regulated rivers to facilitate the raising or lowering of water

mineable storage (groundwater) non-replenishable reserves of groundwater additional to the divertible groundwater resource; the volume of water practically extractable on a once-only basis from a groundwater storage, obtained by lowering the storage from normal levels to new equilibrium levels

New Deal a major period (c. 1933–41) in US history, when the administration of President F.D. Roosevelt became committed to a range of relief and reform measures based on the achievement of 'planned' objectives, including economic development and the 'use but wise use' of natural resources

nutrient levels applied to water quality, most commonly refers to the effects of pollution from sources on land, including fertilizers, animal manure and human sewage

official and popular appraisals applied in academic literature to the interplay of government and non-government evaluations of the Australian environment: occasionally based, in each case, on dangerous misconceptions, these evaluations were nonetheless critical ingredients in the progress of settlement and environmental management

overgrazing persistent grazing at levels which inflict long-term damage on the plant cover; often directly associated with erosion

'overwatering' persistent if unwitting application of more water than plants and soil can cope with, effficiently or usefully; commonly results in marked deterioration

pastoralism see pastoralist

pastoralist normally applied to the operator of a big ranching property (or properties); more substantial than a 'grazier', but the distinction is not

always clearly drawn

patrimony inheritance or heritage

perched water table a water table which occurs above an impermeable zone, which is underlain by unsaturated materials

permaculture type of organic farming based on the maintenance of high productivity and, usually, a wide range of compatible and useful plants

permeable porous, allowing water through

pipehead a small dam allowing the water flowing in a stream to be diverted into a pipe for water supply use

planning a broad term implying a process of considering situations and taking appropriate decisions in order to achieve desired goals

pollution alterations (e.g. of water) as a result of human activities which make a resource less suitable or quite unsuitable for any purpose for which it could be employed in its 'natural' (unpolluted) state

potable water generally considered suitable for human consumption

preservationism a modern variant of conservationism more vehemently opposed than its predecessors to the development imperative

prior streams the ancient lines of sediment-filled water courses

pumpback a pipehead dam diverting streamflow through a pipeline into a storage dam

PWSA a public water supply area defined under W.A.'s Metropolitan Water Supply, Sewerage, and Drainage Act (1909–1977) in which a public supply is developed and the amount of groundwater abstracted privately is controlled through licensing arrangements

'rain follows the plough' a resilient folk idea, insisting that climatic amelioration went hand-in-hand with the expansion of pioneer farming into districts which had been condemned as 'marginal' because of their comparatively low average rainfall; influential in Australia in the later nineteenth century, this notion was even more widespread in North America

recharge area a region in which water replenishes an aquifer — an unconfined aquifer is recharged by rainfall throughout its distribution; artesian aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface or is intersected by a geological fault; recharge of artesian aquifers is often at some distance 'upstream' from points of extraction

region a sizeable division of territory separated from other areas by a mixture of tangible characteristics which simultaneously sets it apart from neighbouring areas and declares a degree of commonality, or shared identity, among the physical features and / or the inhabitants of that division

regional planning based on the incorporation of regional concepts into planning processes (see planning)

regionalism the various expressions (literary, political, etc.) of identification with particular regions; a special type of group consciousness

regionalizations the art and science of formulating regional divisions

regulation of rivers mainly refers to human interventions designed to manipulate flows in such a way as to lessen the risks accompanying extreme events under natural conditions (e.g. floods and droughts), and otherwise to ensure that more use can be made of the resource

reservoir an area where water is deliberately stored; often created by the building of a barrier or dam across a watercourse

reticulated supply the network of water supply to users

ring-barking method of killing a tree by removing a complete ring of bark from the trunk, and thus stifling its vital processes

riparian rights relates to principles of access to a river via its banks

river basin entire area drained by a river and its tributaries

run off that part of precipitation received on a slope which is not taken up immediately by the soil, together with the surface discharge of underground sources

saline scalds a bare land surface caused by salting

saline seepages increases in surface salinity caused by downwards or lateral percolation of water and its emergence, with salts, at ground level further down a slope

salinity the measure of the total soluble (or dissolved) salt (i.e. mineral constituents) in water; water resources are classified on the basis of salinity in terms of milligrams per litre of Total Soluble Salts (mg/l TSS)

salinization accumulation of soluble salts within the soil; also labelled 'salination', it is commonly described in two main categories, dryland salting and irrigation salting

saltbush large groups of shrubs and herbs dominating wide expanses of saline and partly saline land

saltwater interface the interface between a layer of fresh groundwater and underlying saltwater

saltwater intrusion mainly the inland intrusion of a layer of saltwater into a freshwater aquifer

sand drift better entitled 'soil drift', since the term usually refers to the wind-deposited products of soil erosion

scalds see saline scalds

sediments deposited particles or rock-grains; frequently employed to describe all material laid down by ice, rivers, wind and the sea

service reservoir a reservoir built near consumers to receive bulk supplies of water from major sources prior to final distribution

siltation deposition of fine material laid down in water; commonly used to describe the build-up of materials in rivers and reservoirs, where the process may detract from the value of the resource for human uses

sludge nineteenth- and early-twentieth century term referring to residue from gold-mining operations associated with the repeated use of water

'snagging' partial or complete removal of trees from rivers and streams

soil acidity as measured by the 'pH' reading, the term describes a set of problems affecting plant growth which may result in a decrease in vegetation cover and an increase in soil erosion

soil erosion a set of processes resulting in the removal of soil by wind and moving water, often associated with human activities such as vegetation clearance, poor cropping practices and overgrazing

soil exhaustion indicates a severe reduction in the capacity of soil to sustain its initial or early productivity

soil fertility setting aside moisture and temperature characteristics, this generally relates to the efficiency with which the soil is capable of supplying the necessary elements for plant growth; the most important elements are nitrogen, phosphorus and potassium, but soil structure is also highly significant

Soldier Settlement is a special variety of Closer Settlement in which 'returned' service personnel were to be assisted to become rural producers, usually on relatively small blocks; backed by federal and state authorities, the major schemes introduced after each World War achieved mixed results

sources development timetable a schedule for the chronological development of new water sources to supply projected demand

'squatting' essentially, the illegal occupation of Crown land; in Australia the term is applied to early pastoral pioneers whose security of tenure was gradually regularized and improved through the nineteenth century; viewed more strictly, the term was inaccurately retained after the first few generations of settlement, but it stuck; in other countries this ancient term describes small-scale illegal occupation in urban as well as rural locations

'stations' (sheep, cattle) usually applied to large outback pastoral properties

stewardship in the context of this volume, denotes the careful and sensitive management of natural resources with a view to their long-term viability

storage reservoir a major reservoir of water created in a river valley by constructing a dam

streamflow movement of water in rivers and streams, as measured by various methods

subsoil broad description of the lower strata of soil, not necessarily highly differentiated from the upper layers in every instance

sumplands basins that are seasonally inundated (flooded)

surface water water flowing or held in creeks, lakes, rivers and wetlands in the landscape

sustainable use diversion of water resources at a replenishable rate: for example, sustainable groundwater use limits extraction to no more than the

recharge rate and requires sufficient throughflow to prevent significant saltwater intrusion into aquifers

sustainable yield (for example, of an aquifer): the quantity of water that can be drawn over a period of time that will be replaced by normal recharge

'sustainability' one of the more confusing terms in today's jargon-ridden political lexicon, it is redundant without an accompanying indication of the specific context to which it applies: for example, 'ecological' sustainability emphasizes the maintenance of environmental integrities over time and of course may be best achieved without economic development; 'ecologically sustainable development' however, begs much larger questions about the need for environmental impact statements and the like

system yield the maximum unrestricted annual demand that the water supply system can sustain under specified expectations

topography description of surface features or relief; in the strictest sense it includes not only 'physical' environmental features but also the direct products of human occupation on the earth's surface, including settlements and lines of communication

tunnel erosion an insidious process involving the removal by water of sub-surface soil, causing the formation of underground passageways which sometimes exhibit partial collapse

TVA Tennessee Valley Authority

unconfined aquifer an aquifer which has its upper boundary at the earth's surface (the upper surface of the groundwater within the aquifer is called the water-table)

utilitarian arguments for conservationism mainly emphasize 'use, but wise use'; the corollary is 'for the greatest good of the greatest number of people', but — since that opens up a wider debate — it is usually avoided

UWPCA refers to a definition of an (under)ground water pollution control area under the Metropolitan Water Supply, Sewerage, and Drainage Act (1909–1977) in which restrictions were placed on activities which might pollute the groundwater

'vernacular' regions divisions based upon and reflecting popular opinion and historical experience, with wide community acceptance; may be seen as simple, taken-for-granted geographical frameworks, but can take on large significance when they become implicated in environmental, developmental and political disputes

washdirt normally refers to the discarded residue of mining operations, where water has been employed in the breaking-down of the mineral-bearing materials

water balance a statistical account of water entering and leaving a system over a specific period

water catchments may be applied at various scales; for the most important use, see river basin

water deliveries water supplied to rural and urban consumers; most commonly employed with reference to the organization of irrigation supplies

water holes usually, natural depressions in the beds of watercourses, sometimes providing useful small reservoirs in times of low flow; in many instances they have been artificially deepened

water rights normally attached to property rights as a legal entitlement, but this has changed in recent years

water-table the surface of unconfined groundwater, which may be above ground (i.e. swamps or lakes in lowlying areas); also measured as the level to which water rises in a well tapping an unconfined aquifer

watercourse route or channel occupied by a river or stream

watering bays paddock management of irrigation water in which the supply is deliberately ponded or confined in specific sectors as required

watershed line, ridge or zone separating head-streams flowing into different basins

WAWA Water Authority of Western Australia

weir substantial structure placed to raise the level of the upper reaches of a stream, thereby regulating volumes and velocities

well (bore) a hole dug or drilled from the ground surface into a groundwater aquifer to test for or withdraw water; in Western Australia, household wells are commonly termed 'bores'

wellfield a grouping of wells to extract large volumes of groundwater, generally for a major scheme supply

wetland seasonally, intermittently or permanently waterlogged area, whether natural or otherwise, fresh or saline

wetland water water with intrinsic, on-the-spot value for maintaining wetland ecosystems and for recreational and cultural uses

World Heritage internationally-backed system for the registration of highly significant sites and areas; assessment may encompass environmental or cultural factors, or both

WRC Water and Rivers Commission, Western Australia

'yeoman' farmer Old World term adapted in the New World (especially North America and Australia) where it gained ambiguity; more common in south-eastern states than in Western Australia, and most often refers to privately-owned, small-scale, family-operated farms, but co-opted and further adapted in the introduction of larger grazing leaseholds

A note on metric and other conversions

1 acre = 0.4 hectare; 1 hectare = approx. 2.5 acres; 10 acres = approx. 4 hectares;
1 sq. mile = 640 acres or 259 hectares; 1 mile = 1.6 km; 10 miles = approx. 16 km;
1 acre foot = 1,234 cubic metres; 1 inch of rain = 100 points and 1mm = 4 points.

In the nineteenth century and in the early decades of the present century, a 'ton' of firewood was frequently accepted to be 50 cubic feet (i.e. a linear measure). The value of £1 in the Australia of the 1890s would be the equivalent of over $50 today. The mysterious 'megalitre' (1 of which = one million litres) is more realistically conceived as the amount of water contained in an Olympic-size swimming pool.

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Other books by J.M. Powell

J.M. Powell has been researching and teaching in historical geography and environmental history for more than thirty years. Most of his recent work has been focussed on Australia, but he has also written extensively on North America and New Zealand. His other major publications include the following.

'MDB'. The Emergence of Bioregionalism in the Murray–Darling Basin

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Inside back cover: A satellite image of wind erosion in southern Western Australia, 1995. Landsat kindly provided by the Australian Centre for Remote Sensing ('ACRES'), AUSLIG, Canberra, and digitally enhanced and produced by Remote Sensing Services, Department of Land Administration, Perth, Western Australia.