

Progress in the development of a water-care ethic for the Pilbara region of Western Australia

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Mining towns in the Pilbara region of Western Australia have daunting problems that hamper efforts to apply water-conservation techniques: compacted heavy clay water-shedding soils, an evaporation rate ten times the mean annual rainfall (less than 300 mm), summer temperatures above 40°C, and long periods without rain. Town water supplies are drawn mainly from underground sources. Until recently, domestic consumption was heavily subsidised, and water was used copiously to create gardens reminiscent of a less harsh environment. Since the boom times, mining companies have adopted more realistic policies on private and public water use. With the introduction of home-ownership schemes, they replaced water subsidies with generous incentives to convert gardens to low-water use. Major reductions in water consumption were achieved: 50 per cent in Dampier (entire town) between 1985 and 1990; 38 per cent in Karratha (households only) between 1980–81 and 1990; and 39 per cent in Wickham (households only) between 1984 and 1990.

Some important community-based initiatives were developed in the 1980s: native-plant nurseries, arid landscaping for remote Aboriginal communities, demonstration garden projects, and horticultural courses

and programs to help disadvantaged people to acquire work skills. Recent government water-care initiatives have included establishing the Pilbara Water Conservation Advisory Committee, the first of its kind in Western Australia. With support from the Water Authority in Karratha, the committee is undertaking a community education program.

The support of industry, through funding and personal involvement, contributes to the success of local projects. Professionals could contribute further by applying their skills and experience to public education, research, trials, demonstrations, and workshops. The funding of regional and local projects and research, the establishment of water-conservation committees, liaison with local groups, and promotion of a holistic environmental ethic are all appropriate activities for the State and Federal Governments.

The approach to land care provides a good model for the development of a water-care ethic for the Pilbara region. The problems which made land care, and now water care, necessary have their roots in attitudes to the whole environment. The issue of water conservation cannot be tackled in isolation from other conservation issues.

Introduction

Frugal human use of water is essential everywhere today because it can reduce the economic and environmental costs of diverting natural waters and modifying natural hydrological cycles. This is especially so in Australia's arid zone.

Efficient design of our built environment and the lawns and gardens within it can have a dramatic impact on water-consumption levels. Water applied to lawns and gardens accounts for between 40 and 80 per cent of domestic consumption in Western Australia (Western Australian Water Resources Council, 1986), where the challenge of conserving water on a large scale while maintaining or even improving the amenity value of the built environment is being met. This paper outlines how communities in the arid Pilbara region are meeting that challenge.

The term 'water care' is used in this paper to describe a holistic approach to water management, whose primary aim is to maintain as far as possible a sustainable hydrological condition for any given area. Water conservation is one aspect of water care; in urban environments it is a critical component.

On the north coast of the Pilbara region, the town of Karratha (Fig. 1) enjoys an arid tropical climate, experiencing an annual evaporation rate of 3 m and an unreliable rainfall with an annual mean of less than 300 mm (Bureau of Meteorology, 1972). As an example of the variability about that mean, Karratha received less than 50 mm of rain in the 11 months between April 1990 and March 1991 (Bureau of Meteorology, 1990a–i, 1991a–c), yet the equivalent of the town's mean annual rainfall may deluge the town within a few days (Bureau of Meteorology, 1989). Around two-thirds of Karratha's rain is precipitated in falls of less than 30 mm (Nicholson & Edgcombe, 1986).

Towns of the Pilbara region, and much of arid Australia for that matter, typically have heavy clay water-shedding soils, evaporation rates ten times that of mean annual rainfall, and

summer temperatures consistently above 40°C. In any 12-month period, they might receive almost no rainfall at all.

Most Pilbara towns, including Karratha, are moderately new, rely on employment provided by a few major resource-de-

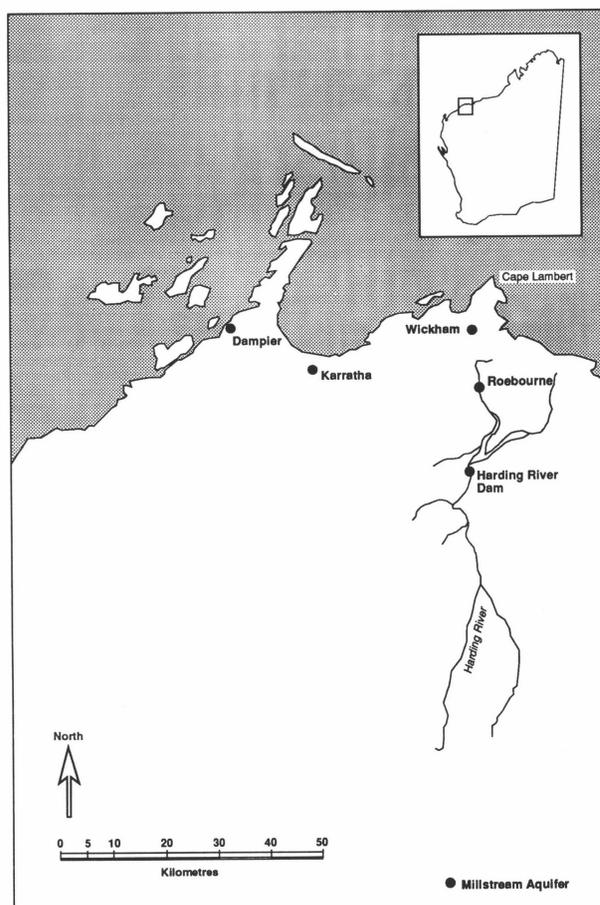


Figure 1. Location of Karratha and nearby towns of the Pilbara region.

All figures for this paper have been supplied by the author.

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velopment companies, and have transient populations. The Pilbara towns of Karratha, Wickham, and Dampier (Fig. 1) and others farther south and southeast — such as Paraburdoo, Tom Price, Pannawonica, Newman, and Telfer — have been entirely developed within the past 25 years. The mean age of the population is much younger than the national average, and residents live in these towns commonly less than four years. Attractive salary packages have lured people to the region. In many of the towns, water was provided free of charge to employees until the last few years.

Significant water resources have been developed to service Pilbara towns. Until the early 1980s, the west Pilbara towns of Karratha, Dampier, Wickham, and Roebourne relied entirely on water from the Millstream aquifer to the south (Fig. 1). This aquifer supports an important wetland system which lies in the Millstream–Chichester National Park. Drawdown in the aquifer eventually led to vegetation mortality, and posed a risk to spring-fed pools and wetlands. The reaction to this problem was to construct the Harding River Dam (Fig. 1), which now supplements the Millstream supply. In all other Pilbara towns, water is supplied from underground aquifers close to major river systems. In Newman, groundwater recharge has been assisted by the construction of a barrage across the Fortescue River. All these water-resource developments have involved not only a substantial capital cost but also an environmental cost.

More recently, greater export competition in the mining industry has led to a close examination of costs. One of these costs is that which is associated with developing new water resources. Consequently there has been a marked concentration of effort on reducing the demand for water resources.

Some of the recent changes in policy and attitude discussed in this paper would have been considered quite remarkable when Nicholson & Edgecombe (1986) described the Pilbara in the early 1980s with average household water consumption 30 to 40 per cent higher than today. However, there is a danger that the recent reductions in water use may not be enduring, or as great as they could be, if they are not occurring for the right reasons.

This paper not only boasts about the real achievements in water conservation in Karratha and, to some extent, other Pilbara towns, but also provides an understanding of why this occurred, where improvements can be made, and what must be done to achieve sustainable water conservation in the arid zone.

Overview of water-conservation techniques for arid landscapes

The greatest opportunity for conserving water without loss of human amenity, is through minimising the artificial irrigation of our lawns and gardens. Considerable water savings can be achieved through appropriate landscaping and gardening techniques.

The application of water-harvesting (capturing and retaining run-off water during natural rainfall events) and water-management techniques for water conservation in arid landscapes are now well documented (National Academy of Sciences, 1974; Nicholson, 1986; Nicholson & Edgecombe, 1986; Western Australian Water Resources Council, 1986; RMIT, 1989).

Effective water management at the micro- and macro-catchment levels is fundamental to the achievement of water-conservation objectives in urban design. Macro-catchment (town, residential size) management for water conservation can be

achieved with good town and residential planning, design, and construction (RMIT, 1989). At the micro-scale, the essential elements are:

- harvesting water during rainfall events by directing run-off from roofs and pavement areas into shallow depressions in which plants are established;
- soil preparation;
- species selection; and
- type of artificial irrigation (at least for the initial establishment of plants).

Water harvesting is a technique which has been used by the Israelis for centuries, and is now being adopted in Australia. At the macro-scale it has been used for growing tree crops and for restoring degraded pastoral lands. At the micro-scale it is now a critical element in urban and residential design. Where run-off from roofs, paved areas, and roads is directed onto gardens, and if a prescribed amount of that water is trapped, supplementary watering of plants can be dramatically reduced.

Soil preparation appears to be one of the most overlooked aspects of arid-garden development in the Pilbara region. Many well intentioned arid-garden projects initiated by mining companies, shopping-centre owners, residents, and local governments have been rendered almost ineffective because of the lack of attention to soil preparation.

It is essential to maximise the efficiency of water and nutrient retention in arid urban soil environments. This most often requires mechanical disturbance (particularly in clay soils), which should be carried out in association with water-harvesting works. Key points in creating the best possible soil environment are:

- breaking up compacted clay soils by ripping or digging (preferably with the aid of a backhoe) to improve water infiltration, root development, and nutrient retention (Fig. 2);
- incorporating dry sewage sludge, other organic matter, and/or coarse sand in clay soils to enhance soil functions; and
- covering the soil surface with a thick mulch (stony or vegetative) to minimise capillary action and evaporation from the soil surface while providing an excellent barrier to weeds.

Insufficient attention to soil preparation can result in poor growth response, which might prejudice residents against the use of indigenous plant species in home gardens. This is a tragedy to be carefully avoided, especially when considerable ground has already been made in converting gardeners of exotic species to using our own water-conserving local species.

The use of local indigenous plant species is one of the most commonsense and practical ways of conserving water. Indigenous species have evolved within the local rainfall regime, and with good soil preparation and a little attention they flourish in the home garden with very little need of artificial irrigation.

Species selection and the details of irrigation design and equipment are important, particularly since there is a belief in some quarters that native-plant species are shortlived, and most native gardens therefore become senile within a few years. This has no doubt come about through experience with some *Acacia* species which grow quickly and become woody if not pruned properly.

Another difficult challenge in getting everything right for an almost self-sustaining attractive garden landscape (or townscape) is to convince the owner (or users) that medium-to-long-term success seldom can be achieved without some short-term sacrifice. For arid gardens, this means planting small seedlings

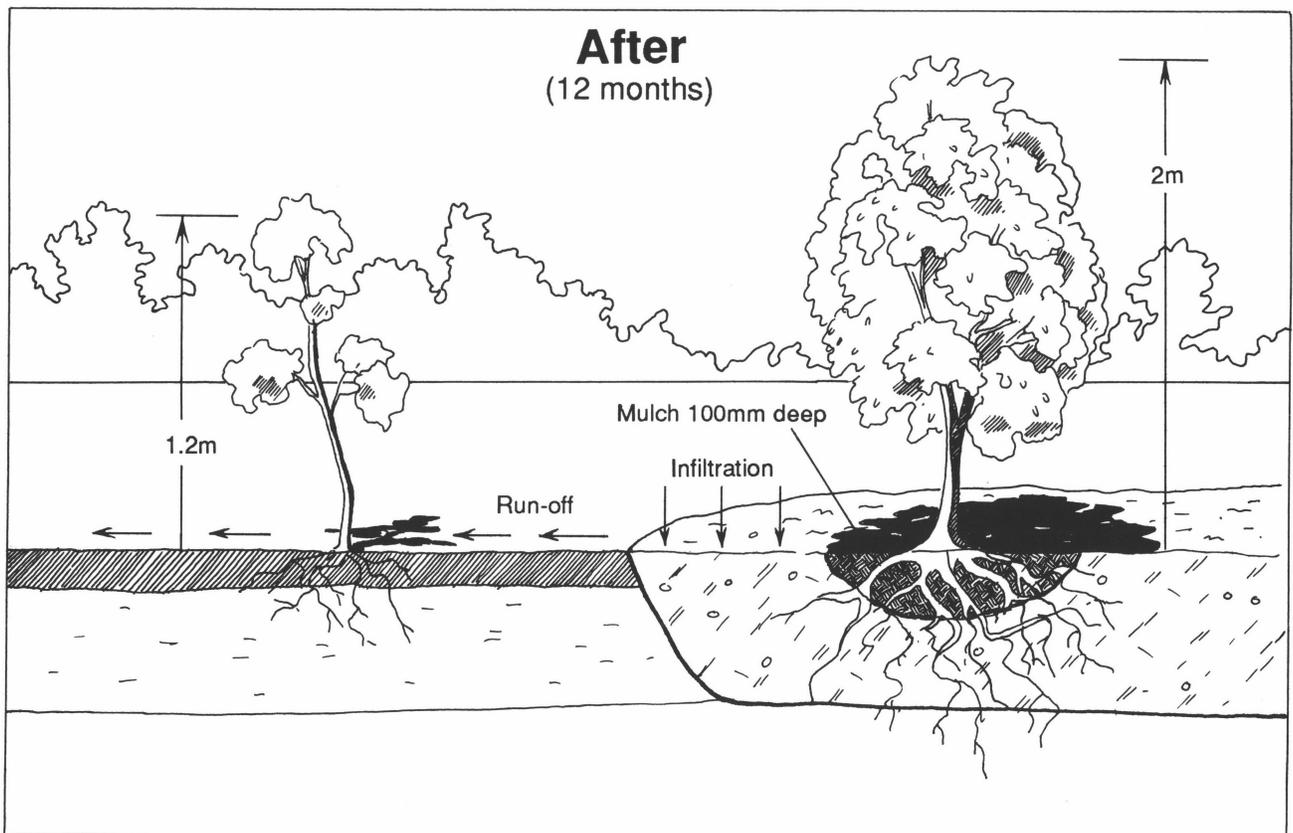
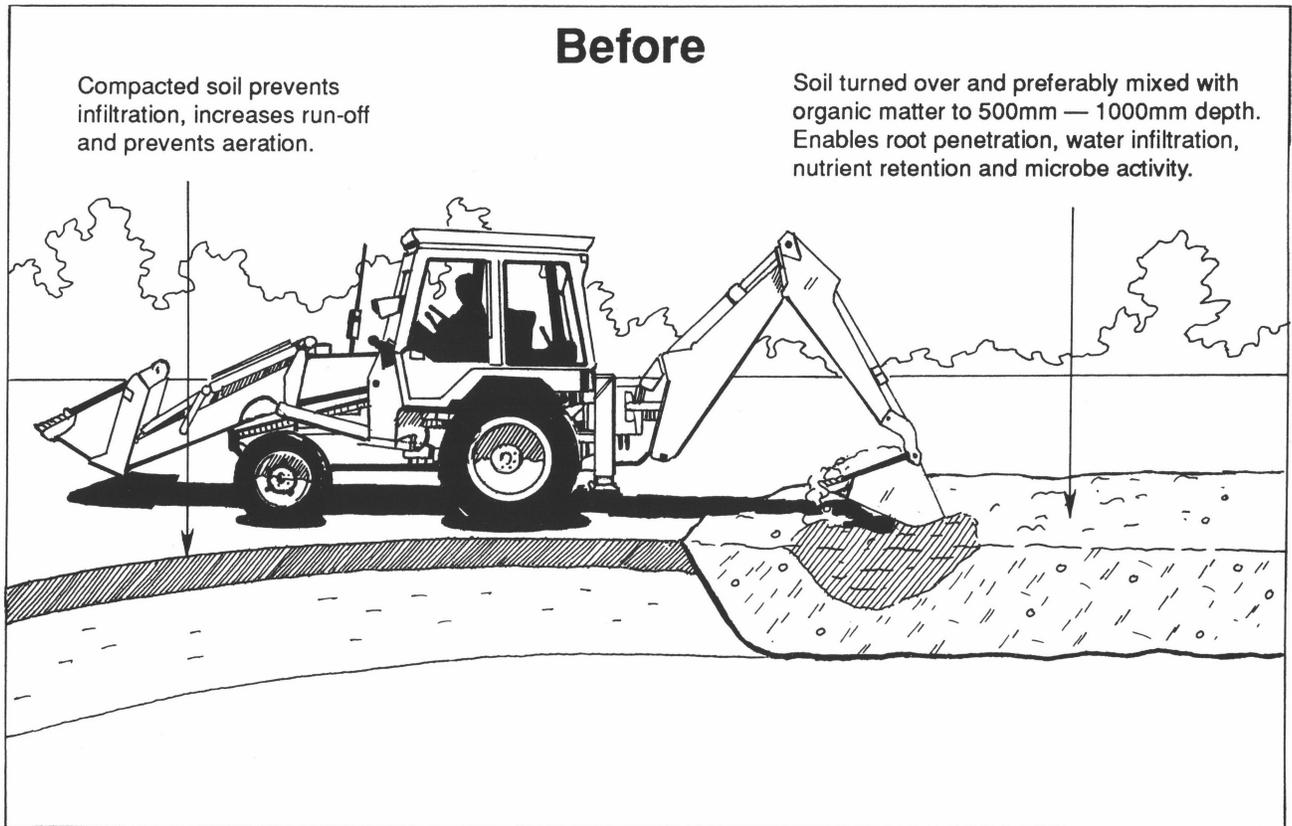


Figure 2. Essential soil preparation for compacted soils.

Table 1. Industry initiatives in Pilbara water conservation.

Company	Town	Policy change	Result
Hamersley Iron	Dampier (69% of former company houses now under home-ownership scheme)	Home-ownership scheme introduced in 1983, later made compulsory for new employees. On entry to scheme, \$1000 provided per home to convert gardens to low-water maintenance	Town water consumption in 1990 less than 50% of that in 1985; 33% fall in consumption in 1987-88
Hamersley Iron & Woodside Offshore Petroleum	Karratha (almost 50% of houses in the town are company-built)	Hamersley Iron policy cf. Dampier. Woodside policy was free garden landscaping (low-water design), incorporating trickle-feeding of plants, small lawns, free tap timers, and reimbursement for paving and pergolas	Average household consumption fell 38% from 933 kL in 1980-81 to 578 kL in 1990
Robe River Iron Associates	Wickham	Water subsidies halved, assisted low-water garden conversions, and water-conservation campaign introduced	Average household consumption fell 39% from 1260 kL in 1984 to 760 kL in 1990

Sources: W.S. Kelly (Hamersley Iron Pty Ltd, personal communication 1991); S. Waller (Woodside Offshore Petroleum Pty Ltd, personal communication, 1991); N. Gay (Robe River Iron Associates, personal communication 1991); P. Roberts (Water Authority of Western Australia, personal communication 1991).

instead of pot-bound, half-matured, force-fed shrubs and trees. The right approach to this problem is to show to the diehards examples of where the right technique has worked, and to convince them that the early days of their new landscape need not be painful if the physical landscaping itself has been thoughtfully designed.

Recent trends in water consumption for some Pilbara towns

Nicholson & Edgecombe (1986) described a Pilbara scene of intensely water-consuming mining towns occupied by heavily subsidised tenants. Fortunately, this scene is changing owing to the tendency for mining companies to review costs in an increasingly competitive industry. Some have taken the bold step of removing or cutting subsidies for water bills. Others have introduced home-ownership schemes which shift the responsibility of payment for water from the company to the employee. In all instances, however, these changes have been accompanied by generous compensation from the companies to their employees in the form of free conversions to low-water gardens, or reimbursement for low-water conversions. Examples of changes in company policy and the results achieved are listed in Table 1.

Private-industry policy initiatives, such as those outlined in Table 1, have brought about dramatic falls in average annual household water consumption in some of the Pilbara mining towns, particularly Karratha and Wickham (Fig. 3). By comparison, average annual consumption has changed little during the same interval in the non-mining town of Roebourne (Fig. 3).

Reduction in water consumption has not been totally confined to households. For example, Robe River Iron Associates has reduced water consumption in its port operations (crushing and stockpiling) at Cape Lambert by 25 per cent with the commissioning of a water-recirculation system (N. Gay, Robe River Iron Associates, personal communication 1991).

It appears unlikely that any more significant reductions in water consumption will be achieved in the foreseeable future. Indeed, the challenge will be to prevent a growing demand for water. In many people, the longing for an exotic high-water garden persists, and older houses are bringing about problems of

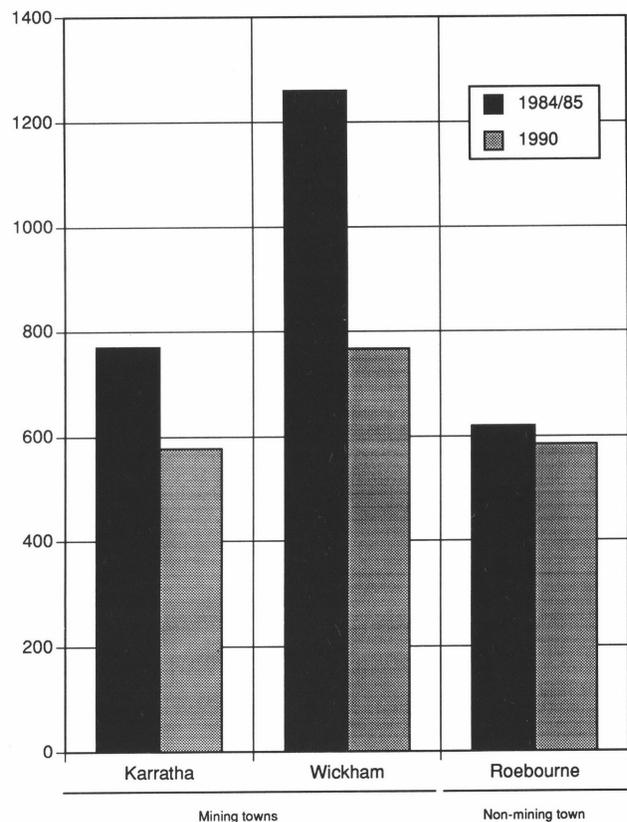


Figure 3. Average annual household water consumption kL in three west Pilbara towns.

Source: Water Authority of Western Australia (1991).

leaking toilet cisterns, taps, and pipes. In housing where tenants are still subsidised (for up to 1000 kL of water per annum), there is little incentive to reduce these water losses due to leakage.

In favour of water conservation is the trend towards less transience in Pilbara workforces, and hence a greater propensity for investment by residents in better landscaping for long-term benefit.

Filling information gaps for water care in the Pilbara

Nicholson & Edgecombe (1986) identified several gaps in basic information on landscaping for water conservation. These included: publication of designs and guidelines for planners and architects; more data for engineers to assist in appropriate engineering design of low-water landscapes; more demonstration projects; more detailed figures on costs of alternative techniques; and specific horticulture and landscape training courses. With the help of public and private funding, and a substantial amount of voluntary labour, most of these gaps have been filled over the last five years. Recent relevant publications and unpublished reports on water conservation include those by the Western Australian Water Resources Council (1986), Nicholson (1986), Tyler (1988), Hill & Nicholson (1989), RMIT (1989), EPA (1989), and Water Sensitive Urban Design Research Group (1990).

Various pamphlets on low-water gardens and other water-conservation techniques were distributed by most local mining companies and the regional offices of the Water Authority and the Department of Conservation and Land Management (DCALM) in Karratha. A videorecording that summarises the message in the Western Australian Water Resources Council (1986) publication was also released.

Even though the gaps in available information identified by Nicholson & Edgecombe (1986) have been largely filled, much of it is not accessible to the public; the effective dissemination and application of this information are today's challenges.

Direct community action for water care

Responses to resource depletion are often complicated. At the very least, there are considerable (and unforgiving) time lags between resource depletion (or over-use), economic response, and community response. It is therefore essential that all sectors of the community understand that water conservation not only makes sense but also has diverse and immense benefits in the form of:

- maximising our capacity to cope with environmental stresses such as drought and/or climatic change;
- improving our understanding and appreciation of the natural environment through the use of indigenous xerophytic plants;
- maximising our efficiency in energy use (e.g., reduced need for water-pumping, and less energy expended on water-resource development); and
- minimising the need for environmentally costly water-resource developments.

The adoption of low-water landscaping and gardening techniques using local indigenous plants can compound the benefits of water care. Embracing a water-conservation ethic can facilitate progress of the community towards a more holistic environmental ethic. Without the development of such ethics in the community, the direction that we take, and the degree of success that we achieve, in water care will at best be limited and at worst non-sustainable.

The growth in available information on water-conservation techniques is evidence of a developing water-care ethic in the Pilbara region. The availability of this information has promoted the instigation of a considerable number of important community-based initiatives (Table 2), particularly in the town of Karratha. All these initiatives have been developed by highly motivated individuals both within and outside government and industry. The keen individuals have diverse back-

Table 2. Community-based water-conservation projects.

Group	Town	Objectives, projects
Arid Gardens Group	Karratha	Operate a nursery now holding thousands of local plants representing ca 100 species. Plants and seeds are available to visitors for a small donation. Current projects include planting public native gardens around Karratha. Future projects include establishing a showpiece public garden near the town centre
Community Work Skills	Karratha	Private organisation helping disadvantaged. Established a native plant nursery with a range of local species
Community College	Karratha	Offers educational courses, including one on horticulture, which are designed for the practical application of techniques for arid landscapes
Community College & Roebourne Aboriginal Community	Karratha	Established an ethnobotanical garden at the college in 1985. Water-harvesting and trickle irrigation are incorporated in the design. It features plants grown for food, and for the manufacture of artefacts and ceremonial accessories
Community College	Karratha	Established (in 1984) the Pilbara Regional Herbarium, now managed by DCALM, which strongly emphasises community ownership
Pundulmurra College & Murdoch University	Port Hedland	Joint project developing arid landscaping for remote Aboriginal communities. Emphasis is on the use of sewage effluent for growing shade and shelter trees. Many local species are available
Local Environment Affinity Force	Port Hedland	Voluntary conservation group planting native species in and around Port Hedland. It has attracted considerable assistance from local government and private sources for some substantial landscaping projects
Bindi Bindi Aboriginal Community	Onslow	Arid-plant nursery re-established in 1991. Plants and seeds of indigenous species are available to mining companies, residents, and land-care groups within a radius of ca 300 km

grounds, but all are entwined in the common thread of the water-care ethic. Once entwined, these individuals retain the ethic, and take it with them when they — like many other transients in the arid zone — travel to other parts of Australia and the world.

Recent government action for water care

A greater public awareness and community participation in conservation issues, including water care, has influenced environmental management. The concept of sustainability also has been incorporated into planning policies for new developments. Examples of this are the adoption of a new planning policy for groundwater resources on the Swan Coastal Plain (Department of Urban Planning and Development, 1991), and the Draft Environmental Protection Policy for the Ngararra Mound (EPA, 1991).

At the local-government level the Shire of Roebourne (which includes the towns of Karratha, Wickham, Dampier, and Roebourne) has recently developed a low-water-landscaping policy. This policy makes low-water landscaping a condition of approval for all new development proposals in the Shire. This

is a novel approach, and, if it proves successful, may influence other shires to introduce such planning initiatives.

In 1987, the Port Hedland Town Council engaged consultants to assist them in preparing a five-year plan (Price Waterhouse Urwick, 1987). The aim of this plan was to enhance the appearance and public perception of Port Hedland, whilst improving the efficiency and effectiveness of its administration. Landscape architects, planners, environmental scientists, horticulturists, and conveners developed townscape-concept plans in consultation with the local community. The concept plans were founded on the principles of water conservation, and emphasised the need to build on the natural character of the area. Implementation of the townscape principles and designs is now in progress.

In early 1987, the Western Australian Water Authority set up a community-based Pilbara Water Conservation Advisory Committee. The Committee developed a list of objectives and strategies aimed at reducing total water consumption in Pilbara towns. By late 1987, the Committee was invited to operate under the umbrella of Section 17 of the Water Authority Act, 1984, which formally recognises community-based advisory committees (Western Australian Government, 1984). The Committee, the first of its kind in Western Australia, has since acquired the support of a working group within the Water Authority's Karratha office. This working group comprises officers with formal responsibility for assisting the Committee in achieving its objectives.

The specific objectives of the Committee are to:

- minimise waste of scheme water (i.e., water provided by the State for domestic and industrial uses);
- encourage consumers to adopt techniques which conserve water use from all sources;
- maximise the use of alternative water sources; and
- encourage the recycling and re-use of scheme water previously used for industrial purposes.

The Committee's functions are:

- to advise on the implementation of conservation strategies, and to monitor results; and
- to develop and implement a community-wide water-conservation education program, adopting both long- and short-term goals.

A number of long- and short-term goals were set, and the Committee meets every six months or so to review the progress of the working group and steer it into the following six months. Among the achievements of the Committee over the past four years are:

- the establishment of water-conservation libraries in Water Authority offices and Shire libraries;
- the compilation of Pilbara water-consumption figures for Pilbara towns;
- the compilation of a list of low-water demonstration gardens already established throughout Pilbara towns;
- the transfer of information direct to schools and mining companies;
- various publicity campaigns funded and co-ordinated by Water Authority Headquarters in Perth, but adapted to the Pilbara environment; and
- the distribution of pamphlets to households advising of the correct watering times (i.e., early morning and late evening).

The Committee and its working group could do more — such as providing assistance to community groups involved in

native-plant nurseries and the planting of arid gardens, and targeting media campaigns more directly at the Pilbara population. Even so, there is no substitute for direct personal contact between people in small communities for promoting an environmentally beneficial concept such as low-water gardening. In this context, a well managed, well resourced native-plant nursery with well presented gardens, a large stock of cheap native plants, and accessible, informal, friendly, free advice provides the ideal surroundings for encouraging such contacts.

Such a service was available to Pilbara residents in the nursery owned and managed by CALM in Karratha. Originally established under the 'Northwest Tree Scheme', whose objective was the greening of the new mining towns of north Western Australia, the nursery grew into an establishment which could boast remarkable credentials in propagating hundreds of indigenous plant species. Free plants were given to residents establishing gardens, and most extra plants were sold for around \$1.00.

In July 1987, the nursery was closed as part of a rationalisation scheme that centralised all nursery activity for north Western Australia in the established government nursery in Broome. The same service to Pilbara residents was offered via the Broome nursery, but the loss of the focal point in Karratha, delays of up to three months to acquire some species, and now a freight charge of \$1.00 per plant sent to the Pilbara are obvious reasons why a nursery 800 km from one's garden is not as practical as one less than 8 km from one's home. Since the closure of the Karratha nursery, nearly all potential native-plant customers seem to have resorted to purchasing non-indigenous species from commercial nurseries.

The delivery of first-hand advice on low-water gardening techniques, without the focus of the nursery, is extremely difficult if not impossible to maintain. Any amount of media promotions and extension from the office cannot come close to the effectiveness of service delivery in a nursery, especially one whose high level of accessibility and institutionalised credibility has established consumer confidence in the business. The closure of the CALM nursery in Karratha has therefore limited the ability of complementary water-conservation programs to achieve their goals.

Other Western Australian initiatives

Some impressive water-management-based landscape-design initiatives have developed in other dry regions of Western Australia. Two are of particular note.

- 'A case study in water conservation through good design' (RMIT, 1989) proposed how the future development of Broome might incorporate total water management at the house-block, neighbourhood, and regional scales. The concepts applied in this case study are being considered now for development in the Perth metropolitan region. The designs cater for extreme drought and floods, and offer great opportunity for 'designing with nature' as proposed by McHarg (1969).
- The concepts of total water management have been incorporated into open-space design for a natural watercourse — Gribble Creek — which passes through Kalgoorlie's Centennial Park. The report on the project (Arid Area Landscape Group, 1990) is comprehensive, and includes a detailed analysis of catchment characteristics. The plan has now entered an implementation phase.

The future of the water-care ethic in Karratha (and perhaps globally)

The emergence of community-based arid-garden groups in various Pilbara towns, and particularly in Karratha, is encouraging in that it demonstrates the acceptance of the water-care ethic within the general community. Average water consumption in Karratha and other mining towns has fallen significantly over the past six years, and appears to be stabilising around fairly acceptable levels (600–700kL per annum per household). There is also commitment to the principles of water conservation in industry and in State and local governments. The basic recipes for achieving long-term success in arid-garden landscapes have been developed and are being implemented.

The future of the water-care ethic in Karratha depends on several key issues that must be addressed so that we maintain the momentum of our achievements so far. These include the following.

- The water-care ethic must become the prime motivating force behind water-conservation efforts. Economic imperatives are justification enough, but long-term success depends on doing water conservation for all the right reasons.
- Those native-plant enthusiasts, of whom most have already adopted a water-care ethic, need strong encouragement and support so that they might achieve something close to perfection in their own sphere of influence.
- Many more people need to be directly exposed to attractive arid-garden landscapes, and have ready access to expert advice. The landscapes and the advice must be located at the same place (e.g., a nursery or arboretum) to be effective.
- A great deal of expertise in arid-garden landscaping, plant propagation, and soil conditioning is still available in Karratha, but much technical information, experience, and enthusiasm has left the town with the souls of those who have moved on to greener pastures in the south. It is imperative that at least the technical information (if not the enthusiasm and experience) be retained in a form which will be permanently available to those who will surely soldier on to new frontiers in arid-garden landscaping.
- We need to be more effective in promoting (to all sectors of the community) the concepts of conservation and personal responsibility for the environment.
- We must provide support for the converted. This requires financial assistance and extension services to be provided by Federal, State, and local government agencies, perhaps in the same way that this support is provided to land-care groups.

Extension services required for water care could be easily drawn from existing resources in a number of government agencies. In Western Australia, these resources are evident from the lists of contributors to recent publications and reports on the subjects of arid-land gardens and water-sensitive urban design. Ideally, one Federal and one State agency should provide the focus for the extension effort. The extension must be provided, wherever possible, in an environment in which the public will feel comfortable, and where they are likely to accept advice. A nursery is the most obvious environment for this type of contact, although a well presented arboretum or demonstration garden might also be appropriate in some places. The notion of governments being directly involved in the nursery business is one of the perceived obstacles to this approach. However, it may not be necessary for governments to own and manage such businesses, if the same results could be achieved through co-operation with the nursery industry and/or the systematic development of arboreta and demonstration gardens in towns and cities.

The retention of expertise within regions requires vigilance on the part of government and non-government organisations. The focus provided by water-care groups will help to ensure that technical information is stored and made easily accessible.

Conclusions

The Karratha experience, and to some extent the experience of other towns in Western Australia, has taught us that significant water can be saved by using appropriate landscaping and horticulture in arid zones. It has taught us that arid gardens can be attractive. We have also learnt that the community responds well to economic stimuli, but may be a little slower at responding to ecological ones. The ecological problems that we face in arid Australia commonly directly affect water, the finite resource.

To hasten the development of a water-care ethic, I suggest that the land-care approach be used as a model (Department of Primary Industries & Energy, 1991). The cost of water-care should be less than that of land care because most of our water use, and hence the opportunity to reduce it, is within the confines of towns, cities, and small settlements — not the vast open spaces of our rangelands. The skeleton of a water-care movement is already there, so it will not cost much to provide the ligaments to make it work. There are many things that we can do as individuals and as groups to develop a strong water-care ethic. Some of these are:

- *for individuals and community groups:*
 - organise demonstration projects;
 - lobby for policies, incentives, research, and project funding;
 - form water-care groups; and
 - establish nurseries for the propagation of local indigenous plants with horticultural potential;
- *for scientists, engineers, horticulturists, and landscape architects:*
 - direct the application of techniques;
 - undertake further research;
 - educate all sections of the community;
 - organise multidisciplinary workshops;
 - carry out trials and demonstrations; and
 - participate in water-care groups and water-conservation advisory committees;
- *for local governments:*
 - encourage engineers, horticulturists, planners, and building surveyors to adopt appropriate landscape design and species selection; and
 - adopt by-laws, policies, and regulations to ensure that appropriate techniques are applied to all new developments;
- *for State or Territory government agencies:*
 - adopt policies in planning, environment, water resources, roads, and railways which require the application of water-conservation principles in all new developments;
 - support regional and local projects and research; and
 - establish regional water-conservation committees to liaise with local water-care groups;
- *for Federal Government agencies:*
 - promote the water-care ethic;
 - promote a holistic environmental ethic;
 - fund water-care projects and research; and
 - encourage the States to adopt appropriate policies.

The issue of water conservation cannot be tackled in isolation from other conservation issues, because the problems besetting us have their roots in attitudes about our whole environment. A holistic environmental ethic therefore needs to be adopted by the whole community — one that tackles not only water care but also land care, marine care, and air care.

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