

**EFFECTIVE APPROACHES FOR ENVIRONMENTAL & WASTEWATER MANAGEMENT AND TRAINING – THE BIRDWOOD DOWNS CASE STUDIES IN THE KIMBERLEY REGION OF WEST AUSTRALIA**

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**Abstract**

The Institute of Ecotechnics on Birdwood Downs, a 1700 hectare property on the Gibb River Road near Derby in the West Kimberley of West Australia has, since 1978, been actively engaged in developing holistic methods of improving degraded lands using stock management, controlling invasive woody weeds, and land regeneration; developing sustainable economics, and environmentally friendly architecture, wastewater management and recycle, using Wastewater Gardens and Ecoscaping. Birdwood Downs also runs hands on training, developing people's potential from the managerial, scientific and artistic aspects, to encourage sustainability. An associated training programme open to people from diverse backgrounds is the Ecological Frontiers Programme, a nine month hands on programme in Savannah systems, combining management, science and art (theatre) trains people in a total systems approach. Birdwood Downs from time to time organizes and hosts workshops for artists. TAFE courses in rural operations and horsemanship are run at Birdwood Downs for indigenous people, to impart the skills necessary for them to enter employment as skilled workers. In an effort to prevent further contamination of spring water and ground water from sewage, Birdwood Downs personnel have been installing Wastewater Gardens, subsurface flow constructed wetlands with a high diversity of wetland plants that provide effective treatment and reuse of black and grey water sewage on Aboriginal communities in the East and West Kimberley. These simple, natural ecological systems use no chemicals, and are gravity-fed except in special cases where pumps are required for wet season operation of houses which were built in too low-lying areas. They result in high levels of water purification and keep the sewage out of contact with people. These systems improve hygiene on the communities by preventing pollution of groundwater and protect the environment from human pollution. Birdwood Downs has also developed "Savannah Ecoscaping" which has created landscape oases of beautiful gardens and tree-scapes on the property, including cool, shady and beneficial micro-climates for people and animals. We have also installed similar Savannah Ecoscapes on Aboriginal communities, in consultation with the residents, to increase greening of the communities by using valued native plants and bush-tucker plants. Savannah Ecoscaping can be done for graywater recycling and for final, tertiary treatment and reuse of the effluent from the Wastewater Gardens. For a community to be sustainable good hygiene and treatment of wastewater to protect its sources of clean potable water are required, protect and intelligently use its environmental and natural resources. Birdwood Downs also offers a hands-on training program so the community can maintain and improve these infrastructure additions.

**History of Birdwood Downs Station**

In the late 1970s the Lands Department of West Australia excised approximately 2000 hectares from Meda Station, a pastoral lease, for the purposes of encouraging environmental work in the demonstration of pasture regeneration and land care protection in the region. The special conditions lease over the property offered to make the title a freehold if half the property could in be planted to improved pasture grasses and legumes and boundary fenced within a certain time period. This special lease in 1978 was for sale and directors of the Institute of Ecotechnics (a U.K. registered charity – www.ecotechnics.edu) decided to raise the investment necessary to do this project because of the opportunity to apply an ecotechnics approach to regenerate pastures that had been severely overgrazed, which led to further environmental degradation and to implement a total systems approach to the tropical savannahs, including appropriate infrastructure, cultural life and environmental technologies (Allen et al, 1984; Nelson, 1985).

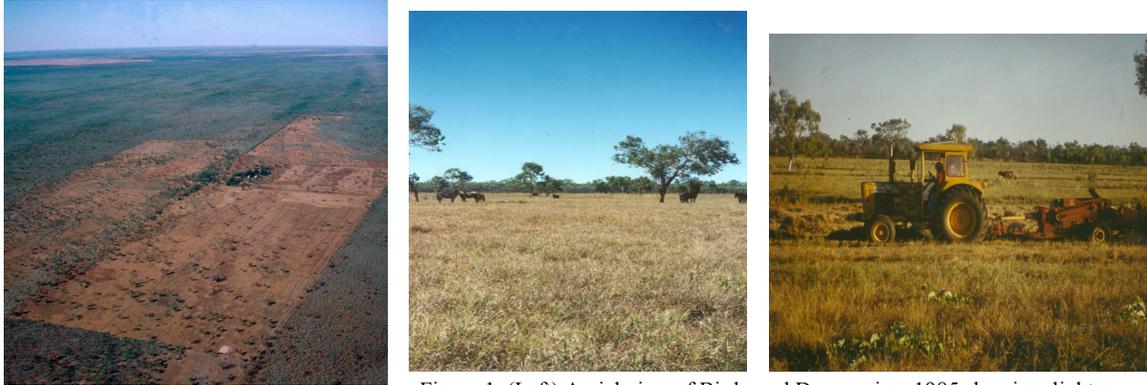


Figure 1. (Left) Aerial view of Birdwood Downs circa 1985 showing, lighter colour, portions of the property which were cleared of invasive scrub trees and planted to improved pasture. (middle) Stock grazing on improved pasture grasses and legumes. (Right) Hay-making on regenerative pasture land.

### **Collaboration with the Institute of Ecotechnics (a U.K. Charitable organisation)**

From 1978, the Institute of Ecotechnics has been consulting on the environmental programme, educational programmes and research of Birdwood Downs. The Institute of Ecotechnics, founded in 1973, is a United Kingdom registered charitable institute that works on ecological theory and practice, consulting to a number of innovative field-demonstration projects around the world, and convening annual conferences (<http://www.ecotechnics.edu/>). The central focus of the Institute of Ecotechnics is developing sound integration of ecology, technology and human culture with the aim of both preserving and enriching the ecology, and demonstrating sustainable ecological economics.

Through the participation of the Institute of Ecotechnics, educational programmes called “Ecological Frontiers” have been offered at Birdwood Downs to give students, WOOFERS (Willing Workers on Organic Farms) and environmental professionals the opportunity to participate in real-time, hands-on training in environmental management and protection. Currently, the Department of Immigration and Ethnic Affairs has recognized this programme and issues Vocational Trainee visas to allow overseas students to take part in these educational programmes for periods of up to twenty-one months

### **Meeting the Environmental Challenges: Setting and Ecology**

Birdwood Downs is located in the coastal ecosystem of the Kimberley region in the semi arid tropical pseudo monsoonal climatic region of North Western Australia. Due to the region’s severe environmental conditions, and a history of poor pastoral practices, overgrazing with sheep and then cattle, coupled with the overuse of fire leading to over burning has lead to widespread desertification, and land degradation, and marginal economics. Temperature extreme ranges from 4 degrees centigrade at night during the April to August cool dry season to 47 degrees during the day during the September – November hot dry season. The humidity of the wet season of December to March moderates these extremes.

Rainfall patterns are highly erratic both in quantity and frequency, with an average precipitation of 26 inches (625 mm) which falls between December and April. Rainfall extremes range between 4 inches and 60 inches per year. This rain can come in flooding downpours followed by weeks of dry, or in some low rainfall years fall in such small amounts that its effectiveness falling onto non wetting soils is vastly reduced as it does not soak in. This coupled with a depletion of perennial ground story grasses, ensures that the soil is open to erosion from water and wind. Evaporation rates are higher than the annual precipitation, and winds particularly in the hot dry season before the wet, whipping up denuded soils, prepare the scene for the then often torrential rains driven by cyclonic winds that occur in the wet season to scour and erode. Winds fan frequent and extensive hot fires. These when too frequent on fragile soils further reduce the species diversity, and contribute to degradation of vegetation and soils.

Birdwood Downs is situated on a series of stabilized sand dune ridges with sandy loam in the valleys on the ecotone with the coastal marsh. In the areas bordering the marsh in the transition zones yellow clays and silts predominate in the valleys between the dunes. These old weathered tropical soils are extremely low in macronutrients such as phosphorus and nitrogen, and micronutrients. A high level of iron and aluminum in the soils ensure that what phosphorus is in the soil is bound to the iron and unavailable for uptake by the plants. Due to the overgrazing, vast areas have been overrun by secondary succession and increaser species- Acacia scrub and annual grasses such as Spear grass (*Heteropogon contortus*). This pindan wattle country which covers 45 percent of the Kimberley region is considered of the lowest potential for development. The carrying capacity of such pindan was amongst the lowest of any land types in the Kimberley, especially since Birdwood Downs includes no river country, nor billabongs. During the decades of use by Meda Station, this land experienced heavy overgrazing, over burning and compaction since three droving stock routes passed through the land. The result was loss of the more valuable pasture species, invasion of dense thickets of Acacia wattle scrub, and soil erosion. Moreover, since there are millions of hectares of similar land in the Kimberley, the Lands Department and West Australian Department of Agriculture were very interested in the ecological experiments and upgrade programme of Birdwood Downs.

### **Major Components of the Pastoral Regeneration Programme**

After the initial mechanical clearing of the invasive woody weed invasion, around half the property has been with planted with improved grasses and legumes to restore productivity lost through the prior overgrazing. Around one thousand acres are kept free from re-invasion by Acacia wattle through manual uprooting. This “wattle chopping” pasture maintenance while ongoing also provides first hand an opportunity to observe at close quarters the changes in the ecology, the interface of soil and root systems and vegetative, insect and animal relationships, while being a more ecologically-friendly means of control compared to the use of toxic herbicides. Over the years, Birdwood Downs has demonstrated that as the improved pasture spreads and the native vegetation recovers from the overgrazing and compaction, that fewer man-hours are needed per hectare to keep invasive weeds under control.

The other half of the property which was not originally cleared of invasive wattle nor directly seeded, benefits from the spread of the better pasture species through ecological management of the horses and cattle. They are the “weeders and seeders” – keeping undesirable species from seeding and spreading valuable species through their rotation. To make this possible, unlike a conventional pastoral leasehold property, Birdwood Downs invested in creating smaller paddocks and laneways to make the frequent moving of livestock easier. A control paddock, called “Wilderness”, is kept fenced and ungrazed as a long-term control to the other land uses at Birdwood Downs so the impacts of pasture improvement and livestock can be gauged.

In the course of this environmental experimentation, methods of minimizing soil erosion and regeneration techniques appropriate to the challenging conditions of the Kimberley region were developed. These methods included:



Figure 2. Regenerated pasture with native trees including Boabs and groves of trees.

1. Leaving all native trees apart from three species of invasive Acacia trees on the fragile, sandy sand dune tops; leaving extensive groves of Bauhinia, quinine and other small native trees;
2. In the valleys between sand dunes, retaining all larger native trees in the pastures for animal shade, soil-holding and to complement the introduced species;
3. Mixing grass and legume species in the pastures to add to the richness of native pasture species and to increase plant coverage;

4. Using drought-resistant species such as Birdwood grass (*Cenchrus setigerus*) and stylosanthes (e.g. *verano*, *Fitzroy* and *seca stylos*);
5. Using strip-planting of improved pasture species as a more economical way than complete clearing/ploughing of commencing ecological enrichment;
6. Contouring and other earthworks to correct erosion gullies;
7. Identifying indicator species and using successional plants to speed up the process of pasture regeneration;
8. Developing an approach to pasture improvement which minimized loss of native vegetation by retaining large trees and groves of trees (such as *Bauhinia* and *quinine*) to hold the soil and provide shade for the animals;
9. On sand dunes, all trees were kept aside from the invasive *Acacias*; and soil disturbance was kept to a minimum to reduce soil erosion.



Figure 3. View of Birdwood Downs from water tank tower showing tree cover on sand dune caps and groves of trees.

Our major challenges were to keep invasive woody weeds from regrowing and overtaking the improved pasture. Deciding against the use of broad-scale herbicides as expensive and dangerous for people and the environment, we followed initial D-4 clearing and stick-raking/burning of windrows, with hand removal using adzes. “Wattle chopping” at first seemed an almost impossible task since *Acacia* seeds can number 20,000 per hectare, and have a long life (20-25 year viability) till their hard seeds are activated by bushfire. But with time, we began to beat the seed-bank to where most of the thousand acres (400 hectares) of prime improved pasture at Birdwood Downs is kept under wattle control with just 0.5-1 hour labour per hectare. Pastures are “wattle-chopped” either once or twice per year depending on labour availability on the station. In the process, staff get a ground-truth view of the health of the pastures and other invasive species (such as South Australian mint, *Sida acuta*, *Calytrix* spp.) can also be dealt with.



Figure 4. (left above) View of dense regrowth of *Acacia* (wattle). (right above) Wattle chopping to control invasive species at Birdwood Downs.



Figure 5. Improved pastures have led to dramatic increase in carrying capacity and year-round weight gains and health of animals on these previously overgrazed and degraded coastal pindan soils.

### Regionally Appropriate Architecture

The Birdwood Downs’ homestead buildings, designed by the Institute of Ecotechnics, use local regional resources (Kimberley colourstone rock), double-vented roofs for natural ventilation, and the use of screened verandahs and louvered windows in place of expensive and energy-consuming air-conditioning. In 2004, Birdwood Downs installed a solar electric system to increase its value as an ecological demonstration of sustainable environmental practice in the Kimberley, reducing by over 90% its reliance on generators and fossil fuels.



Figure 6. Bungalows for staff and tourists built with local rock, double-vented roofs and louvered windows for cooling; and savannah ecoscaped.

### Educational Programmes



In cooperation with the Institute of Ecotechnics (UK), educational programmes in “Ecological Frontiers” have given since 1978. These “hands-on” learning programs in real-time management and operation of ecological projects last from three months to nine months, and are tailored to the level of the student’s background and previous experience. The Department of Immigration and

Ethnic Affairs recognised the educational value of these programmes by making Vocational Training Visas available to overseas students for periods of up to nine months (and renewable for three years). The programme includes pasture management, development and maintenance, horsemanship, cattle management, firebreak and bushfire protection skills, management of tropical gardens and orchards, water and electrical infrastructure maintenance, fence and road maintenance; species identification and surveys, tools and equipment training, and theatre/public presentation training. Birdwood Downs also works with other educational institutions to assist with training. For example, Murdoch University with their Veterinary Dept, participating in their action Farm Experience programme; and Derby District High School, formerly with their Station Training Programme and presently with their Certificate in Horse Handling in conjunction with TAFE.



Figure 7 (Above right) Birdwood Downs Station Manager, Brad Riley, demonstrates fencing techniques. (Top left) A TAFE training course on the Birdwood Downs homestead with certified trainer, Robyn Tredwell, Executive Director of Birdwood Downs Company ((Above left) Horse training in round yard.

### Kimberley School of Horsemanship Programme



Birdwood Downs continues the work done in developing horse breeds environmentally appropriate to Kimberley conditions with its herd of Quarabs – a unique cross of colonial Arab and Quarterhorse horse breeds. Birdwood Downs is continuing the programme of developing better adapted varieties of horse for the Kimberley environment. The horses also demonstrate the higher carrying capacity and sustainability of grazing using ecological management and help provide income to sustain

the total programme through horsemanship and trail-riding programmes offered to town residents and tourists to the region.

Figure 8 (Left) Young horses in the round yard. (Right) Instruction in horse handling, riding and saddlery, Birdwood Downs.



### **Advancement of Culture: Artist Workshops & Theatre Productions**

The advancement of culture is also part of the Institute of Ecotechnics' and Birdwood



Downs' programme. This has been carried out through artistic events and theatre events over the past two decades which have enriched the North West Kimberley community and often bought the community together on neutral ground. One of the most notable events was the Triangle Artists Workshop which bought Aboriginal artists together with San Bushmen from the Kalahari in Africa, to create collaborative artistic works. Certainly having a cultural aspect to the life at Birdwood Downs

has allowed talented and culturally aware people to stay and

work long term, and this has allowed Birdwood Downs to work with the complex cultural scenes in the region with more understanding, Birdwood Downs' staff and members of the local town have collaborated on theatre productions which have played in Derby at the local Boab Festival, on tour in Broome, Fitzroy Crossing and at the mining town on Koolan Island. Currently productions by local and visiting theatre troupes is hosted at the "Crow and Cockatoo Theatre" at Birdwood Downs.

Figure 9 (Left above) A Birdwood Downs production of Noel Coward's Private Lives.

### **Developing Sustainable Economies**

As the land rehabilitation and pasture generation progressed, the development of the cattle herd combined with an enterprise of harvesting and selling the seed of the pasture grasses (*Cenchrus setigerus*). For its first fifteen years (1978-1993), Birdwood Downs harvested Birdwood grass seed from the pastures it planted. This seed was used for improving the pastures at Birdwood Downs and the remainder was sold and assisted in pasture regeneration in similar semi-arid savannah country elsewhere in Australia and worldwide. Seed was sent to Alice Springs, drier parts of Queensland, other Kimberley properties and even overseas to the Middle East and Africa where poor soils and droughts threaten both ecological viability and human welfare. This provided income to offset development costs for the first 15 years, but it did become apparent that the fragile soils with poor texture could not support this enterprise long term without large inputs of fertilizer and heavy use of equipment. Emphasis was then switched back to grazing using rotational grazing to help with the maintenance of the pastures (using our grazing animals, horses and cattle, as "weeders and seeders"); the cattle herd is being improved with introduction of Brahman and Droughtmaster stud bulls and continue to be sold for beef and the horses, introduced to develop the Kimberley School of Horsemanship where we run train sessions, including TAFE courses teaching young local indigenous people skills that prepare them for employment in pastoral and rural industries. Birdwood Downs also offers an Ecological Frontiers program, which are 6 to 9 month Training programs for both Australian and international people. Birdwood Downs is also a venue for workshops and has a tourism enterprise offering accommodation, camping, and ecological tours of the property, showcasing the Ecotechnics approach that has been applied to the development of Birdwood Downs. In addition the project's horses are used for horse trail rides and tours through the regenerated landscapes.

Taking the knowledge learned during the development of the project, Birdwood Downs offers consulting and contracting to external bodies such as mining companies and pastoral enterprises, in land rehabilitation, Savannah Ecoscaping and the development of Wastewater Gardens for Aboriginal communities and remote/rural residences and businesses. In addition, the station has orchards, gardens, cattle, chickens, which greatly reduce the cost of living, as well as adding to the quality of life, a necessary factor in having an enriched community. Because of the swiftly changing conditions socially and economically in the Kimberley we have found that diversity of enterprise base and continuity of managers and personal, and a satisfying lifestyle are essential for sustainability.

### **Savannah Ecoscaping**

The homestead area of Birdwood Downs has been enriched with special micro-climate improving gardens, orchards and silviculture to complement the architecture and demonstrate the beauty and comfort of living in the Kimberley. This approach, using native plants and vegetation adapted to the Kimberley is called “Savannah Ecoscaping” and has been extended by Birdwood Downs to demonstrate greening of Aboriginal communities (e.g. Looma), public buildings (the Derby Youth Centre) and mining company operations and area restoration (the Derby Export facility and tailings dams at Pillara and Cadjebut near Fitzroy Crossing). Savannah Ecoscaping can be designed for the water availability, either using the natural cycles of the wet season, arid zone style irrigation, or using the recycling of greywater. Soil building to provide the conditions necessary for the establishment of the ecoscaping is also part of the process.



Figure 10. (Left) Birdwood Downs homestead buildings – dining room/kitchen/library and gazebo garden shed in early 1980s. (Right) Photographs taken from the same spot showing the “savannah ecoscaping” which has transformed the Birdwood Downs homestead, creating an oasis of shade, beauty and diversity.

### **Wastewater Gardens – Water Conservation, Hygiene Improvement and Greening**

The evolution of more environmentally protective and sustainable use of wastewater occurred in several phases at Birdwood Downs. First, the effluent from the septic tanks which serve the station’s ablution block was modified to run into and partially irrigate a banana and fruit tree area, starting in the late 1980s (Figure 11). This was in contrast to conventional thinking at the time which simply called for “disposal” of septic tank effluent in deep leachdrains, which were kept free of vegetation for fear of pipes getting clogged. But it was clear that in the climate of the Kimberley that a year-round source of water, enriched with nutrients found in residential sewage, could help create a shady micro-climatic habitat for bananas, plantains, papaw (papaya) and guava trees. The leachdrains were lined with gravel to prevent any surface exposure or odour of the discharge wastewater and bananas planted in it, as well as leachdrain water supplying water and nutrients to the lines of banana nearby.



Figure 11. Banana and fruit tree orchard at Birdwood Downs benefit from greywater from septic tank leachdrains – a simple form of subsoil wastewater irrigation. Bananas are planted in leachdrain filled with gravel and adjoining lines receive nutrients and water from the septic tank discharge.

Next, a subsurface flow constructed wetland approach known as “Wastewater Gardens” developed from a prototype system used in the Biosphere 2 closed ecological system laboratory (Nelson et al, 1999) by one of Birdwood Downs’ founding directors, Mark Nelson, was installed (Nelson, 1998). It treats the wastewater from the other septic tank system on the property, which serves the homestead kitchen, as well as a shower and toilet. This was the first Wastewater Garden installed under a pilot program undertaken in cooperation with the West Australian Department of Health which wanted to see new, low-tech approaches to improving wastewater treatment in challenging areas like remote and indigenous communities.

Unlike many constructed wetlands which utilize only one or two common wetland species (e.g. “reedbeds”), Wastewater Gardens in the tropics has demonstrated that an ecosystem design including a choice of well over a hundred species of plants, in tropical conditions, can work effectively in the wetland, thriving in water-saturated conditions. As well, in the final subsoil irrigation of treated water from the Wastewater Gardens, any plants valued by the community can be planted as these irrigation areas are not lined and are appropriate for any crop apart from ones with invasive root systems.



Figure 12. Stages of construction – (left) excavation, (center) installation of pipes and liner, (right) planting of Wastewater Garden, Birdwood Downs homestead, April 2000. Wastewater Gardens can be installed more economically using community labour. Training/education can help people correctly design and install such systems after “hands-on” training.



Figure 13. (left) Wastewater Garden serving homestead at Birdwood Downs one year after planting, April, 2001 (right) system after two years of growth. The system now has abundant canna lilies, Heliconia (Bird of Paradise) and oleander flowers as well as supporting banana, coconut, elephant ear, papyrus and pandanus palm.

In the past four years, additional Wastewater Gardens have been installed at two Kimberley indigenous communities and at an ecologically-oriented family house and bed and breakfast in the Broome area.

The Wastewater Gardens installed at the Emu Creek community east of Kununurra, West Australia helped solve a very bad situation which resulted from half of the community's houses being located next to natural wetlands and soils which are very easily saturated during the wet season. This had resulted in sewage frequently on the ground surface, a dangerous health situation for children and adults at the community; and high expense since septic tanks needed to be frequently pumped out as leachdrains failed to function. For such a small community (30-50 residents), installation and operational costs of a centralized sewage lagoon would have been quite prohibitive – as well as making the system dependent on electricity for pump stations every day of the year. We designed three Wastewater Gardens in a decentralized fashion, making the wetlands sunken 0.5m in the ground to permit gravity-flow operation from the septic tanks. Two of the Wastewater Gardens have the capability of using submersible pumps to send water to higher ground for discharge during heavy wet seasons when the soils in the gravity-flow leachdrain area get saturated, and one system (on higher ground) operates with just gravity-flow year-round. The Wastewater Gardens have significantly added to the greening of the community, and feature many flowering plants, decorative plants and fruit trees (banana, papaw) as per the requests of the community during planning meetings. Artists at the community did dreamtime paintings on the control boxes (see Figure 14) to increase local “ownership” of the systems. The systems have operated without serious problems, in some drier years without need for pumps at all, despite a somewhat sporadic local maintenance. The installation cost of the systems was at least five times less expensive than the centralized sewage lagoon solution, and operating costs are almost negligible in comparison.



Figure 14. Emu Creek (Gulgagulaneng) community, Kununurra, W.A. artists painted dreamtime stories on the Wastewater Garden control boxes (right)/ One of decentralized systems at the community treating residential sewage and featuring canna lilies, heliconia (Bird of Paradise), palms and banana trees (left).

Two years of quarterly water quality tests at these first two Kimberley region Wastewater Gardens showed that effluent water was reduced 89-95% reduction in BOD (a measure of organics in the water), 90-95% in suspended solids, 30-58% in total phosphorus and 48-73% reduced in total nitrogen. Fecal coliform was reduced over 98% without disinfection, but since wastewater is kept away from surface exposure at all stages, there is little danger of accidental human contact (Nelson and Tredwell, 2002).

An ecologically-oriented tourist operation near Broome, the Coco Eco Bed and Breakfast also installed Wastewater Gardens to recycle wastewater into beautiful gardens both in the wetland in the landscaped final subsoil irrigation/leachdrain area (Figure 15). Like the Birdwood Downs system, this is operated off-the-grid with no use of machinery/electricity nor chemicals. It fit in well with their solar energy powered operation and helped the operation win the prestigious 2005 Laminex Group Single Residential Award from the Royal Architectural Institute of Australia.

The award citation noted that: “Coco Eco is a totally ecologically sustainable project north of Broome. It is fully solar powered, all waste is treated on site without the aid of chemicals and all aspects of climate, solar heat gain, ventilation, the choice of materials etc have been carefully considered. The jury was most impressed by the way in which the project draws its imagery, form and detailing directly from the solutions to passive design principles. The resulting complex not only works from a sustainability point of view but creates the ambience requested by the client in an unforced and natural way by adopting forms and materials that reflect the Tropics, the sometimes harsh conditions of climate such as heat and cyclones and the open lifestyle requested by the clients. The resulting project could well serve as an exemplar for similar projects in the future and the architects are to be congratulated.”



Figure 15. Courtyard Wastewater Garden, centred between family house and guest rooms at Coco Eco B&B, Coconut Well, Broome, W.A. creates a lush tropical garden without use of machinery, electricity nor chemicals at the facility.

In 2004, four low-lying houses at the Joy Springs (Eight Mile) Community east of Fitzroy Crossing, West Australia were retrofitted with Wastewater Gardens, gravity-flow leachdrains and submersible pumps to get wet season effluent from the Wastewater Gardens to an inverted leachdrain area built 0.5m above ground level (Figure 16). The systems were fenced with wooden bollards and wire mesh to prevent children from playing in the gardens, and to exclude grazing livestock. The inverted leachdrains, just at the back of each house, was also planted with native bushtucker and medicinal plants, as well as fruit trees and decorative flowering shrubs. A supplemental drip irrigation system on a timer was installed to ensure adequate irrigation of the garden which benefits from wastewater nutrients when pumps are required during the wet season. A fifth house at the community on higher ground had a simple Wastewater Garden with gravity-flow leachdrain area since its soils do not get saturated during the wet season.



Figure 16. (left) Wastewater Garden for individual house, Joy Springs community, Fitzroy Crossing, West Australia. (Right) one of 80m<sup>2</sup> raised inverted leachdrains serving as backyard gardens.

These applications of Wastewater Gardens and Savannah Ecoscaping to our own and other community projects in the Kimberley are indicative of a very healthy and long-overdue shift in the way we think, a paradigm shift. We are increasingly recognizing that so-called “wastewater” is not simply a problem and potential environmental and health risk; but if productively treated and reused can be a sustainable natural resource beautifying communities and conserving water by lessening the need for valuable potable water for such purposes. Fortunately a range of solutions incorporating that thinking are also emerging, including subsurface constructed wetlands such as Wastewater Gardens and greywater irrigation methods where locally adapted “ecoscaping” can be also be achieved using valuable native and well-adapted shrubs and trees.

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