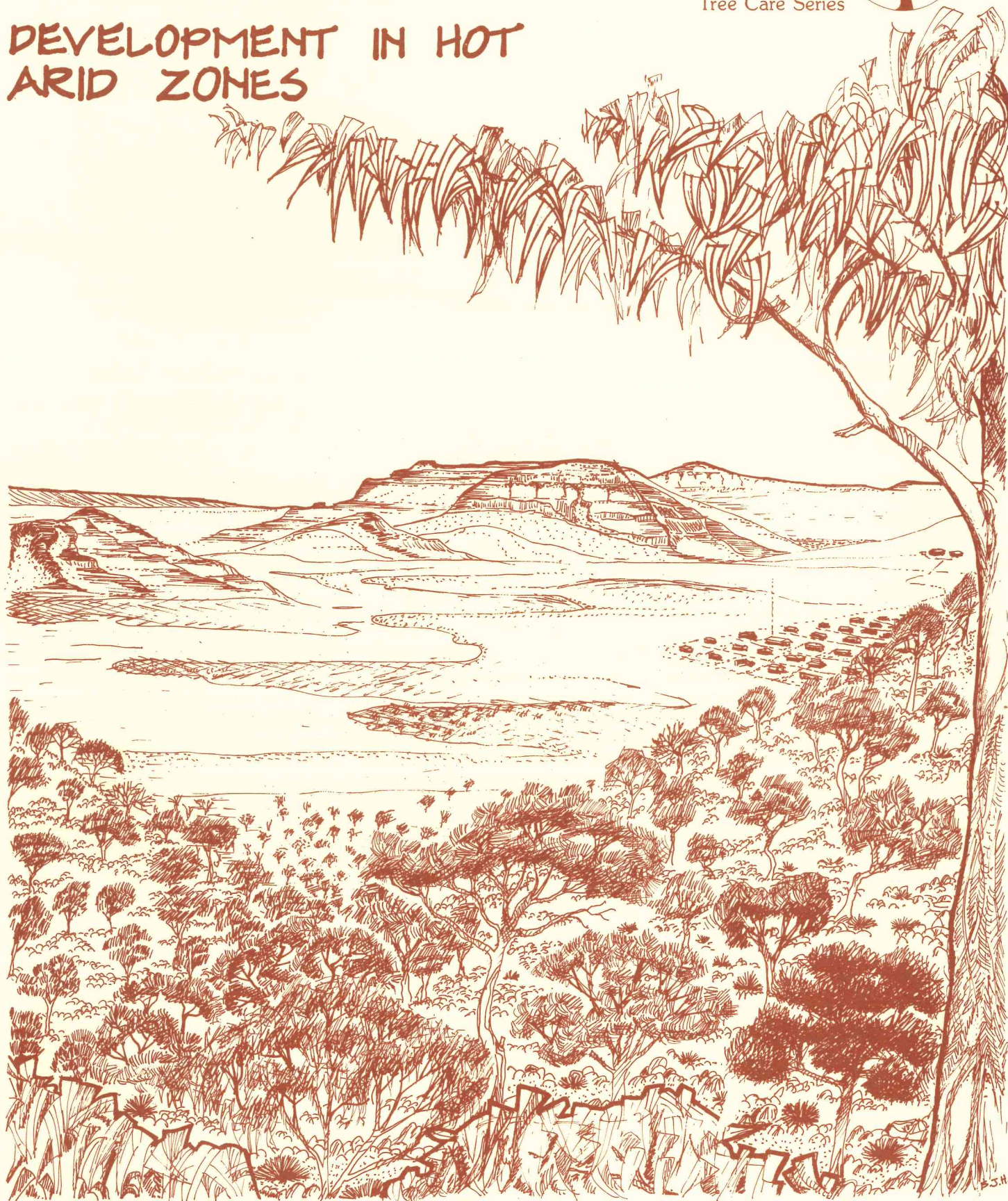


DESIGN AND SITING GUIDELINES



Tree Care Series

DEVELOPMENT IN HOT ARID ZONES



INFORMATION ON HOUSE SITING & LANDSCAPE TREATMENT.
FORESTS DEPARTMENT, WESTERN AUSTRALIA.

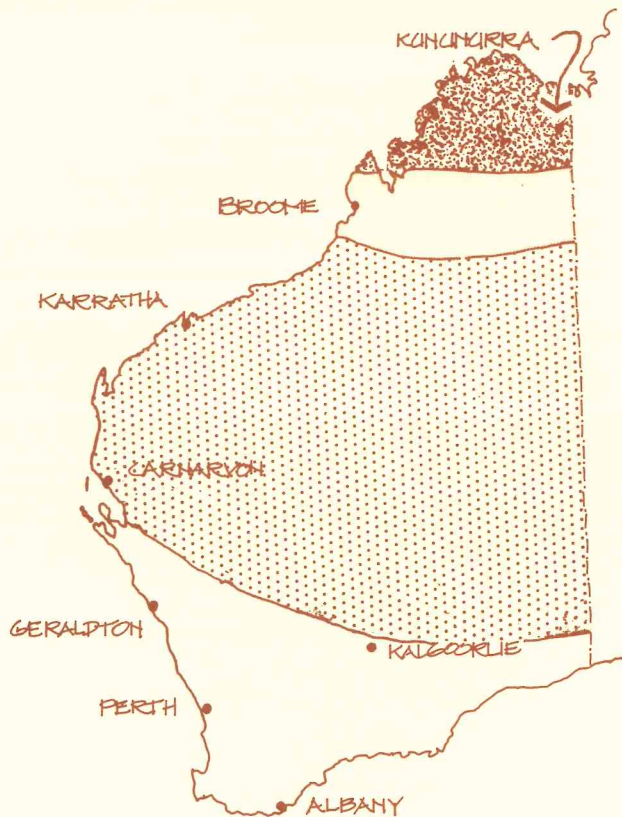
Introduction

This broadsheet provides basic landscape planning and design guidelines for the hot arid zones of Western Australia. New town development in these zones has created a need for detailed information on the planning and design of residential landscapes.

The zones covered by this broadsheet are essentially low rainfall, hot, drought-prone areas, with access to limited fresh water supplies. For these reasons, plant selection and landscape design are concerned primarily with naturally occurring arid zone species and water harvesting techniques.

Climatic histograms show rainfall and maximum temperature on a mean monthly basis for the townships of Kununurra, Broome and Karratha. While these towns are not truly representative of their respective climatic zones, they and their surrounding areas do account for a major proportion of each zone's population.

WESTERN AUSTRALIA CLIMATIC ZONES

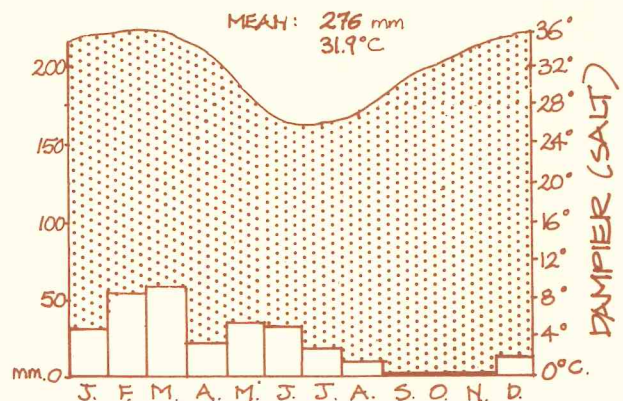
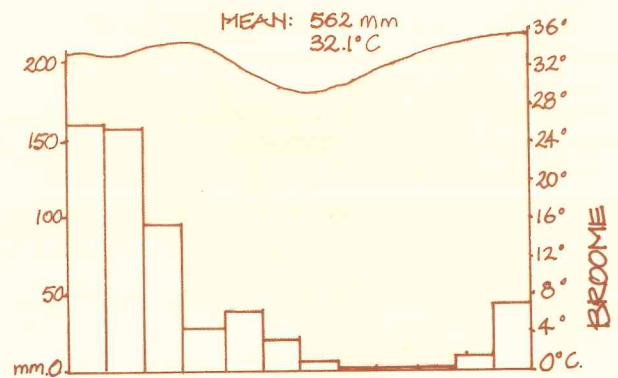
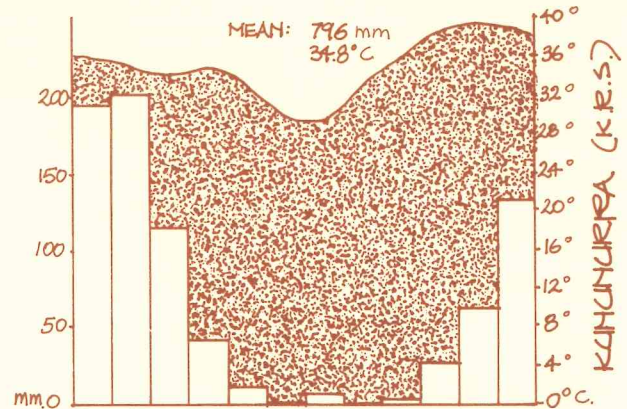


-  TROPICAL SAVANNAH - HOT ALL YEAR, DRY WINTER, SCIMMER WET
-  TROPICAL SEMI-ARID - HOT SUMMERS MILD WINTERS LOW SCIMMER RAINFALL.
-  HOT DESERT: HOT SUMMERS, MILD WINTERS, VARIABLE & DEFICIENT RAINFALL.

Siting & Design

Effective landscape design is dependent on the house and buildings being designed to fit in with the existing site conditions. These conditions are largely determined by a number of environmental factors (climate, slope, soils) which together form the existing landscape character. Thus, identifying the existing landscape character and borrowing elements from it (colours, forms, lines, textures) is the first step towards successful site planning.

The following sections provide a guide for development in the residential and rural areas of hot arid zones.



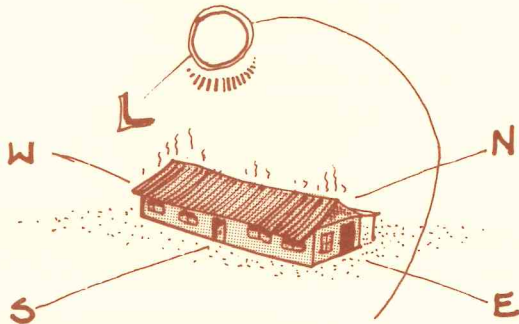
Site Analysis

This initial step involves analysing your site (urban block, hobby farm etc) with regard to the following factors. An understanding of the way in which these factors act to provide opportunities and/or constraints for development is particularly relevant to those people who have the opportunity to select their own building site.

Orientation

In the arid zone, orientation of the house to minimise solar exposure is essential. The long axis of the house should be oriented east-west in order to reduce the building area exposed to the sun during the hottest part of the day, i.e. mid-late afternoon.

HOUSE ORIENTATION



ORIENTATE THE LONG AXIS OF THE HOUSE ALONG AN EAST-WEST LINE TO MINIMISE THE BUILDING AREA EXPOSED TO THE SUN DURING THE HEAT OF THE AFTERNOON.

Correct orientation will affect the living conditions within the house, for example:

- rooms facing east and west should have a minimal area of glass. In fact, in the Karratha, Broome and Kununurra regions, the area of glass on all sides of the building should be minimised to reduce conducted heat flow. It is usually necessary to compromise for this lack of window space with an adequate ventilation system.
- bedrooms should be located on the eastern and southern sides of the house.
- outside living areas should be aligned on the eastern and northern sides of the house (as these sides will not get the afternoon sun) and incorporate sun shading elements such as wide eaves, verandahs, pergolas and awnings. Maximum exclusion of sun is essential to reduce cooling requirements during the hot summer months.
- solar energy collection panels for hot water production should face north and be considered as an integral building element in the initial housing design. For year round collection, a collector panel angle of $1\frac{1}{2}$ times latitude angle is required, e.g.

Karratha	21°S	=	31.5°
Broome	18°S	=	27°
Kununurra	16°S	=	24°

Slope

When choosing a house block, flat land on a ridge or lower slope will have the advantage of good drainage, views, less cut and fill and avoid frost hollows, should they exist. On steeper slopes and upland sites, soils tend to be shallow with rock outcrops and therefore require more expensive construction methods.

A problem may also exist with exposure to cyclonic winds during the wet season.

Bottom slopes are generally less exposed, are more accessible, development is less prominent and naturally available groundwater will be closer to the ground surface.

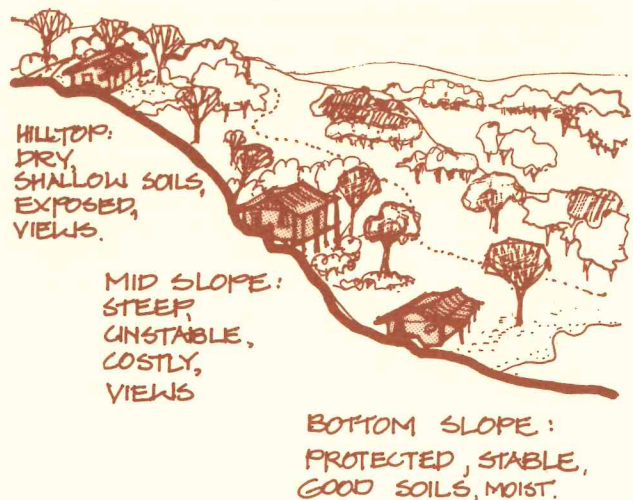
Existing Vegetation

Because shade is such an important factor for human comfort in the arid zone, existing vegetation should be retained wherever possible. This may necessitate some reorganisation of the building design but the advantages of retained mature vegetation make such adjustment worthwhile. Retained vegetation is also important as a soil stabiliser in disturbed building sites, especially on steep slopes. Knowledge of the vegetation's growth characteristics will ultimately determine its retained proximity to the new house.

Wind Protection

Hot, dry winds typically accompany the arid zone summer. They normally come from the east and north and in the wet season (December/March) can be of gale force or greater. House construction must meet the local building standards regarding these strong winds. Out-buildings, fences, trees and shrubs should be located to provide wind protection for the house.

SLOPE

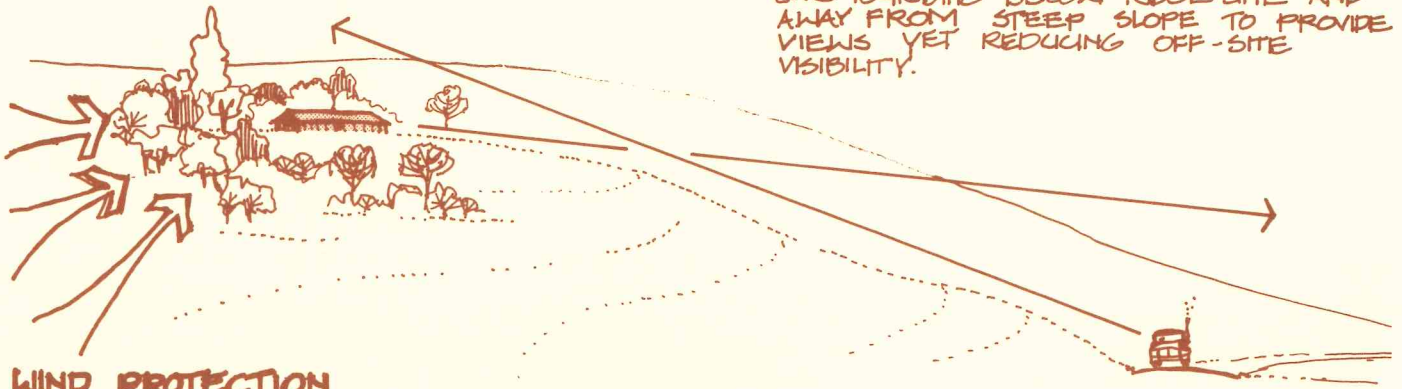


Soils

Soils not only influence building construction but also have a marked effect on the growth and long term survival of plants. Obviously wet sites are to be avoided and rocky soils can provide extra site preparation costs in terms of blasting, bulldozing etc., for footings, sewage systems and in the provision of soil for plants.

VIEWS & VISIBILITY

SITE BUILDING BELOW RIDGE LINE AND AWAY FROM STEEP SLOPE TO PROVIDE VIEWS YET REDUCING OFF-SITE VISIBILITY.



WIND PROTECTION

LOCATE TREES TO PROTECT BUILDINGS FROM WIND AND ENHANCE VIEWS.

Townsites without stable building soils often import such soils to form a large compacted pad over the actual building site. The area covered is often twice that required for the building floor plan and thus the overlap must be ripped or removed to facilitate planting.

Views & Visibility

Siting of the house to obtain views must also be co-ordinated with the previously discussed factors of sun orientation, slopes and protection from wind. Living areas can be sited in the northern and western portions of the house to take advantage of prominent views provided that adequate sun screening is located to shade windows etc.

The southern and eastern facing parts of the house will be the most shaded and coolest, hence their preferred use for bedrooms.

Visibility of your housing development from other areas, e.g. roads, recreation areas, should be considered. Where possible, site the house or other development below ridgelines in order to maintain desired views while decreasing your visual impact on the surrounding environment. If developing on a slope, then views will be dictated by the slope's aspect. However, views can be modified by the appropriate siting of tree and shrub species. This is particularly relevant to situations where there is little choice in selection of your building site, e.g. residential subdivisions. House sites without notable views or with a high degree of visibility, can achieve some privacy by screening exterior views, together with the creation of pleasant surroundings with feature planting.

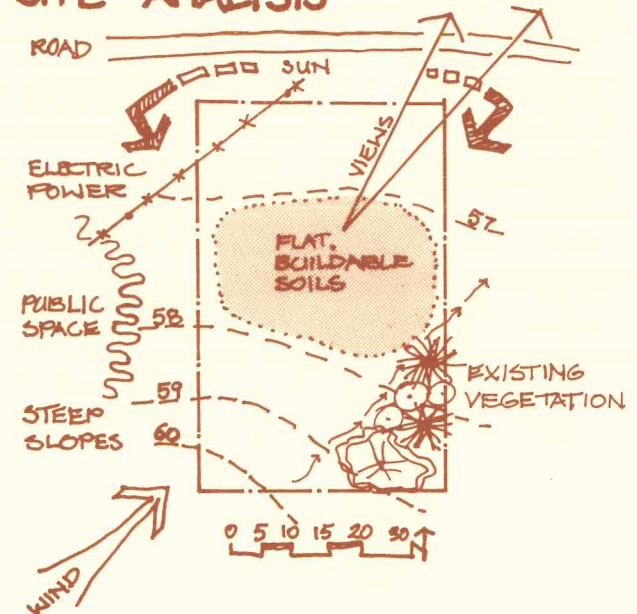
Access

Vehicle and pedestrian access must also be co-ordinated with the previously discussed factors so as not to conflict with desired views and intrude upon outdoor amenity areas. Driveway and carports should be located on the 'working area' side of the house, i.e. close to the kitchen area and away from living and bedrooms. Vehicle parking areas and driveways should not occupy focal areas. Driveways should be partially screened and situated on the periphery of

the site. They should provide a sequence of views of the destination before arrival at the parking area or garage, which in turn should be located on the side of or behind the house. In hilly topography the entrance road should travel along the contours rather than across them.

Circulate roads around building clusters rather than bisecting them, otherwise vehicle/pedestrian conflicts will result.

SITE ANALYSIS



Outdoor Living Spaces

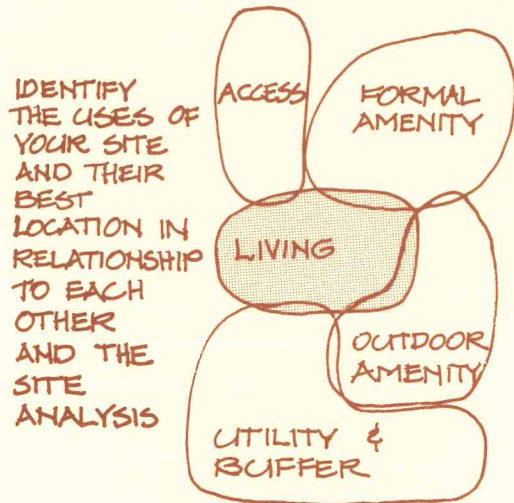
The site analysis, if undertaken correctly, will have sited the house responding to the above factors and thus will have delineated certain areas for certain uses. These will include:

- outdoor amenity areas
- vehicle entry, enclosure and circulation areas
- pedestrian circulation areas
- other utilitarian areas, e.g. work sheds, vegetable garden.

Each of these areas will require certain building and plant materials which should both complement the housing design and provide a functionally attractive setting.

There are a number of steps involved with developing these outdoor living areas.

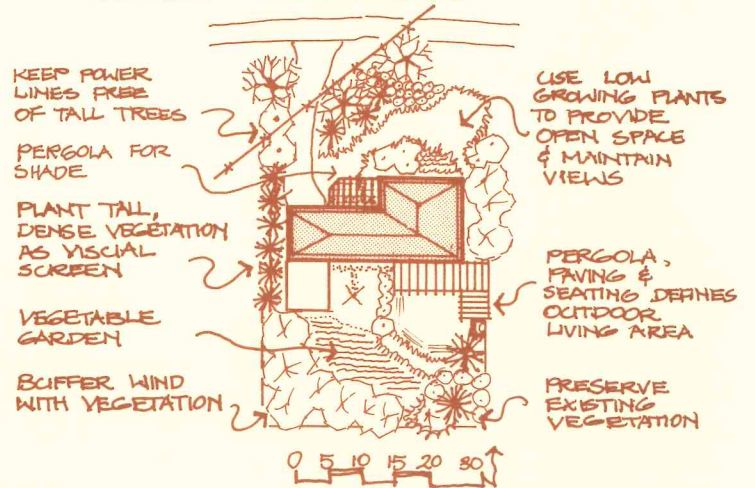
CONCEPTUAL LAYOUT



Site Preparation

1. Layout, via pegs or other markers, the areas chosen for planting trees, shrubs, lawn etc. If redeveloping an existing site, then remove unwanted plant material and kill lawn grass etc., with an appropriate herbicide.
2. Depending on the soil type and degree of compaction from building machinery etc., rip the topsoil to a depth of approximately 60cms. Soil brought onto the site to provide a stable building base may have to be completely removed as it is often unsuitable as a plant medium, e.g. compacted pindan clay. This can be achieved by the hiring of a backhoe which can also be used to redistribute the replacement soil. Be aware of any contrast in colour caused by importing soils not indigenous to the area.
3. The organic and nutrient content of native soils is generally sufficient to meet the requirements of arid zone plants. However, where fruit trees, vegetable gardens and lawn areas are to be established, it will be necessary to first amend the soil. This is usually done by the addition of sewerage sludge or similar organic material (composted lawn clippings and household scraps). Mix well with a rotary hoe.
4. Layout and install the underground section of the reticulation system.
5. The preparation of hard surface areas such as patios, driveways and paths can now take place using materials such as brick, stone, concrete, steel and treated wood. It is important to carefully choose these materials so that they blend with and complement the existing landscape character, each other and the building design. Select a simple combination of building materials and use them throughout the whole site. For example, pathways

HOUSE SITE PLAN



could be constructed from paving bricks of a similar colour and texture to the housing brick and pergolas constructed from jarrah (treated for termites). Retaining walls on the site should therefore be constructed from jarrah railway sleepers to complement the pergola. Alternatively, brick pavers or concrete could be used with treated pine logs as pergola and retaining wall materials. The emphasis here is on achieving a design theme which involves co-ordination of building elements to unify the whole site.

6. Water harvesting is the term given to collecting rainwater from hard surface areas such as roofs and driveways for later or immediate use. This practice is limited in the urban home garden situation but nonetheless it is important to effectively utilise all water supplies in the arid zone. Roofs can be equipped with gutters and the water shed by the roof guided to the garden beds via downpipes and slotted PVC pipe or agricultural tiles. Water runoff from driveways or other paved areas can be collected and channelled to planting beds in a similar manner. When laying dispersion pipes in areas with heavy subsoils, back-fill the channels with gravel or sand to aid percolation and distribution of the collected water.
7. Planting of the various garden areas should preferably occur after all hard surface construction work has been completed, otherwise damage from building equipment may result. Similarly, any retaining walls etc., required need to be constructed before planting begins.

Plant Selection & Siting Guidelines

Most plants which grow naturally in the arid zone can be readily adapted to the urban landscape. Functionally beautiful gardens can be created by using these plants, provided that the site is prepared as above and that the right species are chosen for the appropriate site functions.

Plant Selection

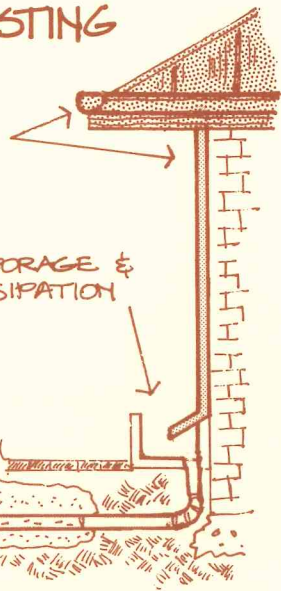
Identify the existing character of your surrounding environment and use it as a guide to plant selection. Select plants that reflect the native colours, textures

WATER HARVESTING

RUNOFF FROM ROOF IS COLLECTED VIA GUTTERS AND PIPED TO TEMPORARY STORAGE

CONCRETE STORAGE & ENERGY DISSIPATION TANKS

SLOTTED PVC. OR AG-TILE PIPING IN TRENCHES BACKFILLED WITH COARSE SAND OR GRAVEL.



and forms so as to blend your development with the natural surroundings.

Suitable plant species must be selected to satisfy the functions of the previously defined outdoor areas. Plant functions would therefore include: windbreak, screen, shade, ornamental shrubberies for a pleasant outlook, erosion control for steep banks or a combination of the above. Care too, must be given to the plants' water requirements. Although most of the plants listed in this broadsheet are from the arid zone and hence drought tolerant, lawn areas and horticultural plants sharing the garden site will require different watering regimes. Hence plants should be grouped according to their water requirements wherever possible.

Plant Siting Guidelines

The spacing and grouping of selected plants again depends on their function. Windbreaks are most efficient when planted with several rows of different plant species on close spacings. The objective is to provide species of different heights to allow for the filtering of wind. Total screening will require close spacing using plants with dense foliage. Ornamental or feature area planting will require plants of different heights and forms to provide an attractive arrangement of foreground, midground and background views. Trees with clear boles and dense foliage are ideally suited for providing shade in pedestrian areas whereas in areas removed from intense human use, less formally shaped mallee type species may be used.

Groundcover species can be sited in foreground situations where achieving a human scale is important, or planted in masses as a substitute for large lawn areas. Some groundcovers may also be used in hanging baskets etc., under pergolas.

The mature height of trees is an important siting characteristic, and location of trees in relation to overhead lines, underground services etc., must also be considered. Avoid placing tall trees closer than 6m against buildings. This is especially relevant in those areas subject to tropical cyclones.

In all cases, plant textures and colours (including leaf, flower and bark colour) must be considered as important factors used to achieve harmony in planting design. Refer to table of plant species and characteristics.

Planting Method

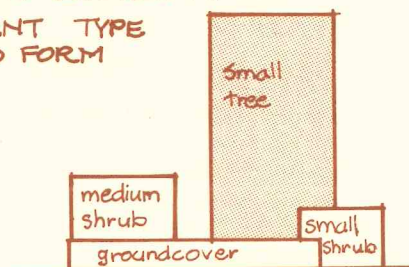
Although arid zone plants are necessarily hardy, they still respond to proper planting procedures:

- soil amendment is usually not required unless the existing soil is exceptionally sandy, clayey, salty, very acid or very alkaline. Site preparation as earlier discussed is generally necessary to alleviate problems of compaction.
- apply a slow release fertiliser to the side or base of the planting hole. Check for root binding if using potted material (tease roots if necessary), place plant in the hole, replace the soil and firm down with the hands or feet.
- water the plant immediately, saturating the soil to remove any pockets of air.
- install a trickle irrigation system and water the young plants at an initial rate of 20 litres per week increasing to 30 litres per week during hot, dry periods.
- after the irrigation system has been installed, the planting bed may be covered to a depth of 100mm with a mulch such as woodchips, shredded bark,

PLANTING DESIGN

BASIC CONSIDERATIONS:

• PLANT TYPE AND FORM

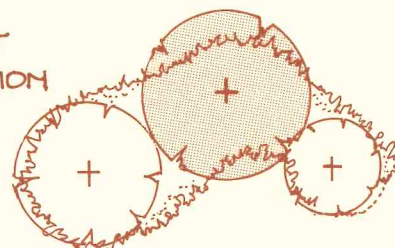


• PLANT COLOUR AND TEXTURE



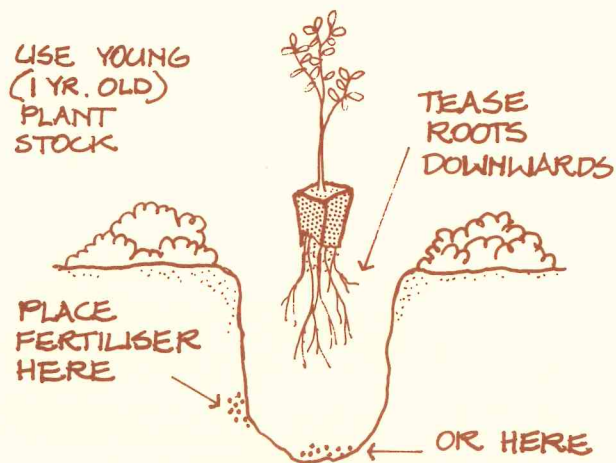
• PLANT FUNCTION

• PLANT LOCATION



3 WAYS OF VISUALISING THE SAME PLANTING ARRANGEMENT

PLANTING METHOD



rocks or gravel. Such a mulch will reduce the rate of soil moisture evaporation and generally reduce the soil temperature. Mulch will also provide an attractive soil stabilising groundcover until the plants mature. Again, use a mulch that is compatible with the existing surroundings.

Maintenance

The use of arid zone plants does not imply that you will have created a maintenance free garden. However, the maintenance requirements of an arid zone garden will be less than that required for a similar area of moisture loving plants. The following points will enable you to maintain your arid zone garden in a healthy and functionally aesthetic condition:

- control weed growth, especially invasion by buffel grass;
- check the trickle irrigation system regularly to ensure that all the drippers are functioning; install a timer on taps used to water lawn areas;
- arid zone plants can become 'woody' and generally misshapen in the artificial environment of a garden. They should therefore be pruned after flowering to increase foliage density and remove unwanted growth;
- replace organic mulch as necessary.

The following table lists plants and their characteristics which are available from the Karratha nursery.

Shrubs to 1m

Species	Common name	Flower colour	Foliage colour	Height (m)	Spread (m)	Use
<i>Acacia translucens</i>	<i>Poverty bush</i>	Gold	Green	1	2	Groundcover
<i>Atriplex rhagodioides</i>	<i>River salt bush</i>	White	Pale blue	1	3	Groundcover
<i>Canavalia rosea</i>	<i>Sea bean</i>	Mauve	Green	.2	2	Groundcover
<i>Capparis spinosa</i>	<i>Coastal caper</i>	White	Green	1	1.5	Groundcover
<i>Cassia oligophylla</i>		Yellow	Blue or green	1	1.5	Attractive flowers and foliage
<i>Cassia pruinosa</i>	<i>Silver cassia</i>	Yellow	Blue	1	1	Attractive flowers and foliage
<i>Clianthus formosus</i> (annual)	<i>Sturts desert pea</i>	Red	Green	.2	2	Groundcover
<i>Enchylaena tomentosa</i>	<i>Ruby salt bush</i>	Yellow-red	Green	.5	1	Attractive flowers edible berries
<i>Ipomoea brasiliensis</i>	<i>Beach morning glory</i>	Mauve	Green	.2	3	Groundcover vine

Information

The Forests Department has offices in Karratha, Broome and Kununurra which provide advice on plants most suited for different purposes in the arid zone.

Karratha

Forests Department Extension Service
Government Nursery
Woodbrook Road (L.I.A.)
KARRATHA WA 6714
Tel: (091) 85 1545

Broome

Forests Department Extension Service
Broome Nursery
Herbert Street
BROOME WA 6725
Tel: (091) 92 1036

Kununurra

Forests Department Extension Service
Papua Drive
KUNUNURRA WA 6743
Tel: Kununurra 81211

Planning Requirements

Before developing your site, see the local council or shire concerning building permits and planning controls. These authorities will usually have rules regarding permissible building materials, road and boundary setbacks, land use zoning and landscape requirements.

Water Supply

The Public Works Department has offices throughout the region which will provide information on water supply connection.

Fire Protection

The Bush Fires Board (Albert House, 10 Victoria Avenue, Perth) through the local shire councils can provide information and advice on fire protection.

Produced by Landscape Section for B. J. Beggs
Conservator of Forests, April 1983.

Forests Department of
Western Australia

50 Hayman Road
COMO 6152 Phone 09 367 6333



Shrubs 1m and above

Species	Common name	Flower colour	Foliage colour	Height (m)	Spread (m)	Use
<i>Acacia tumida</i>		Gold	Blue/green	3	3	Attractive white stem
<i>Acacia trachycarpa</i>	<i>Mimi richi</i>	Gold	Green	3	2.5	Long narrow leaves
<i>Cassia hamersleyensis</i>		Yellow	Blue/green	1	1.5	Small foreground shrub
<i>Cassia notabilis</i>	<i>Cockroach cassia</i>	Yellow	Green	1	1.5	Attractive seed pods
<i>Eremophila maculata</i>	<i>Native fuschia</i>	Red	Green	1	1	Small ornamental shrub
<i>Gossypium robinsonii</i>	<i>Desert rose</i>	Mauve	Green	2.5	2.5	Medium shrub
<i>Gossypium sturtianum</i>	<i>Desert rose</i>	Mauve	Green	2.5	2.5	Medium shrub
<i>Maireana georgii</i>	<i>Blue bush</i>	Red	Blue/green	1	1	Small foreground shrub
<i>Melaleuca eleutherostachya</i>		Gold	Green	1	1	Small foreground shrub
<i>Solanum ferocissimum</i>	<i>Wild tomato</i>	Blue	Blue/green	1	1	Small ornamental shrub
<i>Solanum phlomoides</i>	<i>Wild tomato</i>	Violet	Blue/green	1	1	Small ornamental shrub

Trees to 7m

Species	Common name	Flower colour	Foliage colour	Height (m)	Spread (m)	Use
<i>Acacia inaequilatera</i>	<i>Camel bush</i>	Mustard	Blue	4	3	Landscape—rehabilitation
<i>Brachychiton australe</i>	<i>Kurrajong</i>	White	Green	6	4	Urban—ornamental feature
<i>Callitris collumellaris</i>	<i>Cypress</i>		Green	6	4	Ornamental
<i>Eucalyptus kingsmillii</i>	<i>Kingsmills mallee</i>	Yellow	Green	3	2	Urban—midground ornamental
<i>Eucalyptus socialis</i>	<i>Redwood</i>	Yellow & pink	Green	5	3	Urban—ornamental and rehabilitation
<i>Eucalyptus striaticalyx</i>	<i>Kopi gum</i>	Yellow & pink	Blue/green	5	2.5	Salt tolerant—ornamental and rehabilitation
<i>Eucalyptus torquata</i>	<i>Coral gum</i>	Pink	Green	5	2.5	Urban ornamental
<i>Ficus platypoda</i>	<i>Desert fig</i>		Dark green	6	5	Urban ornamental
<i>Pittosporum phylliraeoides</i>	<i>Native apricot</i>	Yellow	Green	5	3	Urban ornamental—rehabilitation
<i>Thespesia populneoides</i>	<i>Tree hibiscus</i>	Yellow	Dark green	6	4	Urban—ornamental feature
<i>Sesbania formosa</i>	<i>Cork bark</i>	Cream	Green	6	4	Urban—ornamental short lived fast grow.

Trees 7-10m

Species	Common name	Flower colour	Foliage colour	Height (m)	Spread (m)	Use
<i>Acacia aneura</i>	<i>Mulga</i>	Gold	Blue	7	4	Rehabilitation
<i>Acacia coriacea</i>	<i>Wire wood</i>	Pale yellow	Blue/green	8	6	Urban ornamental, shade
<i>Brachychiton gregorii</i>	<i>Desert kurrajong</i>	White	Green	8	6	Urban ornamental, feature
<i>Casuarina equisetifolia</i>	<i>Sheoak (beach)</i>	Red	Green	10	5	Shade, windbreak
<i>Casuarina glauca</i>	<i>Sheoak (swamp)</i>	Red	Blue/green	9	5	Windbreak, shade
<i>Eucalyptus aspera</i>	<i>Brittle range gum</i>	Yellow	Green	8	6	Landscape shade
<i>Eucalyptus leucophloia</i>	<i>Snappy gum</i>	Yellow & pink	Blue/green	7	5	
<i>Eucalyptus patellaris</i>	<i>Weeping box</i>	Yellow & pink	Blue/green	8	6	
<i>Lisophyllum cunninghamii</i>	<i>Bauhinia</i>	Red	Green	7	5	Urban ornamental feature

Trees 10m and above

Species	Common name	Flower colour	Foliage colour	Height (m)	Spread (m)	Use
<i>Albizia lebbek</i>	<i>Albizia siris</i>	Gold	Green	15	10	Shade
<i>Eucalyptus coolabah</i>	<i>Coolibah</i>	Yellow	Blue or green	12	5	Landscape, shade
<i>Eucalyptus papuana</i>	<i>Ghost gum</i>	Yellow & pink	Green	10	7	Landscape, shade
<i>Ficus racemosa</i>	<i>Cluster fig</i>	Yellow	Dark green	10	7	Shade
<i>Livistona alfredii</i>	<i>Millstream palm</i>	Yellow	Blue/green	15	4	Ornamental
<i>Livistona eastonii</i>	<i>Mitchell Plateau palm</i>	Yellow	Green	12	2	Ornamental
<i>Melaleuca leucadendron</i>	<i>Cadjeput</i>	Gold	Green	15	10	Wet sites, ornamental shade
<i>Phoenix dactylifera</i>	<i>Date palm</i>	Yellow	Green	10	10	Urban ornamental feature
<i>Schinus molle</i>	<i>Pepper tree</i>	White	Pale green	12	8	Shade
<i>Tamarindus indica</i>	<i>Tamerind</i>	Yellow	Green	10	7	Shade