Coastal Management Plan Jurien Bay Area

Department of Conservation and Environment
Perth, Western Australia

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Coastal Management Plan Jurien Bay Area

a study promoted by the
Department of Conservation and Environment, Perth
Western Australia
and the
Coastal Management Co-ordinating Committee
in co-operation with the
Shire of Dandaragan

by C.E. Chalmers S.M. Davies

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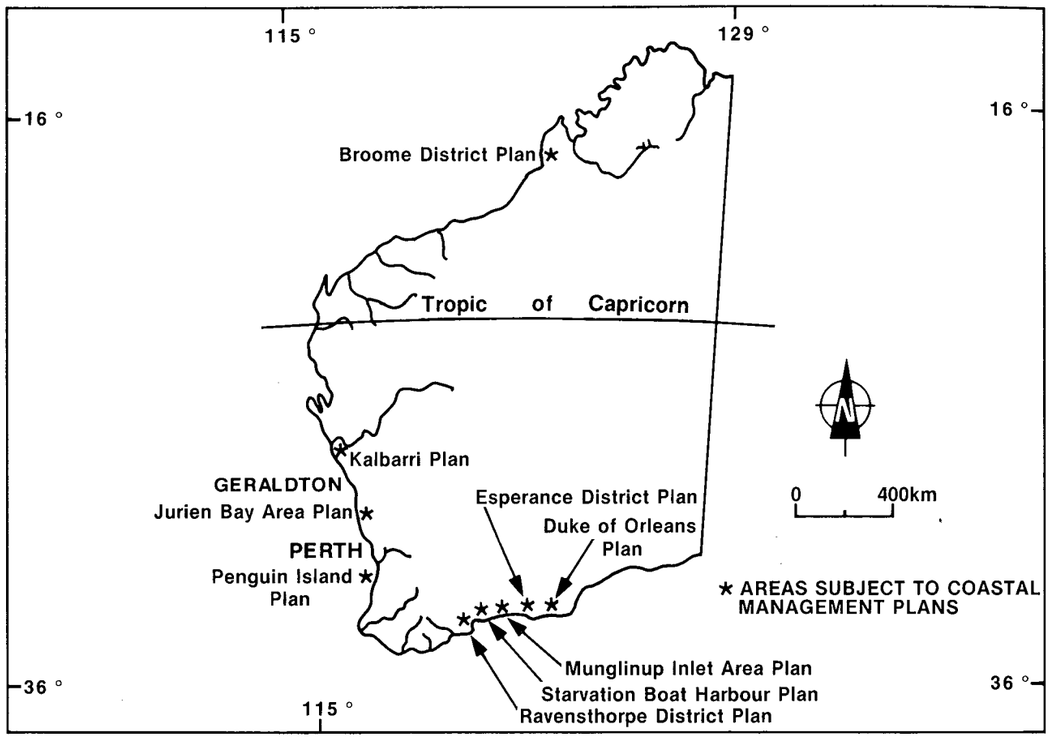
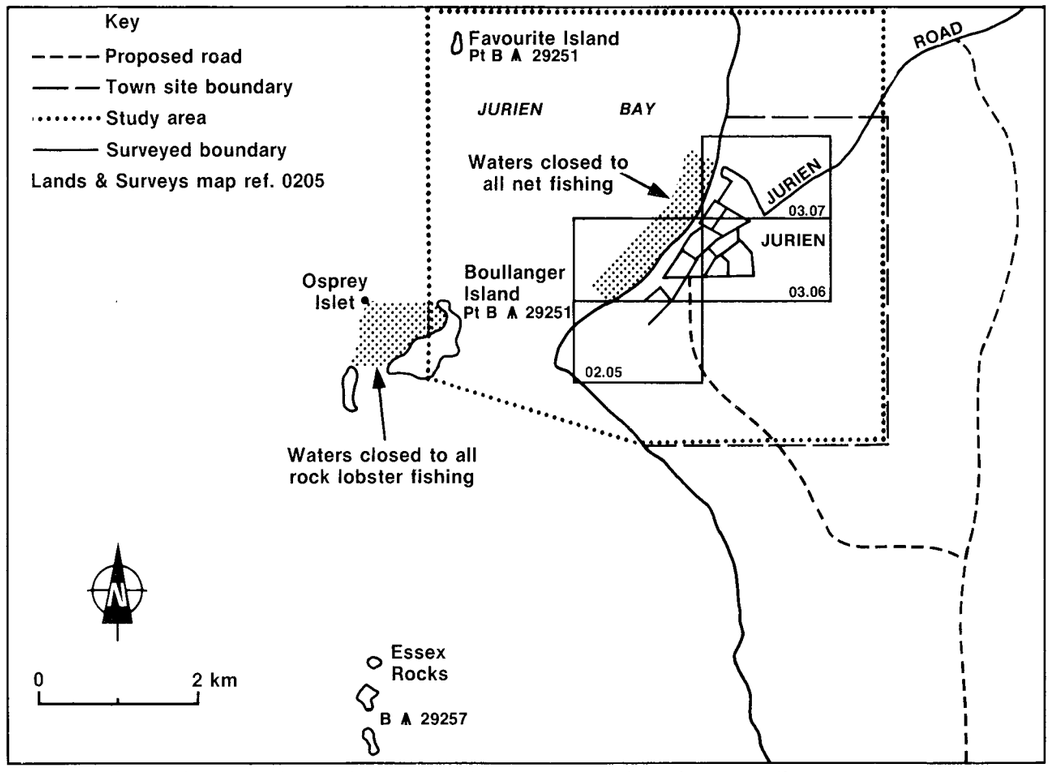


Map 1 Location of Jurien Bay and other areas covered by coastal management plans



Map 2 Jurien environs, study area boundary, MRD road proposals and conservation reserves.

Coastal Planning in Western Australia

In 1982 the Western Australian Government established a Coastal Management Co-ordinating Committee (CMCC) comprising representatives from a number of State authorities to:

- advise government about coastal management policies, legislation and administrative arrangements;
- co-ordinate departmental activities on the coast through the exchange of information and views, and review expenditure programmes and priorities;
- overview the preparation and implementation of coastal management plans at regional and local levels for various locations on the coast of W.A.

This is the fourth final plan prepared under this programme and the locations covered by other plans are shown on Map 1.

Summary

In 1982, the Coastal Development Committee considered an application to subdivide private land south of Jurien for residential purposes. The Town Planning Department recommended against the proposal because it considered that the subdivision design would aggravate coastal management problems in the area. The Committee went on to suggest that all subdivision should be delayed until a coastal management plan had been prepared for the town. Subsequently, the Shire of Dandaragan approached the Department of Conservation and Environment seeking assistance in the preparation of such a plan.

This plan has been prepared to co-ordinate those aspects of land development which influence the coastal environment. It contains an investigation of the natural and man-made resources of the area and use pressures which are likely to be placed upon them. It then determines the following development and management aims:

- protect the coastal environment;
- provide for recreational demands on the area in a manner consistent with its protection;
- define the relationship between residential and industrial development and the coastal environment;
- provide for the needs of professional fishermen and other boat owners using the area;
- develop a system of public environmental education and interpretation for the area;
- integrate existing and proposed developments during the planning process;
- preserve and, where possible, upgrade the landscape character of the town.

The plan contains development and management proposals which have been prepared to assist Council in achieving those aims. Finally, a chapter on implementation gives recommendations concerning priorities and procedures required to effect the plan.

The plan will be subject to review in December 1989, but alteration may be made before that, after discussions between Council, DCE, other interested authorities and public.

Introduction

Location

Jurien Bay is located immediately north of Boullanger Point on the mid-west coast of Western Australia. Jurien township is at latitude 30° 18′ south and longitude 115° 02′ east and 265 kilometres, by road, north of Perth (Map 1).

Background

A meeting of the Coastal Development Committee (CDC) in February 1982, considered an application to subdivide land, south of the town, for residential purposes. The committee resolved to recommend refusal of the proposal because the design of the subdivision did not consider the relationship between future developments and the coast. The committee then recommended that the Jurien foreshore should be the subject of a coastal management plan before further subdivision approvals were granted.

On March 25, 1982 the Shire Council approached the Department of Conservation and Environment (DCE) seeking assistance in the preparation of a plan. However, at that time the Public Works Department (PWD) was undertaking investigations at Jurien Bay to determine the feasibility of constructing a fishing boat harbour in the area, and it was agreed to delay preparation of the plan until PWD's studies were completed.

Purpose of the Plan and Plan Reviewal

This plan has been prepared to integrate the proposals made by the Council and their Town Planning Consultants, PWD, Department of Lands and Surveys (DL&S), DCE, other authorities and private developers which may influence the Jurien Bay area. It will be subject to review in 1989 and alterations to it before then will be made after consultation between Council, DCE and other interested groups.

Area of the Study

The study area is bounded on the north by a line running east-west through a point on the coast 1.3 kilometres north of Hastings Street, and on the south by a line running east-west through the the southern boundary of location 8837. The eastern boundary corresponds with the eastern boundary of the townsite and the western boundary is a line running north-south through Boullanger Island, as shown on Map 2.

The study area is described as the Jurien Bay area. Crown land situated within the study area includes the reserves shown in Table 1.

Silver gull
Larus novaehollandiae

Table 1 — Reserves and Purposes

Reserve	Area (ha)	Vesting date	Vested in	Purpose of vesting
28541	25.3060	28.4.67	Dandaragan Shire	Recreation
35716	13.0413	24.1.79	Dandaragan Shire	Public recreation
34577	0.9712	13.4.77	Dandaragan Shire	Public recreation
30695	0.4191	24.2.71	Dandaragan Shire	Public recreation
24726	0.1214			C.W.A. Holiday Home
29163	0.1725			Nursing Centre
31215	0.1103			Ambulance Depot
34517	0.1012			C.W.A. Centre
37024	0.4313			Church site
37025	0.2277			Fire brigade site
37026	0.3624			Church site
28412	0.1439			Fisheries Department Quarters
27406	3.0984	16.6.72	Dandaragan Shire with power to lease	Caravan Park
26939	0.0905	16.6.72	Dandaragan Shire with power to lease	Kiosk site
26940	0.9247	16.8.63	Dandaragan Shire	Caravan Park
28139	1.1968	21.10.70	Dandaragan Shire	Hall site and Shire Council Offices
27954	0.5206			Police Station and Quarters
28918	3.8698			School site
30766	0.1925			Use and requirements of Shire of Dandaragan
27586	0.1012	26.5.65	Dandaragan Shire	Water
33318	0.2736			Aged persons home
36190	1.8679			Recreation youth camp
33547	0.3600			Buffer strip
27842	0.2919			Shire Depot
28757	0.1996			Depot site PWD
31884	88.7501	8.3.73	Dandaragan Shire	Recreation
35408	82.5126	9.11.78	Dandaragan Shire	Aerial landing ground
30805	0.2696	23.4.71	Dandaragan Shire	Slipway and boat building
31587	0.0809			Government requirements Fisheries Department
34999	0.3893	2.11.77	Dandaragan Shire	Parklands
36713	0.0260			Pedestrian Access Way
34814	0.2012	21.7.77	Dandaragan Shire	Children's playground
36251	1.9611	2.8.83	Dandaragan Shire with power to lease	Recreation
36250	0.8644			Recreation
36254	0.0250			Pedestrian Access Way
36252	0.1040			Recreation
34899	2.6120	21.9.77		Caravan Park
36253	6.8806			Recreation
36256	0.0250			Pedestrian Access Way
36257	0.0250			Pedestrian Access Way

Resources

Geology and Land Form

Jurien is situated within the Coastal Belt as illustrated in the Dongara-Hill River Geological Sheet compiled by Lowry (1974). It is not proposed to reproduce that work here but to outline the features of most significance in coastal planning.

The coastline is characterised by long sandy beaches stretching between low limestone headlands. Off shore there are two or three partially or completely submerged ridges of dune limestone whose westward edges probably mark former coastlines.

Behind the beach a series of unconsolidated sand dunes and beach ridges occur. These structures are a part of deposits known as the Quindalup Dune System or Safety Bay Sands (Woods and Gilkes 1982). This system contains two geomorphic units described as the beach ridge unit and the sand dune unit.

The beach ridge unit comprises a series of low parallel beach ridges which have built out from an old shoreline formed at a time when Holocene seas reached approximately their present level around 5-6000 years ago.

A series of transgressive parabolic dunes extend inland from the present shoreline overriding older coastal deposits.

Off shore, Holocene sediments have been transported into the Jurien Depression leading to the formation of the Boullanger and Favourite Banks. There appears to have been a northerly component in the onshore sediment transport regime which has resulted in the capture of much of the mobile sediment in the more southerly Boullanger Bank. The steep margins to Jurien Basin indicate that the basin is being infilled from both north and south.

These features are shown on Photograph 1.

Coastal Processes

The coast at Jurien was first surveyed over 100 years ago and since that time a good deal of information concerning the area has accumulated. Woods and Gilkes (1982) describe the Holocene history of the area as follows:

Study of the Public Works Department (PWD) plan 52902-3-1 which shows water and vegetation lines at Jurien between 1875 and 1980 indicates that the shoreline south-east of Boullanger Point had retreated approximately 200 metres in 105 years or 1.90 metres per year.

In addition a loss of vegetation on the sand dune unit in that area has ensured a continuity in blowout activity.

As there was probably a northern component in the onshore movement of sediment, the Boullanger system could "capture" sediments that might otherwise have moved onto Favourite Bank. Thus Boullanger Bank is in a position to grow faster than Favourite Bank. At around 2400 B.P. the nature of shoreline progradation changed and the Boullanger beach ridge plain migrated rapidly towards the south-west. Possibly this was in response to the shore coming into contact with the deeper parts of the Jurien Depression so that subsequent progradation could only occur along the apex of sediment accumulation behind Boullanger Island. The Jurien shoreline thus became asymmetrical with the shape of Boullanger Point at this stage, possibly resembling the modern Becher Point in that parallel beach ridges were formed south of the Point with a "slip-face" to the north. Progradation of northern shores was minimal during this time.

Around 1700-1800 B.P. the pattern of progradation changed abruptly with sedimentation taking place exclusively to the north of Boullanger Point. As a result the Point migrated to the north west. This pattern persists today with all beaches north of Boullanger Point prograding, while those to the south erode. Coincident with this northward movement of the Point is the filling of the Jurien Basin from the south.

The average rate of advance of Boullanger Point through the Holocene has been about 1m/yr. Over the last 1700 years there has been around 1250m of north-west accretion (0.7m/yr). This suggests that there must be some mechanism that averages down short bursts of rapid advance.

With inundation of the Pleistocene landscape around 5-6000 years ago sedimentation at Jurien commenced with a series of beach ridges or linear dunes against the mainland coast. The elevation of the swales in these ridges is 3.5m above Australian Height Datum suggesting a higher sea level or high energy conditions. It is probable that these oldest ridges were built on a Pleistocene platform prior to shoaling of the Jurien Depression. Remains of the platform front the present coast from Middle Head North.

As sea level stabilised and possibly dropped, the inner and outer reefs acted as diffraction gratings through which waves moving toward the mainland coast passed. Holocene sedimentation was confined to the zones of swell wave interference behind major features along the inner reef, leading to bank building and partitioning of the Jurien Depression into a series of discrete basins. With shoaling of the waters adjacent to parts of the mainland coast, advance of a beach ridge plain became possible. The shape of individual ridges indicates that up to 2400 B.P. the shore advanced steadily westward along its entire length. A slight bulge indicates that the axis of Boullanger Bank at 2400 B.P. was due east of the island.

The observed beach ridge pattern indicates that every so often an event, or series of events, erodes the western part of the northern shorelines, truncating ridges and possibly pushing sand northwards, thereby filling in beaches north of the point and creating a smoothly curved bay. There appear to have been four or five such events in the last 1700 years, indicating cycles of 350-400 years. The 1875 survey reveals that the northern shore had a smooth curve. Air photo interpretation reveals that there was truncation of older ridges immediately behind this shoreline. Possibly one of these events occurred only a few years or decades before 1875. Since 1875 there has been rapid development of a bulge north of the point. The apex of the bulge is prograding at 3m/yr.

Rates of progradation of the coast fronted by Jurien Basin have been marginally slower than the coast near the point. Near the centre of the basin the shore has advanced 750m in 1300 years (0.6m/yr). Since 840 B.P. the rate has increased to 0.8m/yr. The 1875 survey shows that this coast has in places advanced 100m (1m/yr).

It appears that there is nothing to reverse the present trend in coastal development. With the south coast eroding there is a continuing source of material to feed the northern beaches and to fill in the basin. Possibly the creation and rapid development of a bulge to the north of the point starves beaches further north. No sediment can reach them other than around the margins of the basin, and little sediment appears to travel south from Favourite Bank. It also appears that an event which erodes the shore and smears sediments contained in the bulge around the northern shores is necessary to cause progradation of the coast adjacent to the basin. After the event, a node again develops and the central beaches erode. There appears to be plenty of sand coming ashore through the main ridge, and from the eroding beaches to the south, to allow the coast to prograde into the basin for a long time to come.

The movement of the shore at Jurien since 1875 is shown on Figure 1.

Slope

The coastal dune system of the Jurien area keeps a low relief, the dunes rarely exceeding heights of 3.5 metres above sea level to the north of the townsite. However, even when considering such low dune systems, the degree of slope for bare sand surfaces is significant to coastal dune management. In places along the foreshore the eroded frontal dune slopes exceed the angle of rest for sand surfaces (38°), illustrating their vulnerability to further erosive processes. These slopes need particular maintenance attention in order to protect the foredune reserve.

Vegetation

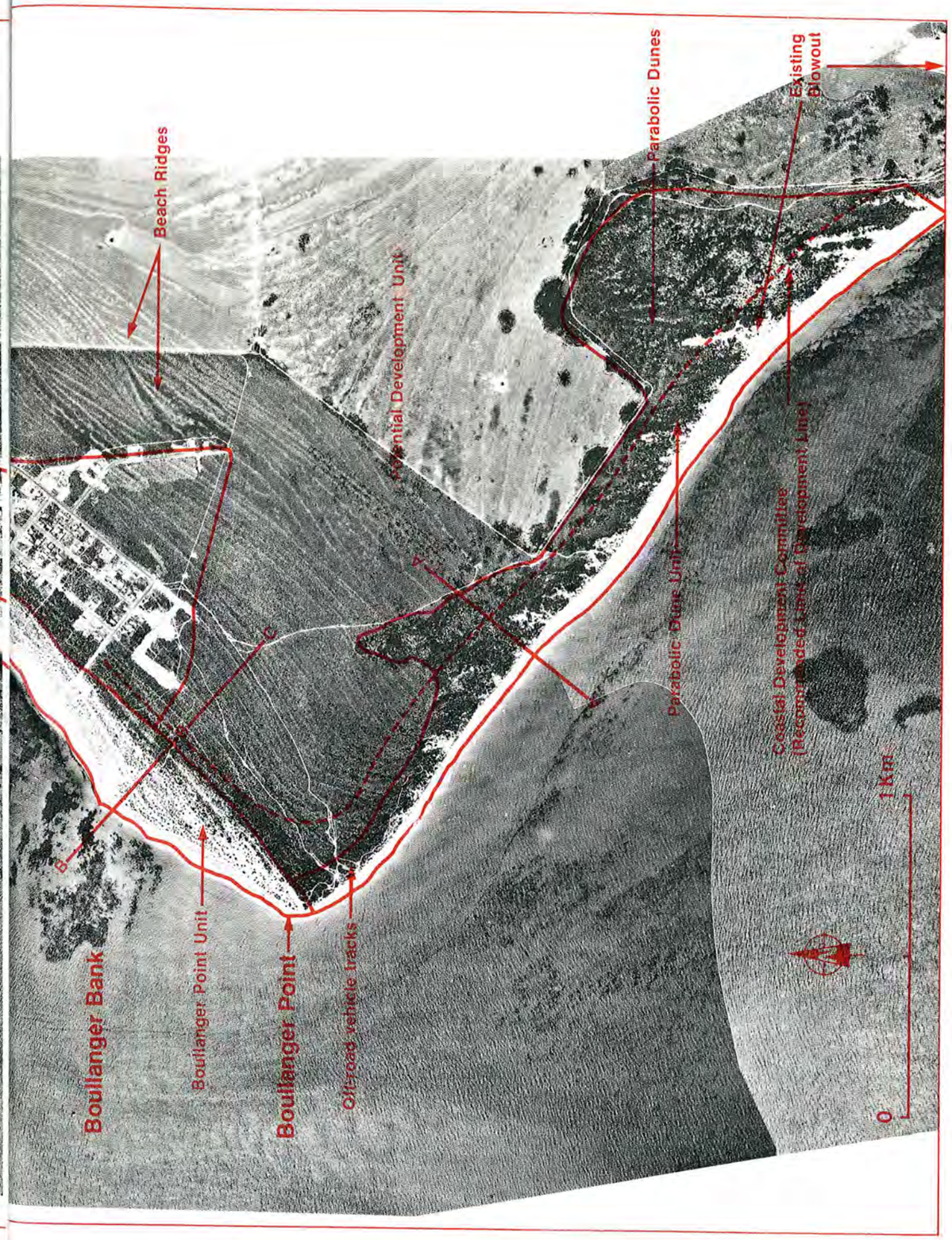
Jurien Bay is situated within the Guilderton system of vegetation as defined by Beard (1969). This system occupies the Recent dunes and sands of the outer coastal belt. The dunes, being composed of relatively little weathered white sand, appear to have a climax of *Acacia cyclops/Acacia rostellifera* thicket. However, this presently only appears in patches owing to frequent burning which defies its proper establishment. As a result it is replaced by an earlier seral stage of heath or low scrub, dominated by *Acacia lasocarpa* and *Melaleuca acerosa*.

Other components of the low scrub vegetation include: *Acacia cuneata*; *Acacia pulchella*; *Anthocercis littorea*; *Eremophila glabra*; *Hakea prostrata*; *Hemiandra pungens*; *Acanthocarpus preissii*; *Grevillea* spp.; *Leptomeria spinosa*; *Leptomeria preissiana*; *Lechenaultia linarioides*; *Melaleuca huegelii*; *Melaleuca acerosa*; *Myoporum gracile*; *Olax phyllanthi*; *Olearia axillaris*; *Ptilotus stirlingii*; *Senecio lautus*; *Templetonia retusa*; *Tersonia brevipes*; *Conostylis aff.*; *Conostylis candicans* and *Spyridium globulosum*.

On flats and interdune areas, Scaevola adds to the dominant species and *Casuarina campestris* or *C. baxteriana* becomes the climax.

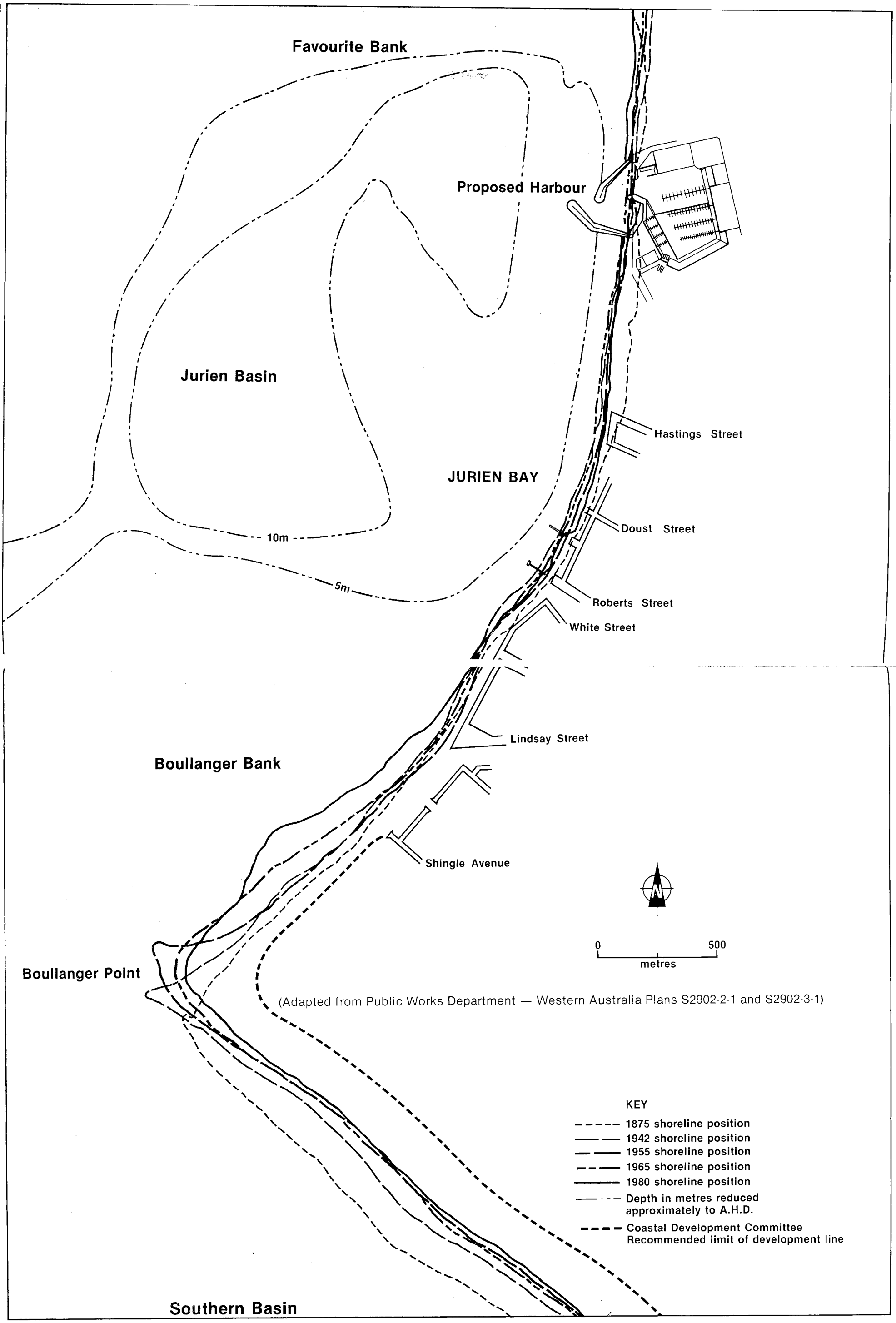
Recolonisation of exposed drift sand generally proceeds with: *Dryandra sessilis*; *Scaevola crassifolia*; *Acacia cuneata*; *Hibbertia cuneiformis*; *Tetragonia decumbens*; *Conostylis candicans*; *Olearia axillaris*; *Spinifex hirsutis*; *Spinifex longifolius*; *Cakile maritima*; and at a later stage: *Acacia rostellifera* and *Hemiandra pungens*.

Specimen plants were identified from four transects taken across different sections of the coast along the tombolo in January 1983. The findings are expressed in Figures 2 to 5.



Photograph 1 — Aerial Photograph — Jurien Bay Area

Figure 1 Jurien coastline movements 1875-1980, and bathymetry



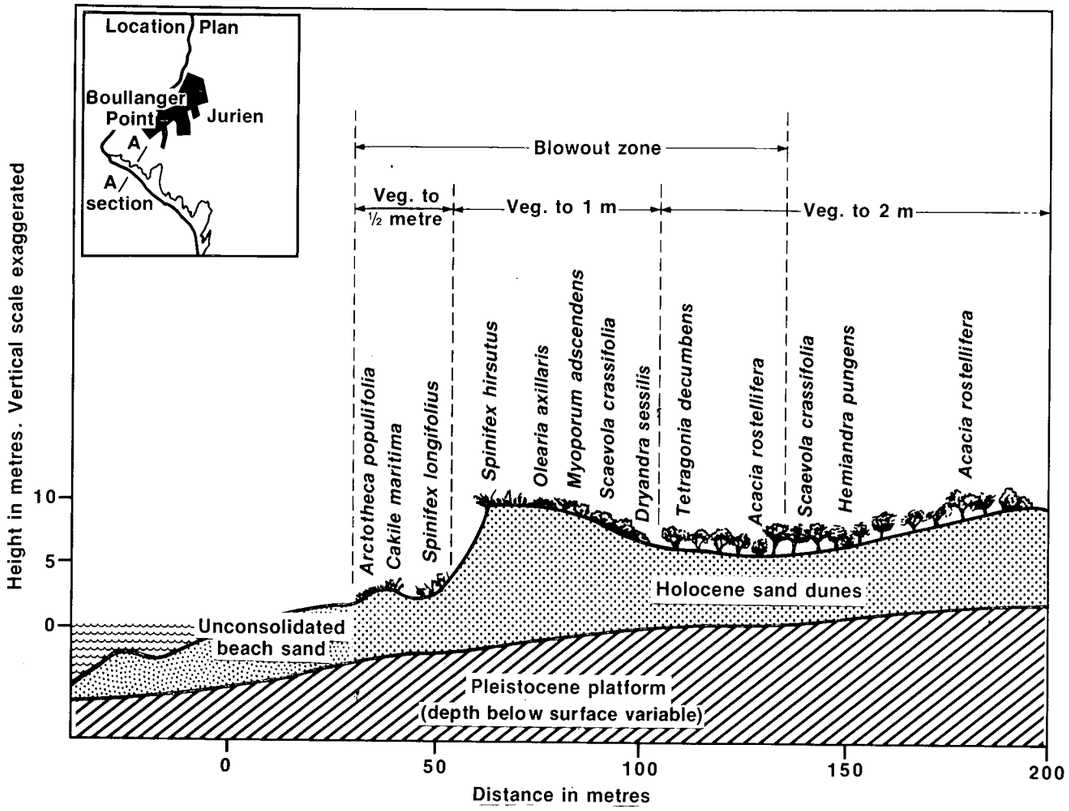


Figure 2 Diagrammatic section A-A through parabolic dunes — south of Boullanger Point.

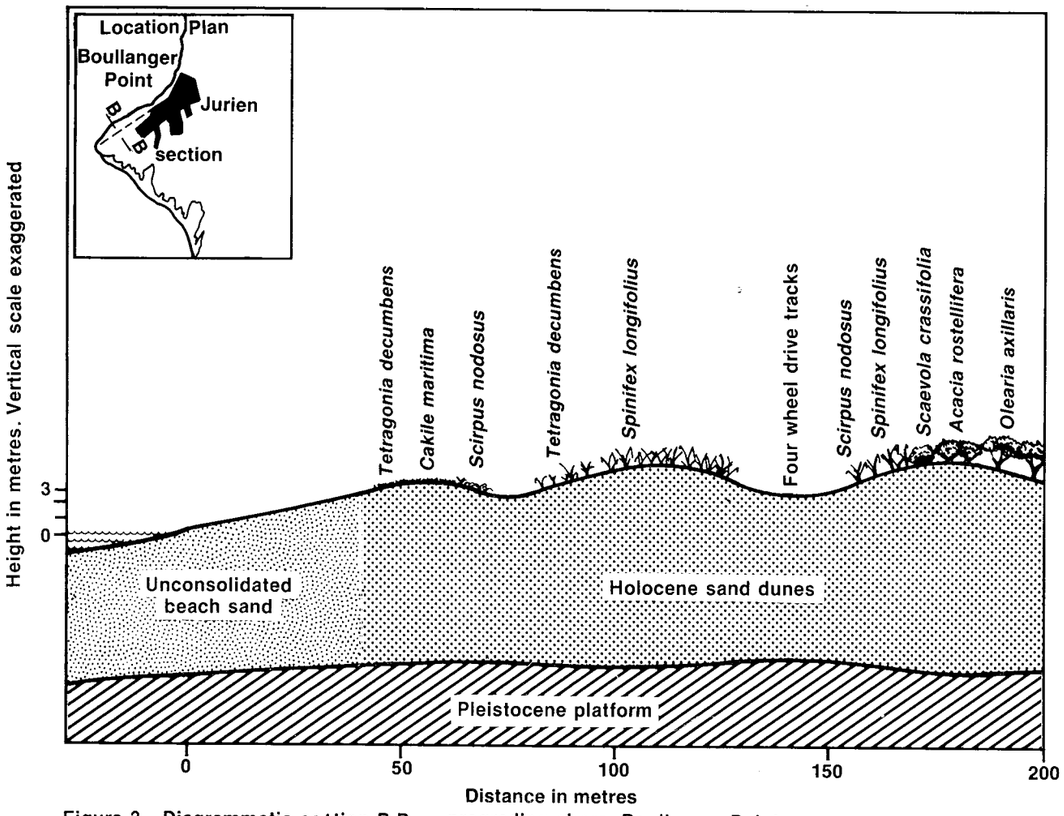


Figure 3 Diagrammatic section B-B — prograding shore, Boullanger Point

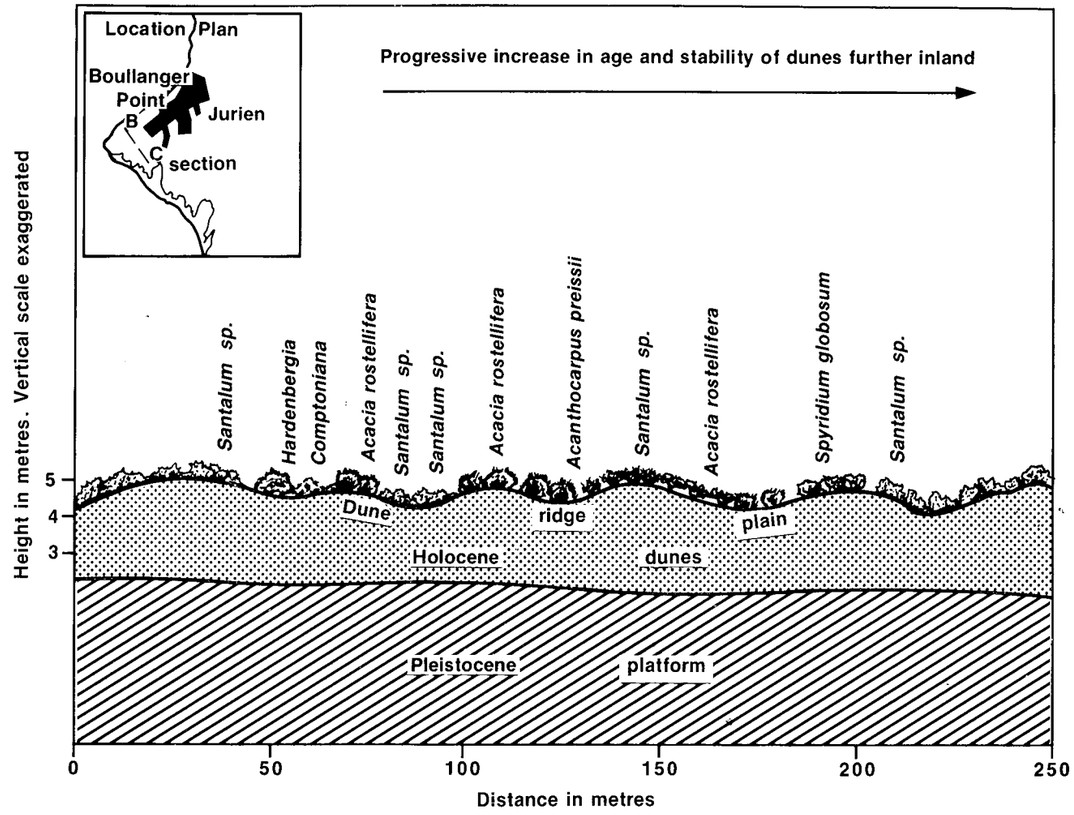


Figure 4 Diagrammatic section B-C through former shoreline (continuation of section line B-B)

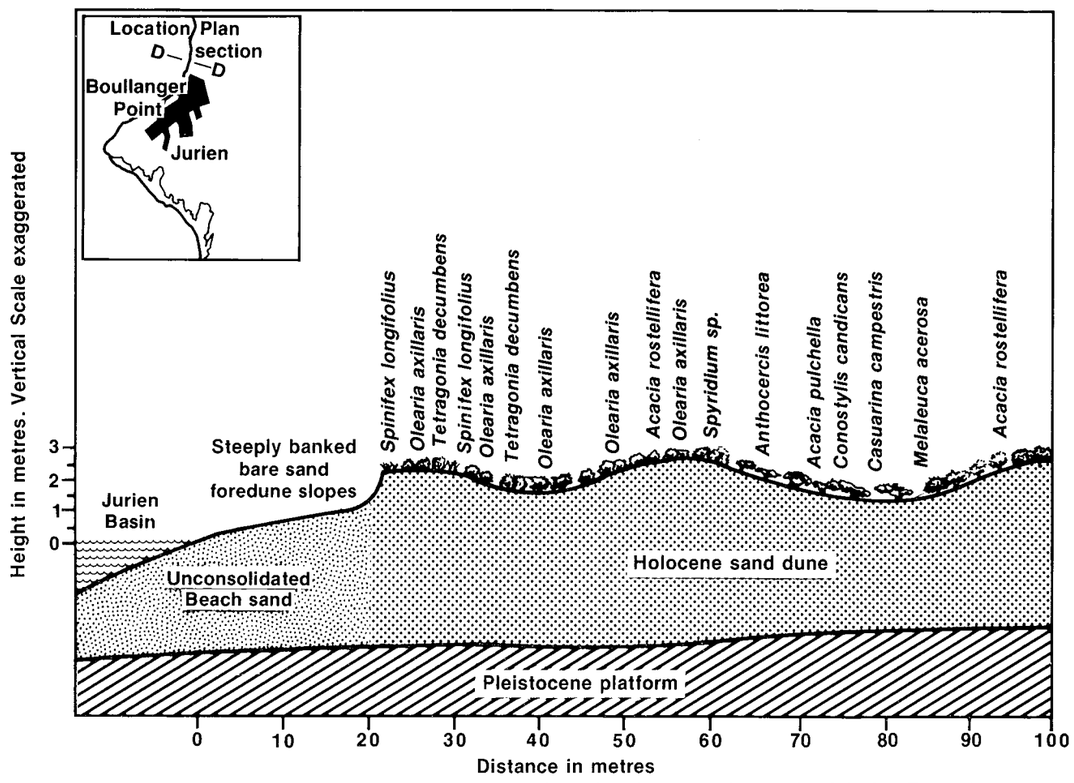


Figure 5 Diagrammatic section D-D — Typical of the foredunes to the north of Jurien Townsite.

Climate

The average annual rainfall is approximately 750 mm (30″) along the coast, falling mainly between May and September. However, it is the availability of moisture for plant growth which is the most important characteristic of the climate and this is a function of the amount of rainfall, its distribution throughout the year and temperature. Moisture stress is most likely to affect vegetation in the 'dry' season when temperatures increase and precipitation is insufficient to maintain growth. The dry season occurs between October and April. This type of regime with a wet winter and a dry summer is termed a 'Mediterranean' climate, within which are subdivisions based on the number of dry months in the year:

e.g. Warm Mediterranean 4 to 6 months
Dry Warm Mediterranean 6 to 8 months

The latter subdivision is typical of wheatbelt country, with rainfall less than 450 mm. The rainfall map (Fig. 6) shows that Jurien lies between the isohyets of 500 and 650 mm, which means that it is categorised between the two distinctive regimes.

The length of the growing season for plants depends on the number of months constituting the 'wet' season. A diagram prepared by the Bureau of Meteorology (1956) and published in the offical Year Book of Western Australia shows a line for 4 wet months in the year coincident with the 400 mm isohyet in Fig. 6 (lying between Watheroo and Miling). On the coastal side of this line the region receives more rainfall and the 5 month line crosses between Moora and Jurien.

The highest mean temperatures of 26°C occur in January and February whilst the minimum mean temperature is 12°C in July. This makes the average temperature range for the year 14°C.

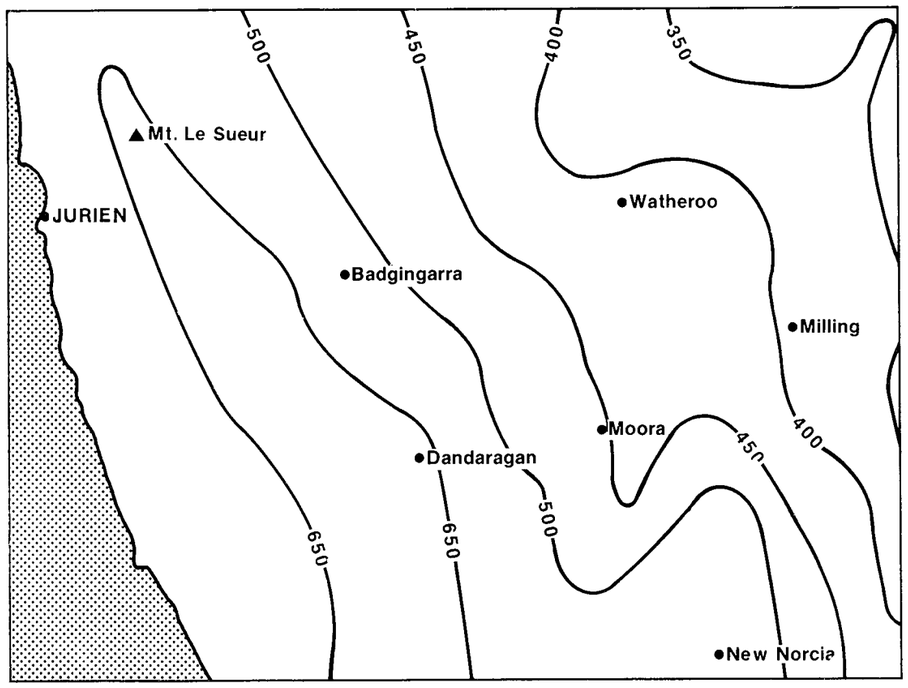


Figure 6 Average annual rainfall in millimetres from Bureau of Meterology 1962.

Landscape Assets and Problems

The coastline northwards of Boullanger Point provides some attractive beaches and low dune scenery. The dunes themselves are gently undulating and create some relief interest in an otherwise fairly flat terrain.

South of Boullanger Point the coastal scenery is more stark and exposed. Problems with wind erosion and steep foredune slopes make access to the beach difficult and exposure to prevailing south-westerly winds may make the area uncomfortable at times. The unstable condition of the soils and erosive forces along this stretch of coast are exacerbated by off-road vehicles and the resultant scars of such activities help to further despoil the area's amenity.

Jurien township has potential for improvements to its landscape and use of outdoor space. It has the advantage that most existing development is low key, which means fewer problems of marrying the townscape with the surrounding natural environment. However, Jurien has several basic deficiencies in its present treatment of open space including the generally flat terrain, predominance of single dwelling houses, absence of multi-storey development, large number of undeveloped lots and absence of significant land marks.

The problems identified above are highlighted in several instances where there are road reserves of extreme width within the town. Bashford Street, for example, varies to widths from 60 metres to 80 metres while the carriage way is only of standard width.

Definition of open space within the framework of the town is generally poor which leads to some confusion in the functions of each space. Overwide road verges and unused reserves of space, together with insufficient planting to give some visual relief, both create the atmosphere of a 'drive-in' town and leave little character about the landscape with which visitors can identify.

Trees and shrubs may also be purposely used to improve pedestrian comfort by providing shelter from wind and shade from the sun. With the exception of a few streets within Jurien where planting has been used to some such advantage there is considerable scope to make walking through town more pleasant.

Wildlife

The Jurien region contains a number of significant wildlife populations which exist in terrestrial, marine and island habitats. The area is interesting zoogeographically because three botanical districts merge there, and as a result it represents the edge of the range of a number of animal species (Chapman 1977). While relatively little wildlife research has occurred within the boundaries of this study area a number of conclusions can be inferred from the results of work undertaken nearby.

The coastal dune systems of the region support mammal populations including *Macropus fuliginosus* (western grey kangaroo) *Rattus fuscipes fuscipes* (southern bush rat) and *Pseudomys albocinereus* (ash-grey mouse), the latter two species occurring in relatively high densities at times.

The region supports a rich avifauna including terrestrial species and seabirds. Chapman (1977) states that most of the resident passerine birds recently recorded in the Swan River District occur in the region, often existing in greater densities than in more urban areas. These higher population densities indicate the region is important in the conservation of many bird species.

The region represents the edge of the range for some birds like *Stipiturus malachurus* (southern emu-wren) and *Eopsaltria georgiana* (white-breasted robin), (Ford 1965; 1959). In addition, it is the only location where the four species of *Malurus* (malurid fairy-wrens) are thought to live near each other in the same heath formations (Chapman 1977).

The islands of Jurien Bay provide breeding and resting habitats for a number of seabirds including *Pelagodroma marina* (white-faced storm-petrel), *Puffinus assimilis* (little shearwater), *Puffinus pacificus* (wedge-tailed shearwater), *Hydroprogne caspia* (caspian tern) and *Sterna nereis* (fairy tern) (Ford 1965). In addition, they are used by the local population of *Neophoca cinerea* (Australian sea lion).

The islands also support populations of skinks including *Egernia kingii*, *Egernia pulchra*, *Egernia box*, *Lygosoma lesueurii*, *Ctenotus lineopunctulatum* and the gecko *Phyllodactylus ocellatus* (Ford 1963). The distinctive long-tailed subspecies *longicauda* of *Egernia pulcha* only occurs on the islands.

Blue-breasted wren *Malurus pulcherrimus*

Fish and Marine Resources

Jurien is an important centre for the W.A. rock lobster fishery although most of the catch landed there is taken outside the study area. In 1981-82 between 55 and 60 fishing boats landed 750 tonnes of rock lobster worth about $5.2 million (Fisheries and Wildlife 1983).

A portion of the bay near Boullanger Island has been set aside for the monitoring of puerulus (rock lobster) larvae and juveniles, and this area is closed to all rock lobster fishing and netting (see Map 2).

Jurien Bay east of a line between North Head and Boullanger Island point is considered a good nursery area for fish. In addition, it is proposed to declare the waters around Jurien Bay as a special protection locality against oil spills because of its value for seabird nesting, Australian sea lions, rock lobster fishing, recreation, anchorage and sport fishing.

An unpublished report, prepared by the Fisheries and Wildlife Department, about the results of an amateur fishing competition indicates that beach anglers take tailor, whiting, Australian herring and skipjack. In addition, anglers fishing near shore from boats take the above species and garfish, while divers take dhufish, coral trout, baldchin groper and abalone.

Existing Access and Facilities

At present there are a number of facilities which have been developed on the Jurien foreshore providing services for local residents, professional fishermen and tourists.

Roads

Much of the area is well serviced by roads and streets existing within the township. The remainder will be serviced by roads which will be constructed in association with the fishing boat harbour and associated subdivisions. The roads are shown on Map 3.

Car and Trailer Parking

Car parking is available at several locations on the foreshore. In 1982 Council constructed additional parking near the jetties in accordance with the Draft Jurien Jetties Area Plan (Chalmers 1982), to overcome congestion which occurs when professional fishermen and tourists seek access to the area.

In addition, two car parks exist on Grigson Street and limited parking is available on Grigson and Hastings Streets. Informal car and boat trailer parking is available on the beach near Boullanger Point and access to this area is obtained via Shingle Avenue.

However, development of the fishing boat harbour and associated works will alter requirements for parking on the foreshore completely.

Beach Access for Pedestrians

Until recently pedestrians have freely crossed between the beach and nearby roads, car parks, tourist accommodation and houses. This has led to a gradual deterioration of the foreshore vegetation resulting in wind erosion problems and a corresponding deterioration in the amenity of the area.

In 1982 Council undertook a beach management programme in accordance with the Draft Jurien Jetties Area Plan. This work involved fencing off areas of sand dune to control pedestrian movements and enable the regeneration of the dune vegetation. This Plan will outline programmes to rehabilitate other areas of coastal vegetation.

Boat Launching Facilities

At present there is no formal boat launching facility on Jurien Foreshore. However the compact nature of the beach and calm seas which normally occur north of Boullanger Point facilitate the launching of boats from trailers in that area.

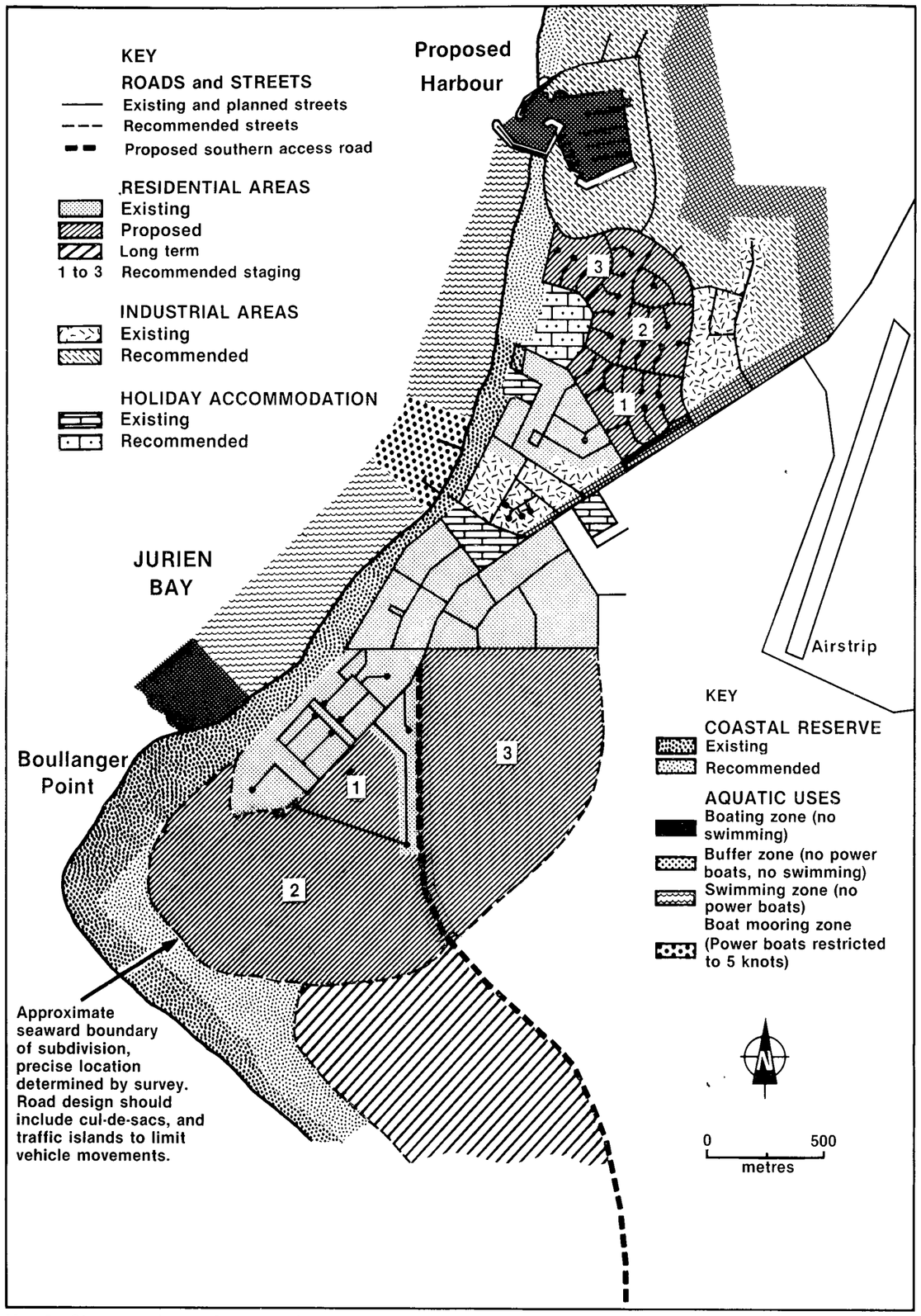
Jetties

At present two jetties exist at Jurien which belong to the Fishermen's Co-operatives. These jetties are used to land professional crayfishermen's catches, fuel and service boats, moor dinghies and support pipelines used to dispose of crushed crayfish offal. The general public has free access to the jetties which provide valuable recreation opportunities associated with angling and sight seeing. It is also considered that the jetties provide an interesting landmark and are an asset to the townscape.

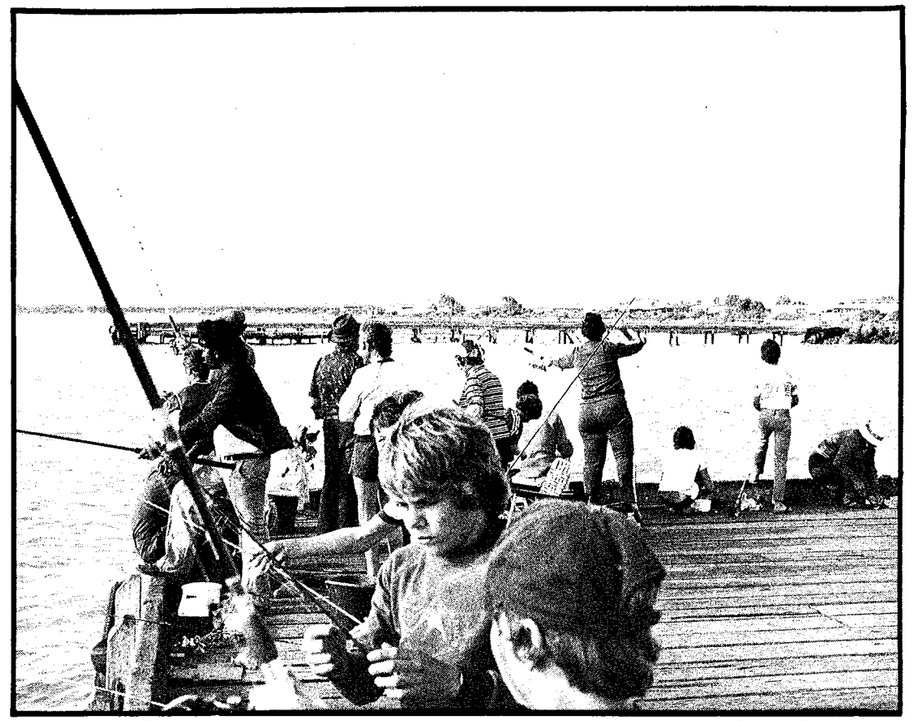
Parks and Toilet Facilities

A small grassed parkland has been established south of the intersection of Grigson and Lindsay Streets. Another grassed picnic area with toilet facilities has been established on the western side of Grigson Street opposite the intersection of Cook Street (Map 6).

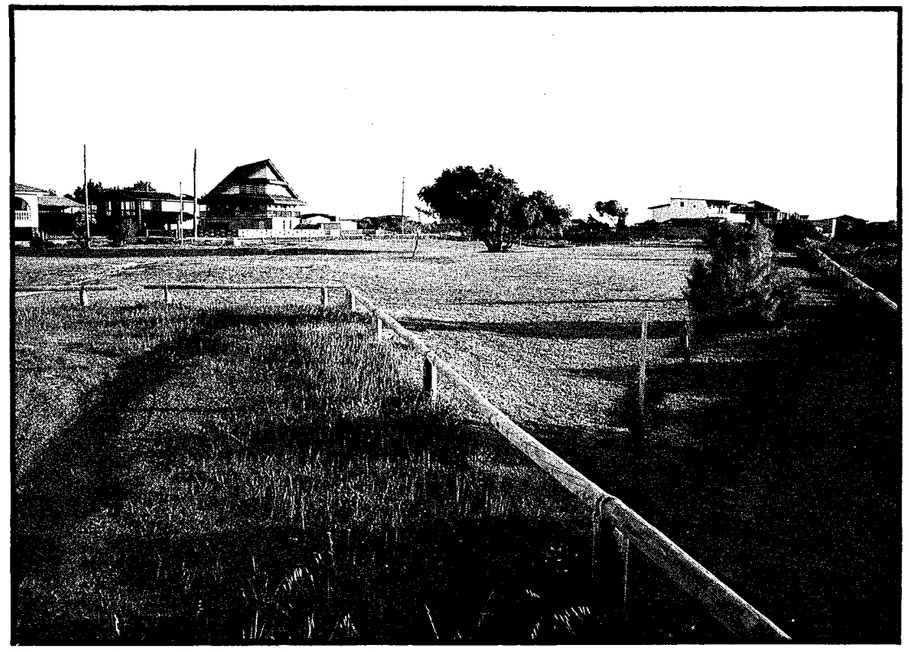
The development of the fishing boat harbour and associated subdivisions will radically alter the activities and movements of pedestrians, vehicles and boats in Jurien, and the need for various facilities will have to be reconsidered.



Map 3 Structure plan — Access, existing and proposed uses



Photograph 2 Anglers on the southern jetty, with the northern jetty in the background. These facilities are owned and managed by the Fishermen's Co-operative, but provide valuable recreational opportunities and are a tourist attraction.



Photograph 3 Park near Lindsay Street.

Tourist Facilities and Accommodation

Jurien presently offers a range in types of holiday accommodation. Hotel rooms are provided on Padbury Street along with bar and restaurant facilities. Apart from private houses which are rented out to holiday makers, chalets are available at the north-eastern end of Bashford Street and on Grigson Street. A caravan and camp site situated between White, Roberts and Bashford Streets provides shower, toilet, laundry and barbecue facilities for caravan users and campers alike.

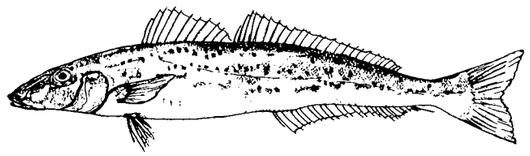
In addition to the hotel restaurant, the Shell Roadhouse on Andrews Street offers a second restaurant whilst takeaway meals can be obtained at Doust Street.

The main store is located in Cook Street which is currently identified as the main commercial centre within the township. Another kiosk exists by the Caravan Park (as mentioned above) next to Heaton Street.

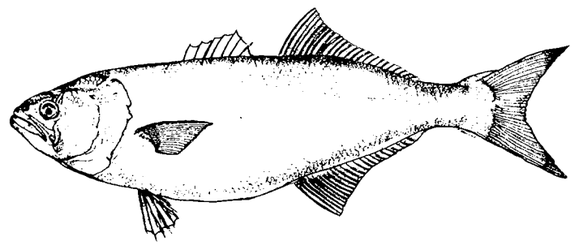
Active Recreation Facilities

Outdoor games and organised sports are held on the grounds of Jurien State School. The school grounds comprise one of the most attractive areas in Jurien since the native shrub belts around the perimeter of the field are reinforced with tree planting to provide a degree of enclosure. Parts of the scheme are being degraded due to inadequate protection of the vegetation. To remedy this, the flow of pedestrians through the grounds should be rationalised and this tied in with initiatives to protect and supplement existing planting.

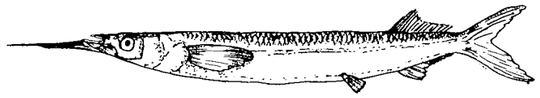
The school grounds also provide children's play equipment for the lower age groups whilst reserve 34814 is vested as a children's playground.



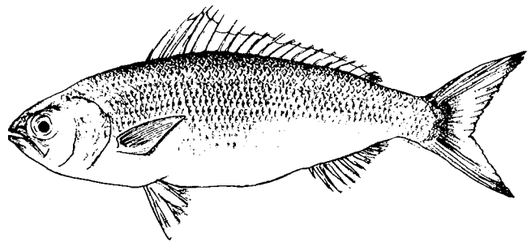
King george whiting *Sillaginodes punctatus*



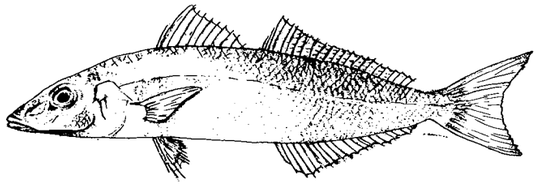
Tailor *Pomatomus saltatrix*



Southern sea garfish *Hyporhamphus melanochir*



Australia herring *Arripis georgianus*



Western sand whiting *Sillago schomburgkii*

Management Planning

Land use planning is a process involving the consideration of an area's resources, the land's ability to support particular uses, constraints on use and likely use pressures. The allocation of appropriate uses to areas of land capable of sustaining those uses is an essential step in management planning. If that step is not taken environmental degradation may occur, resulting in the loss of amenity and increased management costs.

Resources of the Area

The study area has the following significant resources:

- coastal scenery, attractive beaches, sand dunes and clear sheltered waters, suitable for small boats, sailing, bathing and angling;
- off-shore islands which provide amenity and significant wildlife habitat;
- areas of relatively undisturbed coastal vegetation including wildflowers which are a tourist attraction;
- a developed system of roads, tracks and car parks;
- existing jetties which provide a boat servicing and management facility for professional fishermen and fishing for anglers;
- a small but prosperous township based upon the W.A. rock lobster fishery and tourism;
- a management infrastructure based on the facilities and staff of the Dandaragan Shire.

Use Constraints

Use constraints which influence planning and management of the area include:

- sandy soils which depend upon coastal vegetation for stability;
- a sandy shoreline which is receding rapidly in some locations;
- a relatively flat terrain and an absence of naturally occurring large trees with an associated risk of landscape degradation by careless development.

Use Pressures

The coastal area at Jurien will be subject to a number of use pressures which require attention during the management planning process.

Fishing boat harbour

The PWD proposes to construct a harbour for licensed fishing boats. The facility will also include a launching ramp which will be available to pleasure craft and space for the needs of a yacht club.

The harbour and associated facility will require a large area of land and will alter the structure of the entire town. The location of the proposed harbour is shown on Map 3.

Professional fishing

Fishing for the processing of the Western Australian rock lobster provides the basis for the area's major industry. At present, boats operate from Jurien and there are two processing plants in the town. This activity is the main cause of congestion in the foreshore area near to the jetties. As the rock lobster fishery is a closed industry it is not anticipated that activity will increase significantly, and the construction of the fishing boat harbour will provide an opportunity to rationalise traffic movements and ameliorate congestion problems.

Tourism

Jurien Bay is a popular tourist area providing recreational opportunities for people from Perth and the wheatbelt. Tourism provides a significant source of revenue in the town. Recreation is centred upon water based activities, comprising mainly boating and fishing. However, swimming and other beach activities are important along the coast. Nearby national parks and the wildflowers of the Northern Sand Plain also provide an attraction.

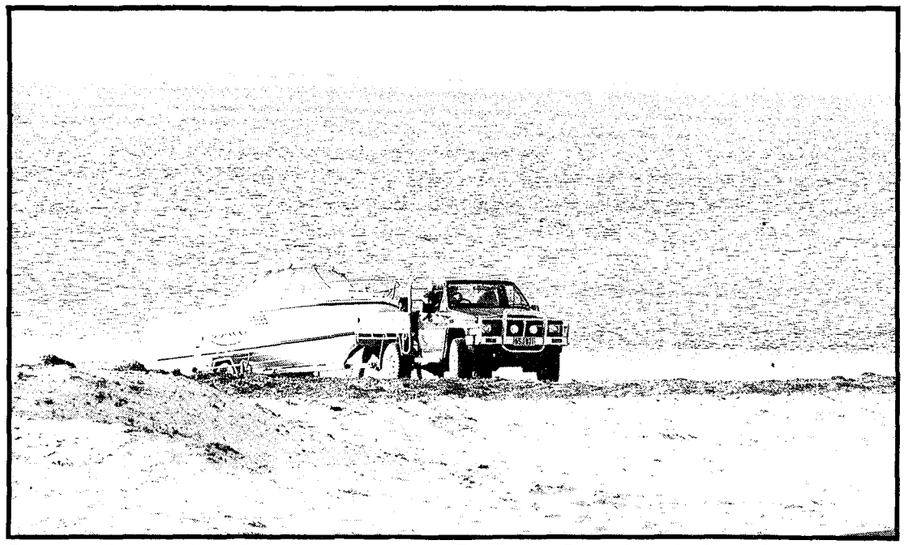
The proposed fishing boat harbour will provide a facility for slipping larger boats than have been launched by visitors to the area in the past, which will increase tourist pressure on the town. Expansion of the tourist industry will also depend upon the provision of more accommodation facilities.

Pleasure boating

Pleasure boating is a major attraction to Jurien. At present most trailed vessels are

launched about 1 kilometre north of Boullanger Point (see Map 3 and Photograph 4). Proper access to this area is obtained from Shingle Avenue, but vehicles also drive in from several other points, including the rear boundaries of private houses and the northern end of the beach. Vehicles approaching and leaving the boat launching area consequently damage the sand dune vegetation, which creates soil instability.

Construction of the launching ramp in the fishing boat harbour will significantly reduce pressure on the Boullanger Point area.



Photograph 4 Small boat launching area at Boullanger Point. This facility will be used less after construction of the fishing boat harbour.

Amateur fishing

Closely associated with boating, amateur fishing is a most popular activity at Jurien. Fishing from boats exerts few pressures on the study area. However, the most favoured fishing area for people who do not have boats is on the existing jetties, and this currently adds to the congestion in the area.

Completion of the harbour will assist greatly in reducing crowding problems as licensed boats will no longer operate from the jetties, and the new groynes will provide extra sites for anglers.

Bathing and beach recreation

Some of Jurien Bay's white beaches and clean, sheltered waters are suitable for swimming and beach recreation when good weather prevails (see Photograph 5). The most popular swimming beach is between Cook and Hastings Streets, although individuals and small groups of people often move north of Hastings Street seeking greater solitude. These beaches are popular because they are near residential areas and adjacent to Jurien Basin which provides deep water. The water adjacent to beaches near the Boullanger and Favourite Banks is shallow and less attractive (see Photograph 1).

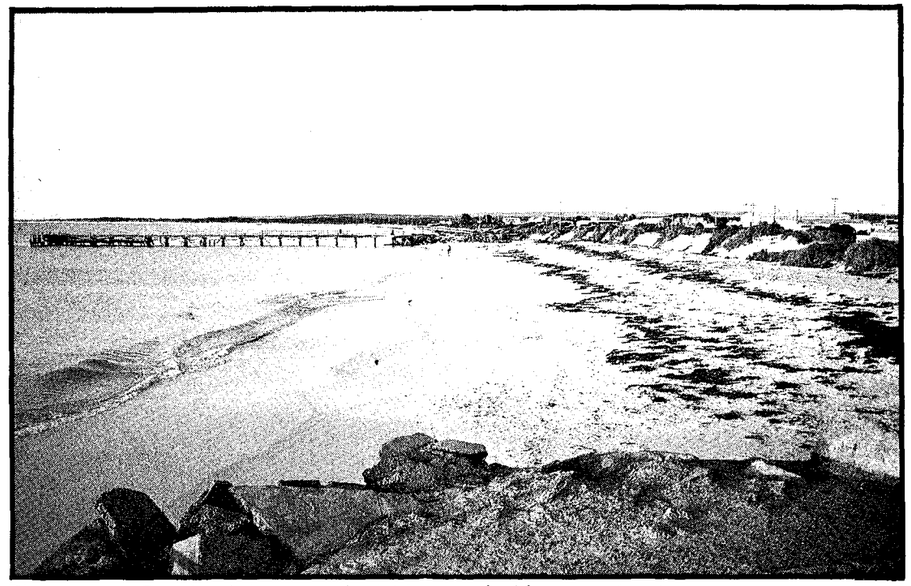
Off-road vehicles

Vehicles are operated 'off-road' at various locations around the town, causing significant damage to the dune vegetation and disturbing other beach users. The problem appears to arise because people seek vehicular access to fishing holes, take short cuts to the boat launching area or merely drive on the beach or across heathland for pleasure (see Photograph 6).

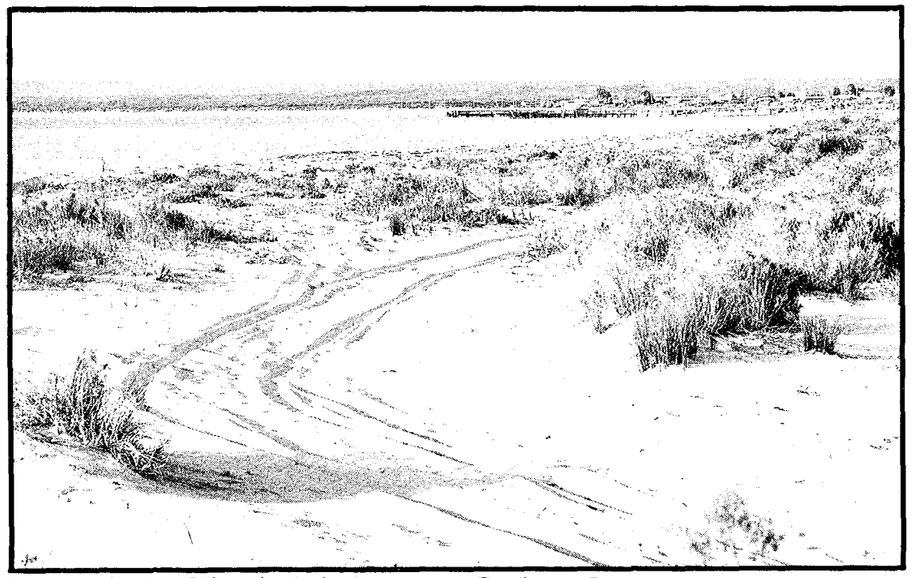
Future residential development

Proposals for future residential development at Jurien have been prepared by the Jurien Syndicate and the DL&S. The area under consideration for private development is south of Coubrough and Ward Streets, being part of Location 8837. The DL&S proposal is north of Hastings Street and involves 250 lots (ref. Map 3). The development proposed by the Jurien Syndicate was delayed pending preparation of this plan to enable consideration of coastal management issues during design and development of the subdivision.

The development proposed by the DL&S was delayed and redesigned after considering the impact of the proposed fishing boat harbour and the need for coastal reserves and foreshore protection works.



Photograph 5 Beach between the jetties, a valuable recreational resource.



Photograph 6 Off-road vehicle damage near Boullanger Point.

Future industrial developments

The fishing industry and increasing permanent and tourist populations at Jurien create a demand for small service industries. The DL&S provides land for industrial purposes at the northern end of the town, and this area could be expanded by filling nearby low land with spoil from the fishing boat harbour. In addition lots will be provided near the proposed fishing boat harbour which will cater for the needs of industries closely associated with the fishing industry. Existing and proposed industrial land is shown on Map 3.

Proposed southern access road

The Main Roads Department (MRD) is considering the construction of a road near the coast, to provide a more direct link between Cervantes and Jurien. While the date of construction and final alignment have not yet been determined it is most likely that the road will be located as shown on Map 2. The road will have a considerable impact on the land to the south of the town as it will bring traffic close to areas of steep parabolic sand dunes, some of which lack vegetation cover and are presently

unstable. In addition, the construction of this road would alter traffic movement in the town and may affect future subdivisions in Location 8837.

Photograph 7 Recent residential subdivision — Coubrough Street.

Management Units

A system of management units has been identified to define areas with differing capacity to sustain likely land uses in the study area. These units are based on recent shoreline movements, soil type, landform, slope, stability, vegetation, landscape character, existing land use and the location of services. The division of these units is shown on Photograph 1 and their attributes are summarised on Table 2.

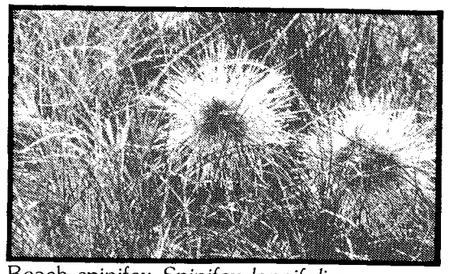
Boullanger Island Point Unit

This unit is located immediately north of Boullanger Point. It comprises land created by the continued growth of the tombolo (sand spit), towards Bollanger Island since 1875 (see Photograph 8). As described in Page the growth of the tombolo has been interrupted by periods of severe erosion which may be repeated. The area is relatively flat and consists of unconsolidated sands which are held in place by a sparse vegetation cover of *Spinifex hirsutis*, *S. longifolius*, *Olearia* sp. *Cakile maritima*, *Arctotheca populifolia* with *Scirpus* sp. in the lower areas. The uncontrolled movement of vehicles has damaged or destroyed much of the plant cover increasing the wind erosion risk (see Photograph 6).

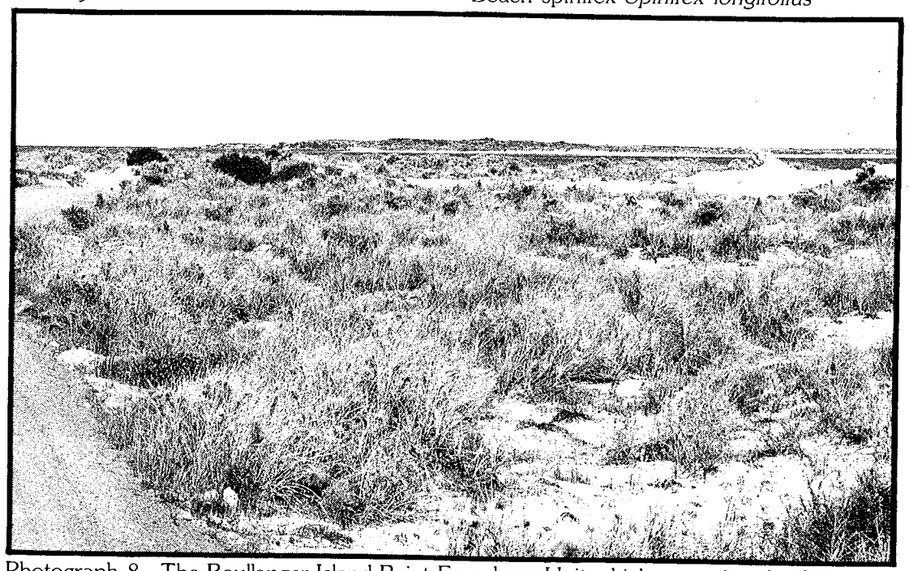
This unit has an unattractive landscape, but the area is heavily used as it is suitable for the launching and retrieval of small boats. While this area will not be used as heavily after alternative boat launching facilities have been constructed in the proposed harbour, it will remain an area of considerable activity. If further damage to the vegetation is to be avoided the movement of vehicles will have to be rationalised. Because the shoreline is susceptible to rapid retreat under extreme storm events with an associated risk in the destruction of existing facilities, future developments should be of an expendable nature.

Jurien Basin Foreshore Unit

This unit comprises the sand dune system and beach between the Jurien Basin and Grigson Street and includes the area around the existing jetties. The shoreline in this area has experienced periods of recession and progression since 1875. Since 1965 the location of the shoreline has been relatively stable south of the jetties, but receded significantly to the north (see Photograph 9). The sand dunes in this area are older than the ridges in the Boullanger Point Island Foreshore Unit and the vegetation is more developed. The foredune supports *C. maritima*, *Tetragonia decumbens*, *S. hirsutis* and *S. longifolius*. Other beach ridges in the unit support a dense stand of coastal scrub including *A. rostellifera*, *Myoporum* sp., *Olearia* sp., *Hardenbergia* sp. and both coastal *Spinifex* spp. The uncontrolled movement of pedestrians and vehicles has caused a general deterioration in the condition of this important vegetation system, increasing wind erosion problems are degrading its landscape and amenity value. The dunes in this unit act as a privacy strip, by separating the beach from the road and urban development, improving the amenity of the foreshore. In addition they provide the township with valuable shelter from the south-westerly winds.



Beach spinifex *Spinifex longifolius*



Photograph 8 The Boullanger Island Point Foreshore Unit which comprises land recently formed by the growth of the tombolo toward Boullanger Island shown in the background.

Photograph 9 Storm erosion has caused shoreline recession in the northern part of the Jurien Basin Foreshore Unit, resulting in damage to the road in Dalton Street and nearby improvements.

Table 2 Management Units — as shown on Photograph 1

UNIT	RECENT SHORELINE MOVEMENTS	TOPOGRAPHY AND SLOPE	SOIL TYPE	VEGETATION	LANDSCAPE CHARACTER	EXISTING LAND USE	COMMENTS & USE RECOMMENDATIONS
Boullanger Island Point Foreshore Unit.	Shoreline has been progressing by up to 3 m year since 1875. May be prone to rapid recession during storms.	Relatively flat with parallel beach ridges to 1.0 m. Elevation 1.5-2.5 m. above AHD.	Fine uncemented lime & quartz sands. No visible soil profile. Prone to wind erosion if the vegetation is disturbed.	Sparse cover of *S.hirsutis* with *S.longifolius Scaevola sp. Olearia sp. Cakile maritima Arctotheca populifolia & Scirpus sp.* Occasional *A.rostellifera*	Flat, exposed and harsh landscape which has been degraded by uncontrolled vehicle movements.	Beach access, boat launching, vehicle and trailer parking. Indiscriminate vehicle movements.	Existing land use is appropriate for this unit providing vehicle movements are rationalised & controlled. Expensive developments should be avoided because of the risk of storm damage.
Jurien Basin Foreshore Unit.	Shore has been progressing & receding by up to 1.0 m year since 1875. Relatively constant between 1965-83.	Steeper dune ridges to 4 metres. Some blowouts.	Fine uncemented lime & quartz sands. No visible soil profile. Highly prone to wind erosion if the vegetation is disturbed.	General cover of *A.rostellifera* with *S.hirsutis Hardenbergia sp.*	More sheltered environment with an attractive vegetation cover, separates the urban development from the beach. Some degradation resulting from uncontrolled traffic.	Beach access with some development of parkland, car parking and toilets.	This area has an important function in the beach-sand cycle & should be protected. Use should be confined to managed beach access.
Favourite Bank Foreshore Unit.	Shoreline has been progressing & receding by up to 1.0 m year since 1875. Some recession between 1965-80.	Low dune ridges to 3.0 metres.	Fine uncemented lime & quartz sands. No visible soil profile.	*S.hirsutis* and *Olearea sp.*	Attractive rolling sand dunes and vegetation.	Little use although a 4 wheel dune access track runs along the eastern boundary of the unit.	A relatively unspoiled sand dune system which has an important function in the beach-sand cycle. Worthy of conservation for aesthetic reasons. Use should be limited to managed beach access. Care will be required during the harbour development or this area will be degraded.
Parabolic Dune Unit.	Shoreline has been receding at about 2.0 m/year since 1875.	Steep parabolic dunes resulting from recent blowouts, to 10 metres. Very steep scarp on seaward side.	Fine quartz & lime sands. No visible profile. Numerous active blowouts.	*S.longifolius* on seaward side with dense stands of *Myoporum sp Scaevola sp A. rostellifera* on landward side.	Rugged coastal dunes with views of nearby land and sea. Some degradation resulting from uncontrolled vehicle operations.	Some camping and beach access.	The land in this unit is constantly exposed to forces of the wind and sea, & soil will become mobile if vegetation is disturbed. Use should be restricted where possible. If beach access is provided, management will be expensive.
Development Unit.	–	Originally an undulating sand plain. Topography substantially modified by use.	Fine quartz and lime sands. Pale grey A horizon to 10 cm on eastern side of the unit.	–	Underdeveloped urban landscape. Buildings of varying character, under utilisation of open space.	Roads, houses, industrial, developments & holiday accommodation.	Proper development avoids most conservation problems, however better use could be made of much of private & public open space. Linear development along the coast should be limited. The southern end of the unit could be liable to storm damage.
Potential Development Unit.	–	Undulating plain of parallel beach ridges 30-50 m apart & 2-3 metres high.	Fine quartz sand pale grey A horizon to 10 cm on eastern edge of unit.	Heathland	Pleasing rolling landscape easily degraded by the proliferation of tracks. Attractive wildflowers.	Little use except uncontrolled access by off-road vehicles.	Has potential for future development. However care and protection of landscape values is required.
Harbour Development and Buffer Zone Unit.	–	As above.	As above.	–	As above.	As above.	Area will be developed in accordance with PWD proposals and will provide framework for pedestrian access between existing developments, harbour & beach. Care will be required during development or natural values will be destroyed.

The existing use of this area includes minor development for parking and recreation with the provision of a small park and toilet facility. Future development should be limited to carefully located car parks and beach access (see Photograph 10).

Photograph 10 Car parking and fencing near the northern jetty, in the Jurien Basin Foreshore Unit.

Favourite Bank Foreshore Unit

This unit includes the beach between the northern jetty and the southern end of the Favourite Bank and the adjacent sand dune system.

The shoreline in this area has been through periods of both progression and regression during the last 100 years, within the last ten years erosion has resulted in some shoreline recession. The dunes in this area are not as high or steep as those in the Jurien Basin Foreshore Unit. They support a light cover of spinifex and native scrub which is dominated by *Olearia* sp. (see Photograph 11).

Photograph 11 Vegetation — Favourite Bank Foreshore Unit.

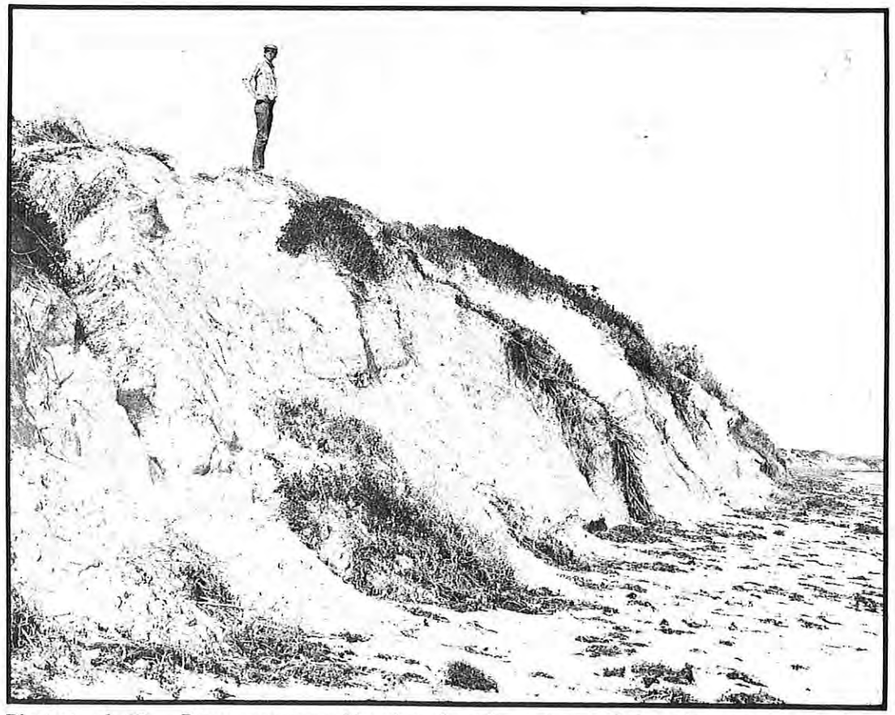
The northern section of this unit does not adjoin urban development and access has been limited. As a result the flora is relatively undisturbed, providing a pleasant landscape, worthy of conservation.

The soil is sandy and has developed little profile. It would be subject to wind erosion if the vegetation were disturbed.

This unit will be greatly affected by development of the proposed harbour and adjacent residential areas. Careful planning and management will be required if permanent environmental damage is not to occur.

Parabolic Dune Unit

This unit is located to the south-east of Boullanger Point and contains the steep parabolic dunes shown on Photograph 1. The coast in this unit is exposed directly to the forces associated with the persistent south-westerly winds which occur in the district. During the last 100 years the shoreline has retreated at an average of 2.9 metres per year (see Photograph 12). In addition the winds have produced blowouts which have formed steep parabolic dunes. Some of these blowouts are currently active.



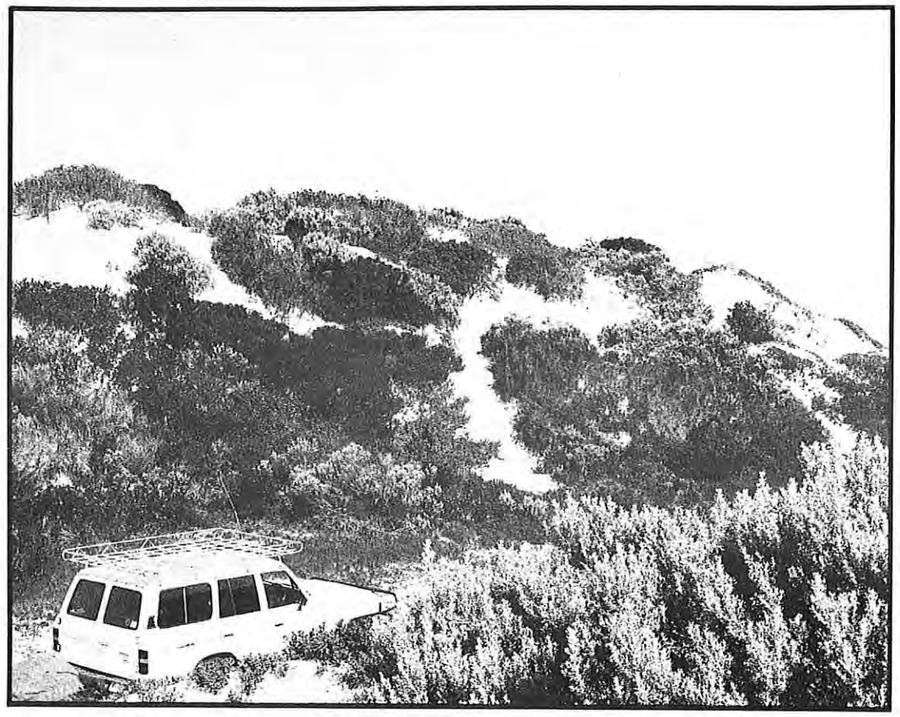
Photograph 12 Dune scarp resulting from beach erosion and shoreline recession in the Parabolic Dune Unit.

The sand dunes rise to about 10 metres and include the steepest slopes in the study area. The soil comprises unconsolidated white sands which are highly prone to wind erosion when the vegetation cover is removed (see Photograph 13).

A well-developed plant community exists on the dune system. The foredune has largely been replaced by an erosion scarp which supports *Spinifex* sp. The top and back of the ridge support *Olearia* sp., *Myoporum* sp., *Scaevola* sp. and behind the ridge the main plant is *A. rostellifera* with a ground cover of *Tetragonia decumbens*.

This area has an attractive landscape providing some ocean views and shelter from the sea breeze is available on the northern side of the sand dunes. There is evidence that the area has been used for camping and as access for fishermen. Uncontrolled access for these purposes has resulted in a loss of vegetation, severe erosion of the dune system and littering.

Any use of this area should be strictly limited and controlled.



Photograph 13 Sand Dunes — Parabolic Dune Unit. The stability of these dunes, depends upon the maintenance of an effective vegetation cover.

Development Unit

This unit includes all of the land which is currently used for roads, urban and industrial development and holiday accommodation.

Formerly this unit was a rolling plain of parallel beach ridges 2-5 metres high, and 30-50 metres apart. However, development has changed the shape of the land and it is now much flatter. Originally the soil near the beach was fine white sand with little profile, while on the eastern side of the town a pale grey soil with horizons had developed. Landforms and soils have been significantly modified during development.

Most of the indigenous vegetation has been removed during development and replaced with exotic grasses, shrubs and trees. Because the town is relatively new and contains a large area of unused space the landscape is underdeveloped and a little dull.

Development will continue in this zone in accordance with Shire's plans and regulations. The landscape of the town could be significantly improved by a well-planned tree planting programme.

Proposed Development Zone

Land which has been subjected to proposals for urban or industrial development during the next 5 years is placed in this unit (see Map 3). Most of this area is on the system of parallel beach ridges described in Page 4 and supports the vegetation system described in Page 5 .

These rolling coastal heaths provide an attractive landscape which is quickly degraded by the uncontrolled movement of vehicles. Careful planning and management will help to reduce the rate of degradation which does occur before the land is required for development (see Photograph 14).

Harbour Development and Buffer Zone Unit

The PWD is preparing plans to develop a fishing boat harbour to the north of the existing townsite and this will be separated from future residential land by a 50 metre wide buffer zone and a road. This unit is also located on the beach ridge system described in Page 4 and supports relatively undisturbed indigenous vegetation. Considerable change will occur in this area during construction of the proposed harbour and nearby residential land. These projects will be the subject of separate environmental review, and planning will be required to ensure that areas of vegetation which are to be retained are protected during development.

Photograph 14 Potential Development Unit. An attractive heathland landscape which can be affected by fire, off-road vehicle tracks and rubbish dumping.

Development and Management Aims

The following development and management aims are defined to guide the Dandaragan Shire and other government authorities and private developers in the long term development and management of the area.

Where possible the Shire should:

- protect the natural systems of the area;
- provide for recreational demands on the area in a manner consistent with its protection;
- provide for the needs of professional fishermen and other boat owners using the area;
- develop a system of public education and information which will aid in the conservation of the area and promote public awareness and enjoyment of the region;
- integrate new developments with existing features and incorporate both into the planning process, undertaking any rationalisation or improvements which may assist in achieving other management aims;
- preserve landscape assets of the area and upgrade areas of wasted landscape character.

Development and Management Objectives

To assist in achieving the aims listed above, a number of objectives have been defined:

- to rationalise and upgrade the system of roads, tracks, car parks and walking trails within the area. These facilities should be designed to provide adequate access to the reserve without impairing the landscape or damaging the vital vegetation cover which stabilises the soil;
- to rationalise and zone incompatible use pressures on the beach so as to avoid conflict between such activities;
- to develop facilities which will make boating in the area safer and more pleasant and assist in the control and management of launching activities;
- to undertake beach management programmes which will provide visitors and residents convenient access to the beaches without degrading sand dune systems or interfering with coastal processes;
- to implement a soil conservation programme to prevent erosion;
- to implement a native tree and shrub planting scheme which will upgrade the appearance of the town and improve its amenity value and landscape character;
- to develop an efficient system of garbage disposal and litter control;
- to provide an effective system of signs and interpretive material to orientate, educate, inform and control visitors;
- to develop low-key passive recreational facilities such as seating areas, picnic and

barbecue facilities at appropriate locations around the town;
- to encourage recreational activities which cause least disturbance to natural ecosystems and to restrict potentially damaging activities.

Landscape Protection and Enhancement

To improve the character of the landscape in Jurien it is necessary firstly to assess the value of existing resources such as planting, to promote the conservation of those features of the landscape which are considered to be valuable assets, and to design a scheme for the landscape which incorporates existing and proposed features in a manner which is both functionally and aesthetically rewarding.

Protecting the existing vegetation

Jurien has some components within its landscape which should be considered as valuable assets. Established vegetation often falls into this category, in particular mature and semi-mature trees which are difficult to replace as they stand without incurring considerable expense. Such trees exist in areas of parkland and public open space around the townsite but owing to the controlled parkland management regimes there is little or no natural regeneration.

In some areas which are left to look after themselves (such as the unmown shrub and tree borders on the periphery of the school field) natural regeneration of native shrubs is prevented by trampling pressures. In these situations some degree of protection should be afforded to the vegetation to prevent further degradation. Pedestrian control fences are inappropriate in the parkland situation since they may appear obtrusive. A low post and rail fence would be more in keeping with the function of parkland though any form of low-key edge trim (in particular using natural as opposed to man-made materials around the shrub borders) may be appropriate since generally a visual barrier is sufficient to guide people along footpaths, whereas the use of physical barriers often breeds hostility towards a scheme and encourages vandalism.

Upgrading the townscape

It has been suggested that Jurien has several basic deficiencies in its landscape which can be ameliorated simply and effectively by initiating a tree and shrub planting programme. This can and should be designed to create a framework for a new open-space network within the existing town structure.

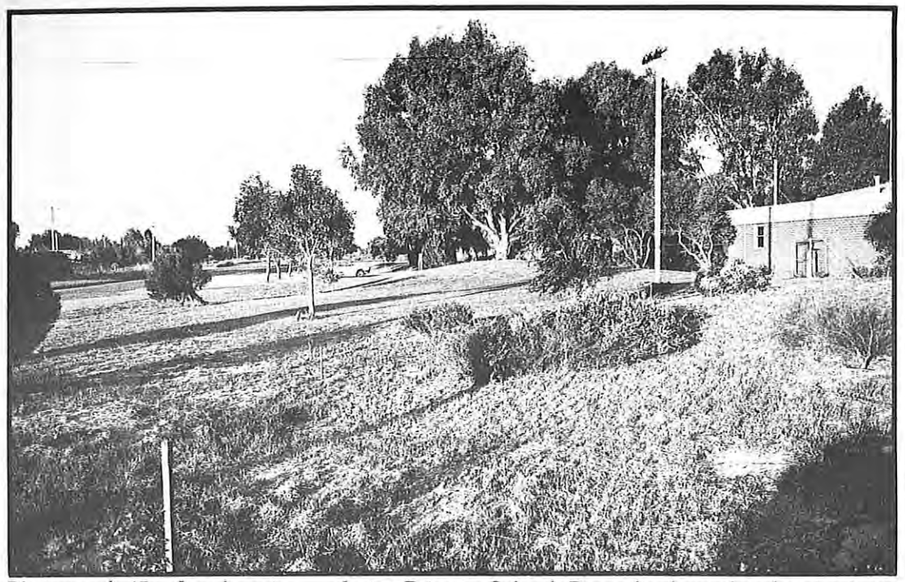
Tree and shrub planting has a multiplicity of uses in landscape design which are determined by the needs of a particular situation. If handled properly, such a scheme would reap the following benefits:
- give edge definition to open space;
- provide a controlled degree of enclosure which could be designed to create more interesting and intimate spaces;
- improve shade and shelter in respect to user comfort;
- provide more privacy in residential areas by utilising the screening or partitioning abilities of plants as an engineer or architect might use walls (see Photograph 15);
- identify the townscape with its natural surrounds;
- upgrade the appearance of the town by providing visual relief and by softening the formality and starkness of man-made structures.

Ecological fitness must be a primary consideration in the choice of plant species for use in such a scheme since the coastal environment prohibits the use of many plants. Those species which are found to occur naturally in the area are good indicators of suitable plants for use. There is an abundance of low to medium shrubs to choose from in this range but since few trees of any stature grow around Jurien the use of Western Australian natives from other coastal locations is appropriate for higher canopy effects. Trees which have been shown to grow successfully in the town include *Casuarina campestris* (native she-oak) and *Agonis flexuosa* (peppermint). It is recommended that this theme be continued with the inclusion of *Eucalyptus platypus* (coastal moort) and *Eucalyptus gomphocephala* (tuart).

The recommended scheme has four basic components:
- Road verges
- Pocket parks
- Supplementary planting
- Residential sector planting

- *Road verges*

Generally road verges will be planted in a similar manner to the median strip near the commercial area, but some streets of high civic importance may receive more intensive treatment as illustrated in Figures 7 and 8. The nature of the scheme lends itself to a phasing strategy for planting in that individual roads or parts of roads can be treated as units which



Photograph 15 Landscaping — Jurien Primary School. Properly planned and maintained plantings can be of great benefit to the amenity of the Jurien townsite.

should be placed in order of priority for attention. For example, Bashford Street should be given a higher priority than most streets since it forms the approach to Jurien and the main spine of the existing road network in the town. In this way phasing can be manipulated to achieve the overall aims of the planting programme over a period of time to suit the means of Council.

In terms of the overall planting scheme, verge planting itself should hold a higher priority since it will effect the greatest improvement to the appearance of the town in relation to the cost of implementation. A staged road verge planting programme will be undertaken with the objective of achieving the effects illustrated in Figures 7, 8, 9 and 11. However all plantings will be undertaken in accordance with guidelines outlined in the booklet "Public Utilities Information Manual for Western Australia". In addition all planting will integrate with public utilities and services.

- *Pocket parks*

The present nature of open space in the town is expansive and extrovert. There is a notable lack of smaller scale, more intimate spaces for sitting, resting, picnics and barbecues etc. A number of openings exist for the development of such 'pocket parks' around Jurien in areas of public open space which are, at present, little used for any form of recreation. These openings include:
- existing parks which require upgrading;
- presently undeveloped reserves of public open space;
- future proposed area of public open space;
- some of the wider road verges, especially those around street corners (which are up to 10 metres wide).

These openings are located on Map 4 whilst recommendations for their treatment are expressed in Figures 8 and 9.

- *Supplementary planting*

A number of parks within Jurien have well-established planting schemes which need to be reinforced with supplementary planting to improve their amenity value. These sites include: the grounds of Jurien State School; the small grassed park situated adjacent to the intersection of Grigson and Lindsay Streets (See Photograph 15) and the grassed picnic area located opposite the Grigson Street/ Cook Street intersection. Each of these is located on Map 4.

As suggested previously the latter two parks may be prime sites to develop the 'pocket park' scheme (as illustrated conceptually in Figures 8 and 9). However, the school grounds merits detailed design consideration owing to its larger size and more complex problems related to public access. It is recommended that, in essence, the periphery of the grounds should form a generously wide mass planting border (approximately 12 to 15 metres wide as exists) using a mixture of trees and shrubs from the list in Appendix 1. The planting design should be integrated with carefully routed footpaths winding through and across the border to provide interesting and convenient walkways.

• *Residential sector planting*
The aims of an overall tree and shrub planting programme for Jurien would be advanced considerably if the same were encouraged to be extended into private residential areas.

To lend support to the promotion of this, a wealth of informative leaflets are available from the Forestry Department, Department of Agriculture and Department of Conservation and Environment with recommendations on how, what, where, when and why to plant. Being thus encouraged to voluntarily participate in the planting programme the community will be nurtured into developing a sense of responsibility for the project which will help to ensure its success.

Future landscape units
In view of the proposals for the northward extension of Jurien towards the new fishing boat harbour it would be necessary to rationalise the future landscape and to plan development in accordance with this. There are two basic areas of development:

• *Proposed subdivisions*
PWD have proposed landscape buffer zones to development which incorporate pedestrian access routes (ref. Map 4) and provide belts of greenery. The existing swathe of natural vegetation is to be retained in these green belts and it is recommended that small spaces are created adjacent to the footpaths for low-key, informal seating, picnic and barbecue facilities as illustrated in Figures 8 and 9. The natural vegetation should be protected as recommended in Figure 9 and trees selectively planted to create shade in the picnic/seating areas (also as illustrated in Figure 9).

A road verge tree and shrub planting programme should be incorporated into the new subdivision developments to tie in with the planting scheme for the existing townsite (as illustrated in Figures 7, 8, 9 and 11).

• *Proposed harbour site*
In the course of earthworks associated with the construction of the harbour it would be desirable to store the topsoil layer from the first 300 mm of soil until it can be re-used in landscape works at a later stage. Apart from its value as a suitable substrate for plant growth, the top layer of soil would also contain seed from the dune vegetation which may provide a viable and inexpensive means of promoting the establishment of a vegetation cover as and where needed around the harbour site.

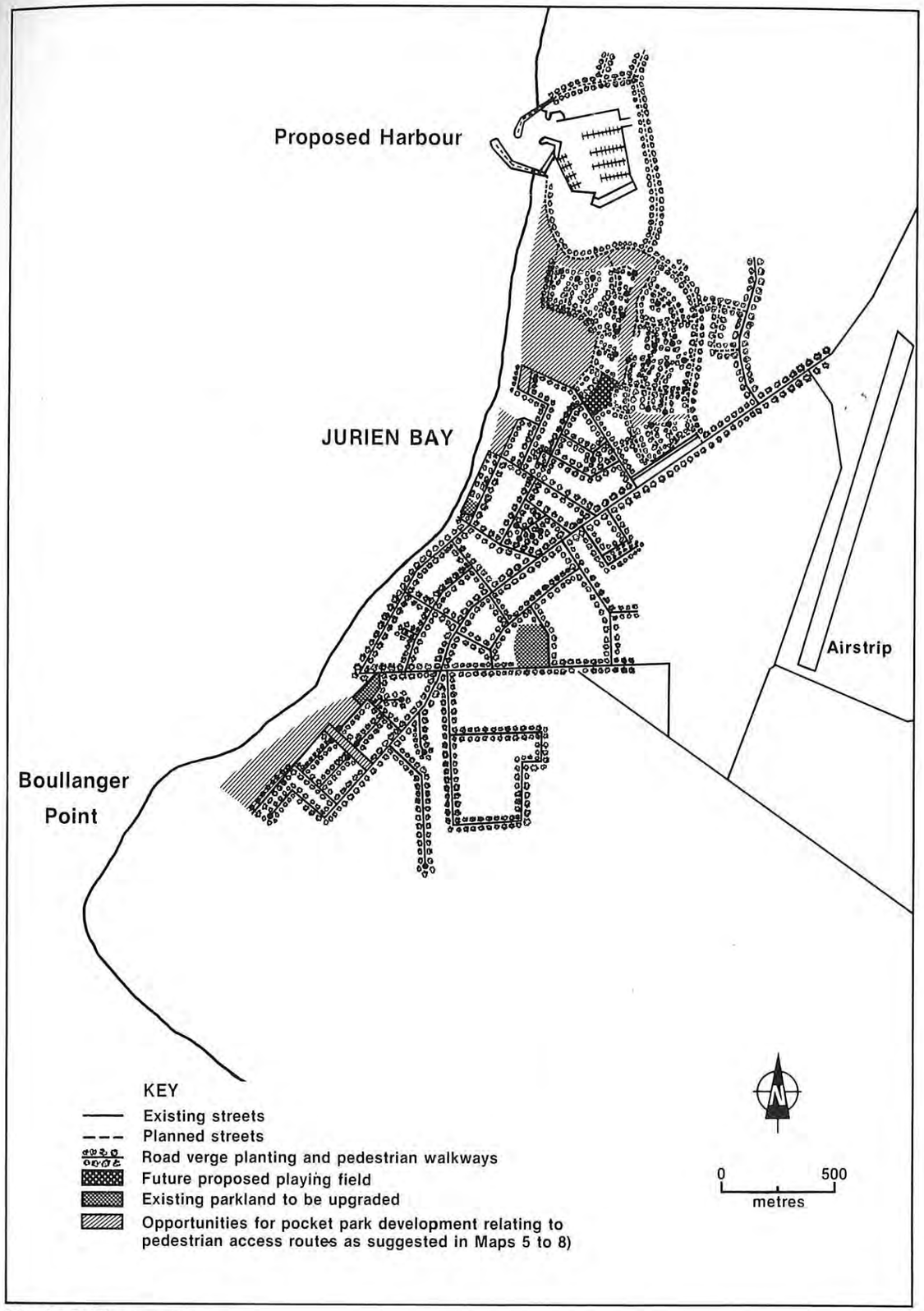
Considering the need for a fairly expansive car and boat trailer parking facility, the layout of this should be broken down to a number of smaller scale car parks, designed also to accommodate vegetation screens and planted borders which would improve the appearance of the car parking area and provide shade for parked vehicles.

Overall landscape character
A tree and shrub planting programme for the whole of Jurien is central to the theme for improving the character of its landscape. Giving the roads in particular a tree-lined character provides innumerable functional as well as aesthetic benefits (as outlined previously).

The choice of species too is important to give theme to the planting. This need not necessarily restrict the individual character of different zones within Jurien, but species should be well chosen to complement the overall theme. For this reason it is advisable to use a small core of main tree species (as suggested in Appendix 1) whilst the shrub understorey may partly reflect the natural diversity of the surrounding coastal dunes. Attention should be given to choosing species which adapt well to shade beneath a tree canopy wherever it is appropriate.

With the present and likely continued expansion of Jurien, such a planting scheme would be of long term benefit in helping to identify the town as a pleasant place to visit and especially to walk in (see Figures 10 and 11).

Implementation
Various aspects of implementing a tree and shrub planting scheme are discussed on Page 49 and as part of the public education programme on Page 45. Illustrations of planting techniques and a list of tree planting promotional material can be found in Appendix 2.



Map 4 Public open space

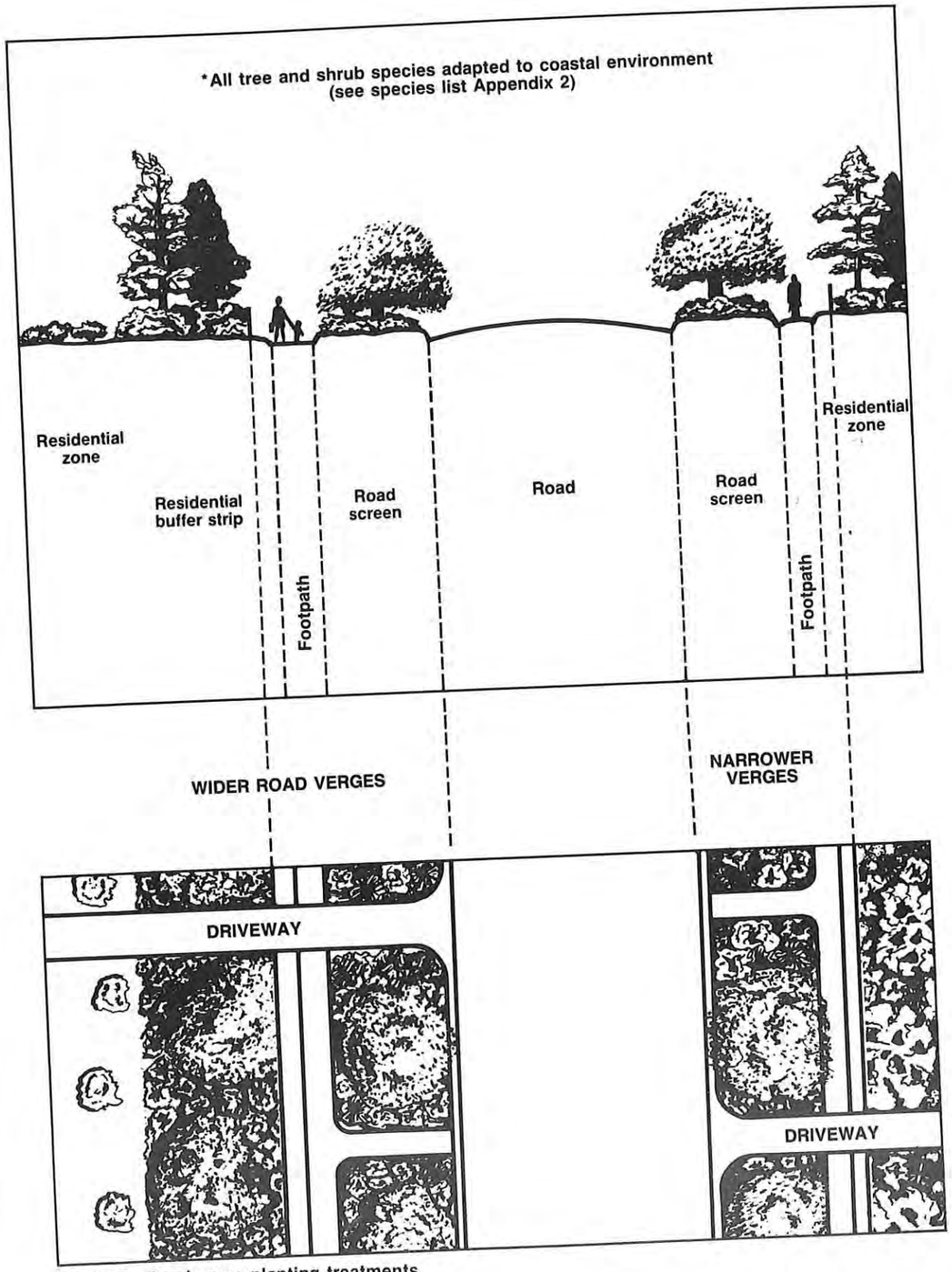


Figure 7 Road verge planting treatments

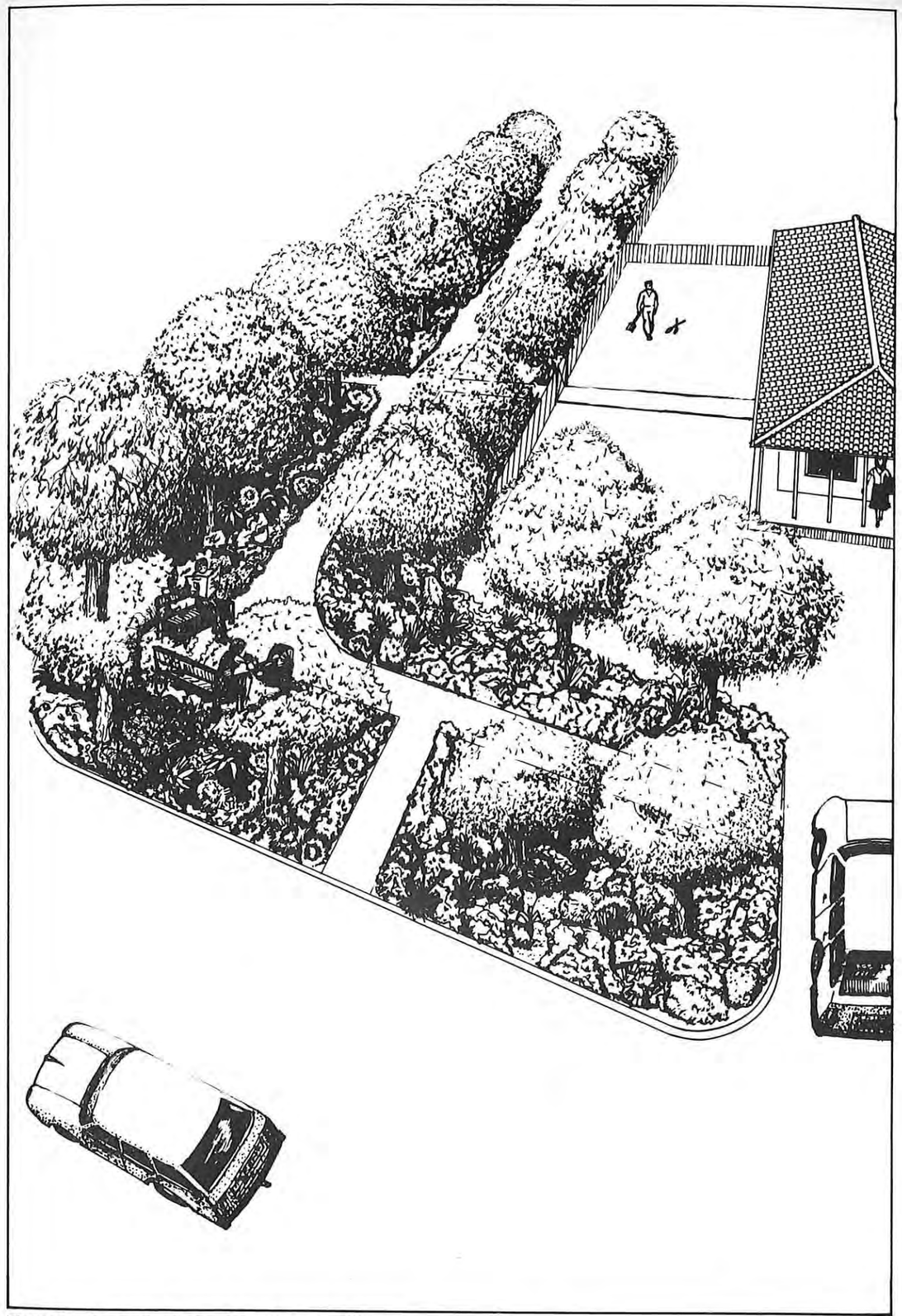
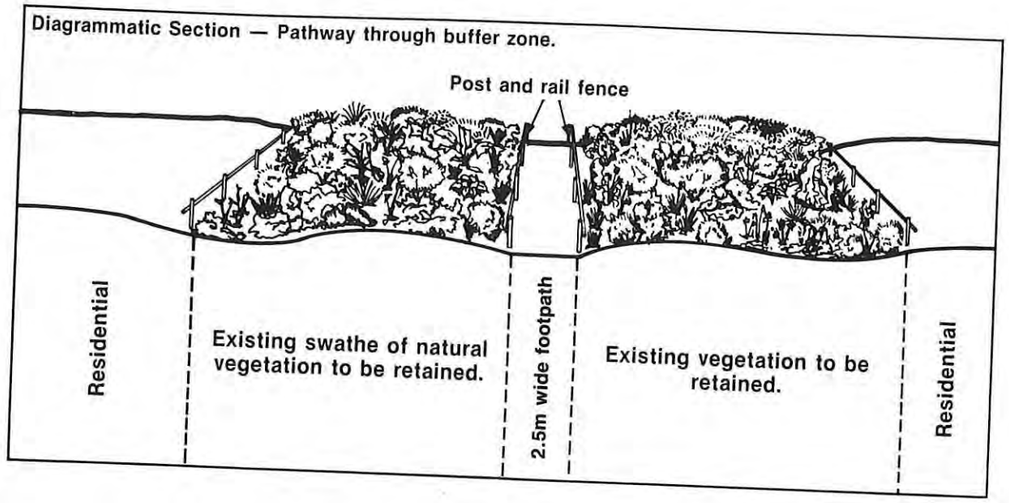


Figure 8 Roadside planting/street corner sitting area.



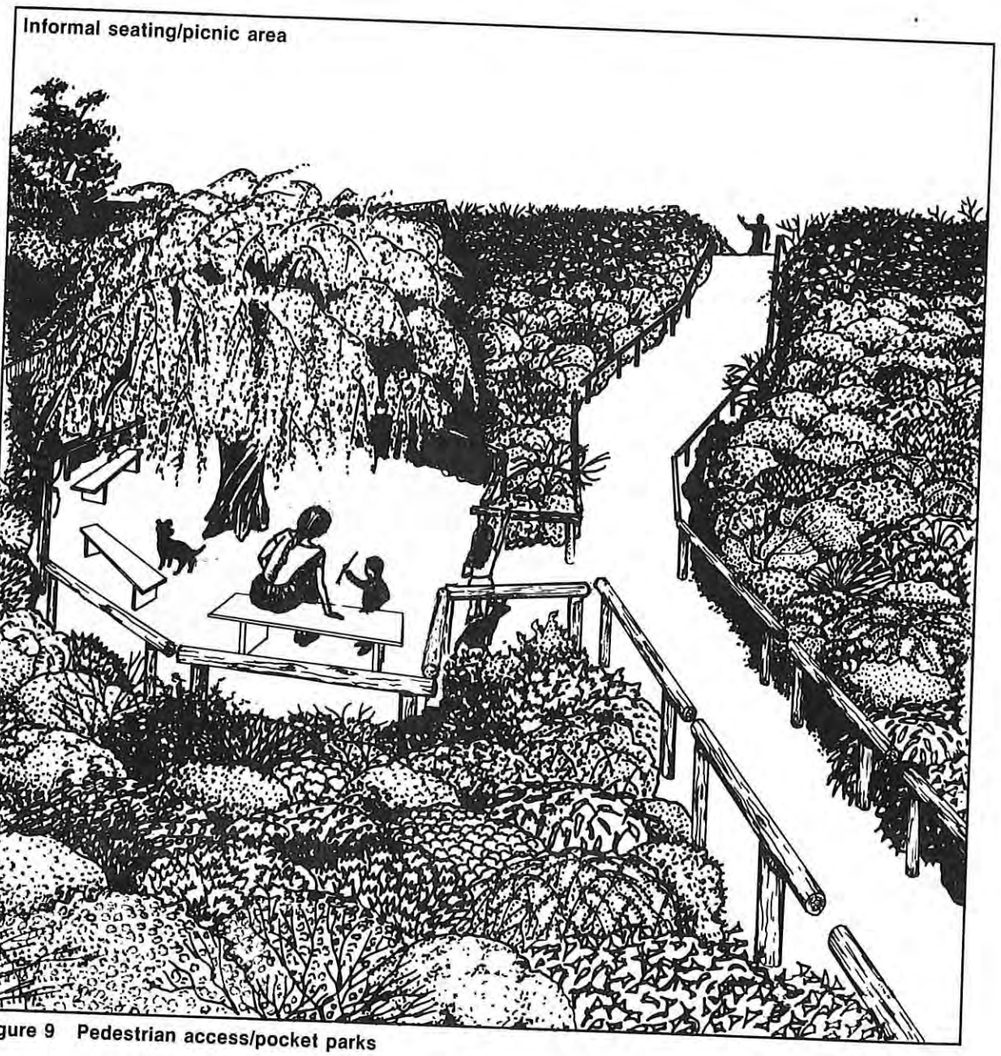


Figure 9 Pedestrian access/pocket parks

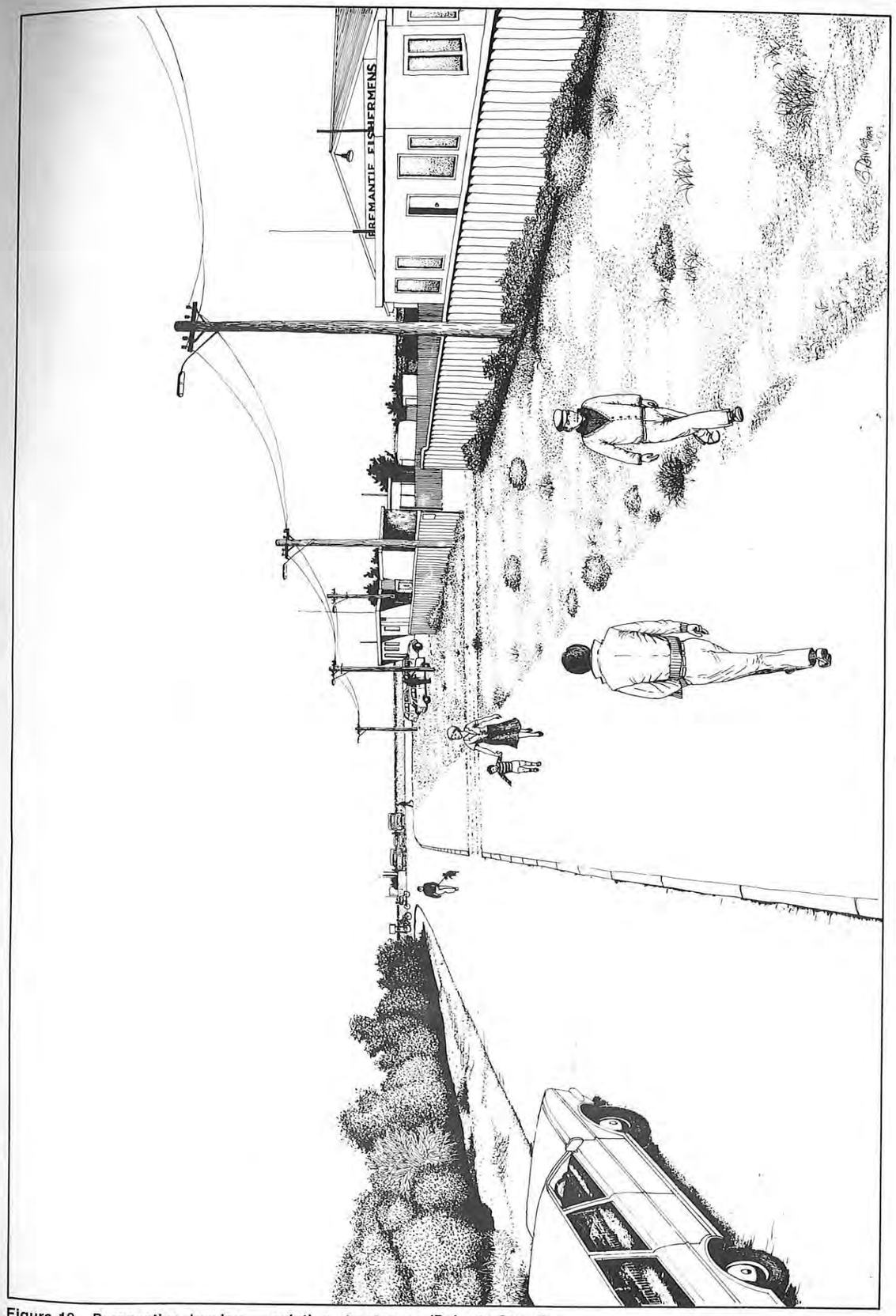


Figure 10 Perspective drawing — existing streetscape (Roberts Street).

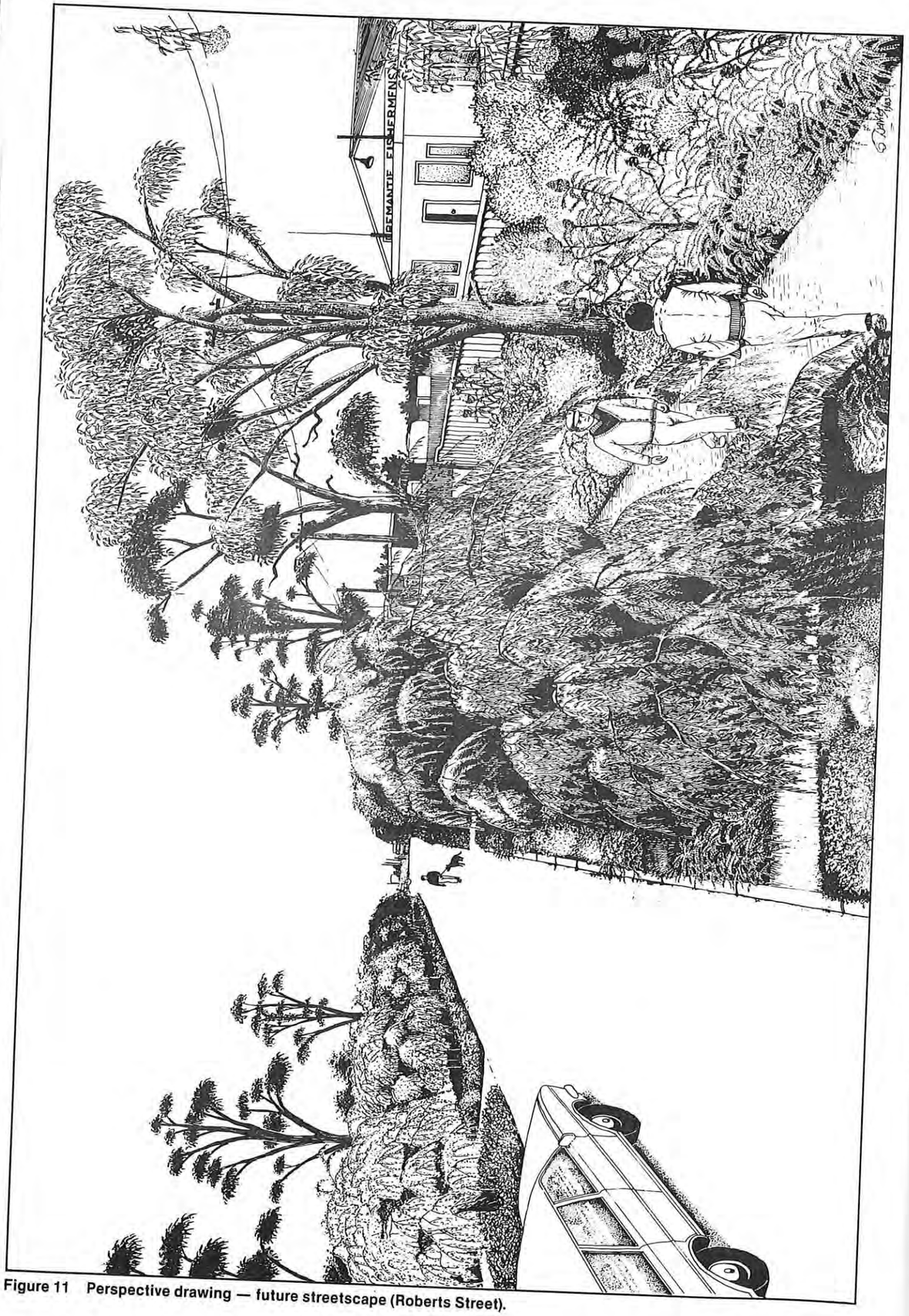


Figure 11 Perspective drawing — future streetscape (Roberts Street).

Structure Plan and Proposed Development Works

The Structure Plan, Map 3, has been prepared to show the recommended location and design of developments, works and management operations required to achieve the objectives outlined on Page 34. In addition it indicates the anticipated movements of people, vehicles and boats, within the town and on nearby waters.

Industrial and Residential Developments

The location and design of future industrial and residential developments should be determined after considering existing facilities, availability and cost of services, likelihood of future shoreline movements and the relevant location and purpose of coastal reserves.

Existing industrial and residential developments are shown on Map 3. Council is anxious that future developments should be extensions of these areas, and where possible should occur in stages, on a face from existing subdivisions avoiding ribbon-like development. Suggested staging is shown on Map 3.

In 1976 CDC considered an application for approval to subdivide land south of the town. After examining available information about the rate of shoreline recession described on Page 4 and progression near Boullanger Point, and the possibility of massive truncation of the point during future storms they made the following recommendation:

> "Development should be set back 300 metres from the point, 200 metres from the coast south of the point, and 100 metres from the old vegetation line north of the point."

This recommended setback is shown on Photograph 1.

The management of reserves containing natural vegetation is difficult when they are adjacent to residential areas. This is because the reserves often become subject to illegal use for such purposes as vehicle access to the back of lots, storage for cars, caravans and boats, construction of illegal structures such as hen houses and stables, and for rubbish disposal. At Jurien a problem occurs as people with residences backing onto coastal reserves use them as access points for off-road vehicles towing boats to the beach.

Generally these problems can be overcome if a road separates all lots from the coastal reserve, and such a road also assists in rationalising all public access to the foreshore. To prevent this facility from becoming a potential hazard to pedestrian users, it is advisable that the road be punctuated with planned cul-de-sacs, right angle bends, traffic islands etc.

After considering these matters it is recommended that roads be constructed between future residential land and the coastal reserves as shown on Map 3.

Existing and Proposed Roads and Trails

The location, design, construction and maintenance of urban roads and streets is an ongoing part of the DL&S and Council's normal operations, and is not given detailed consideration in this plan. However, providing for the movement of vehicles between the town and foreshore is an important aspect of coastal planning and management.

Upgrading and rationalisation of the existing access system will be an integral part of the development in the area, because it will provide an opportunity to increase public use of the coast and assist in protecting the coastal environment.

A number of unplanned vehicle and pedestrian tracks have developed throughout the study area. Many of these tracks are unnecessary and as they create an erosion risk and degrade the landscape they should be closed (see Photograph 6).

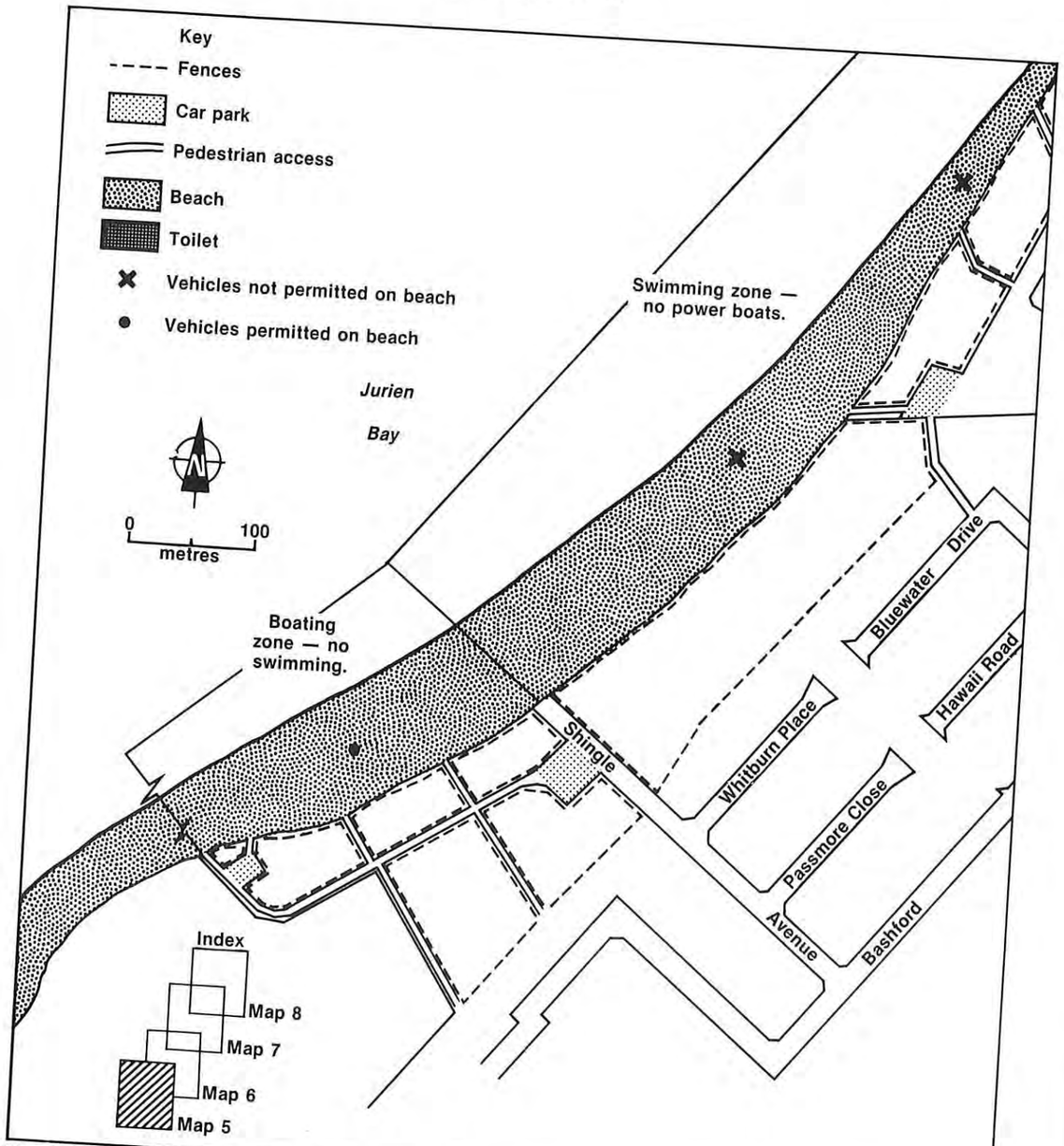
The location of the existing and proposed road and trail system is shown on Map 3.

Car and Boat Trailer Parking Areas

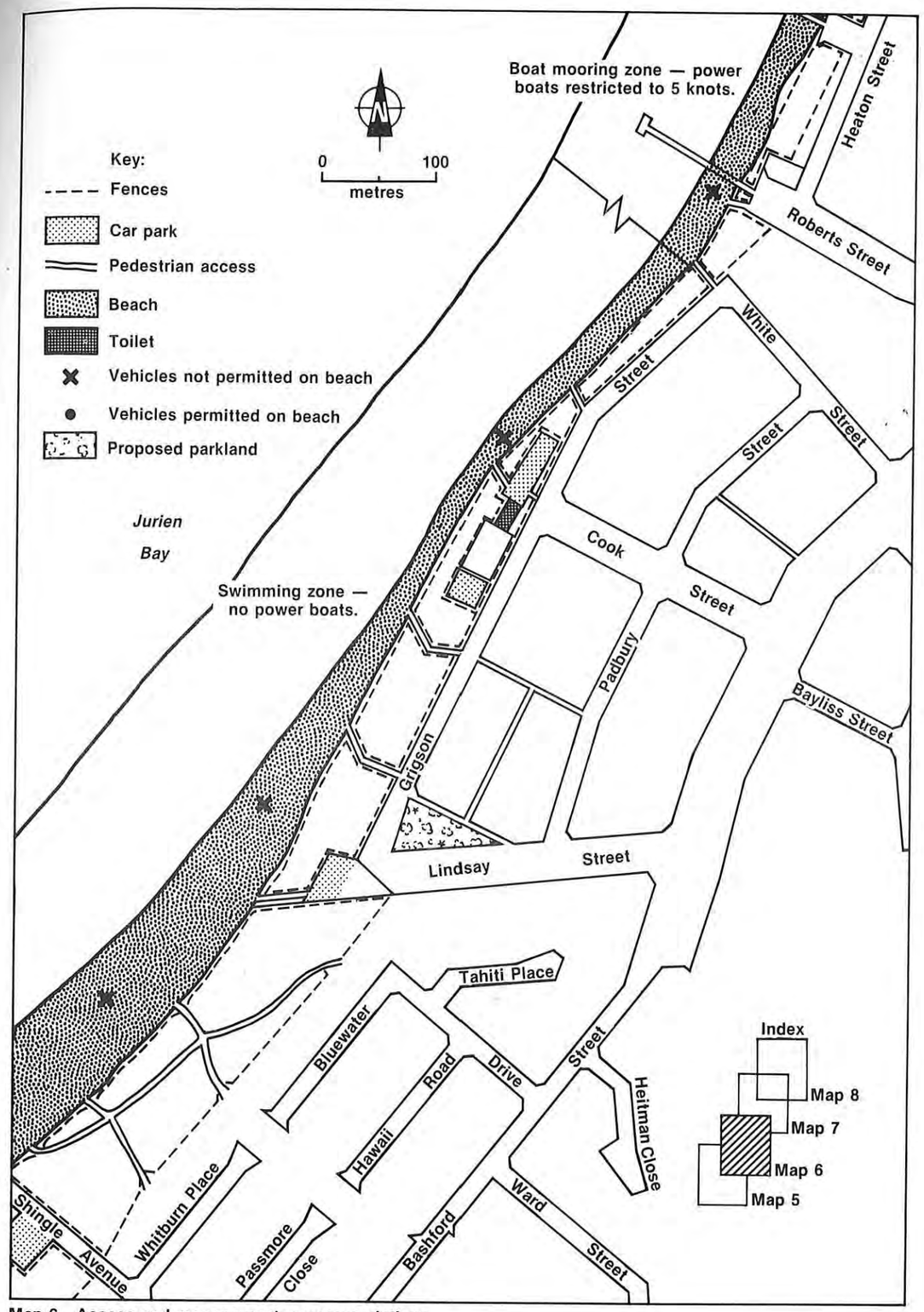
Much of the accommodation in Jurien is remote from the foreshore and so visitors often drive to the beach, generating a demand for car parks. In addition the high use of trailed boats provides a need for car and boat trailer parking facilities.

Currently a number of parking facilities exist on the foreshore but most require some modification to increase their capacity, improve aesthetics and reduce engineering problems.

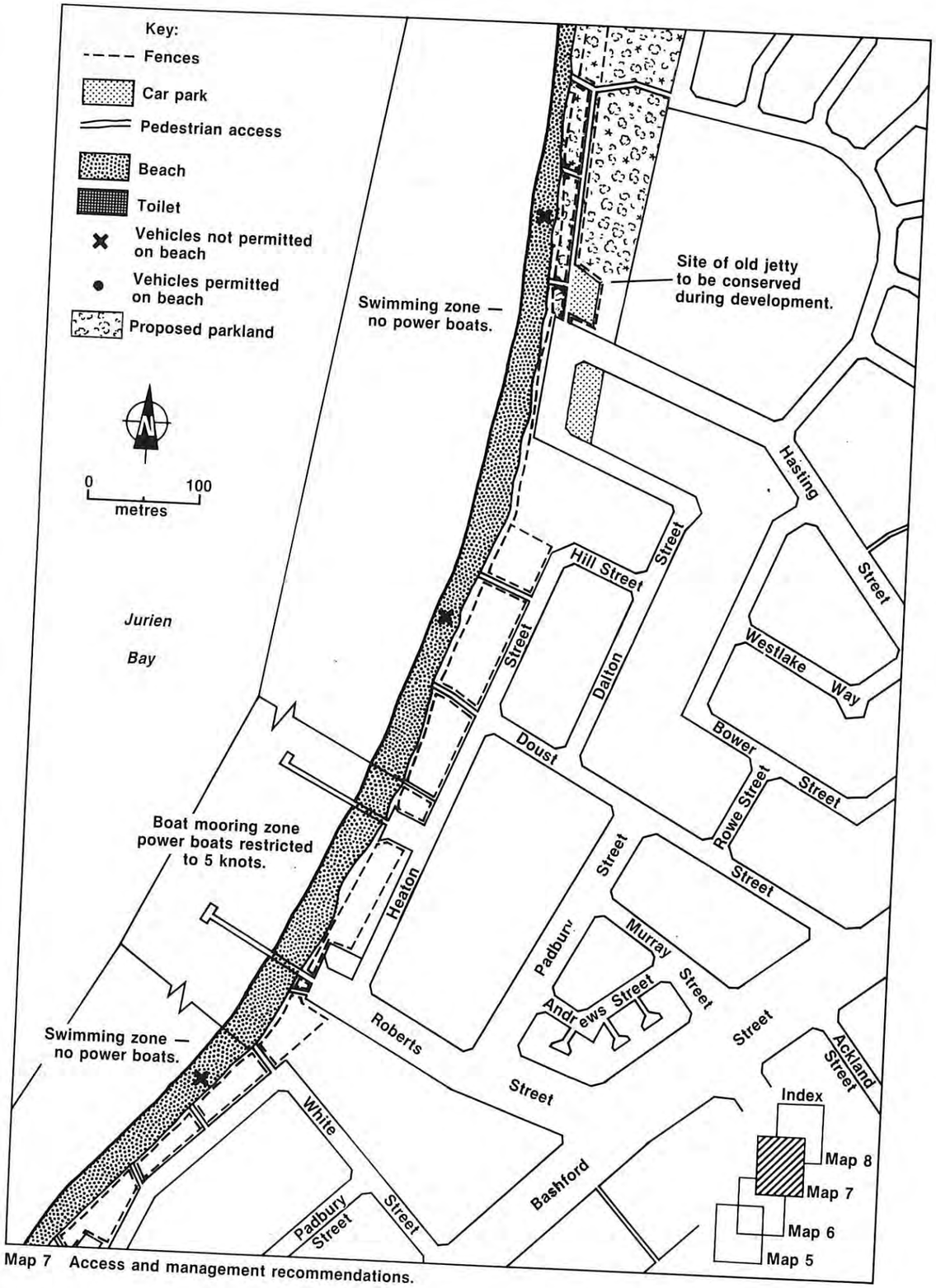
While parking areas planned for construction in association with the proposed harbour will provide considerable capacity, the existing facility at Boullanger Point area will continue to be of value for use by small, trailed yachts and dinghies. Existing and proposed parking facilities are shown on Maps 5-8 and redesign proposals are shown in Appendix 4.



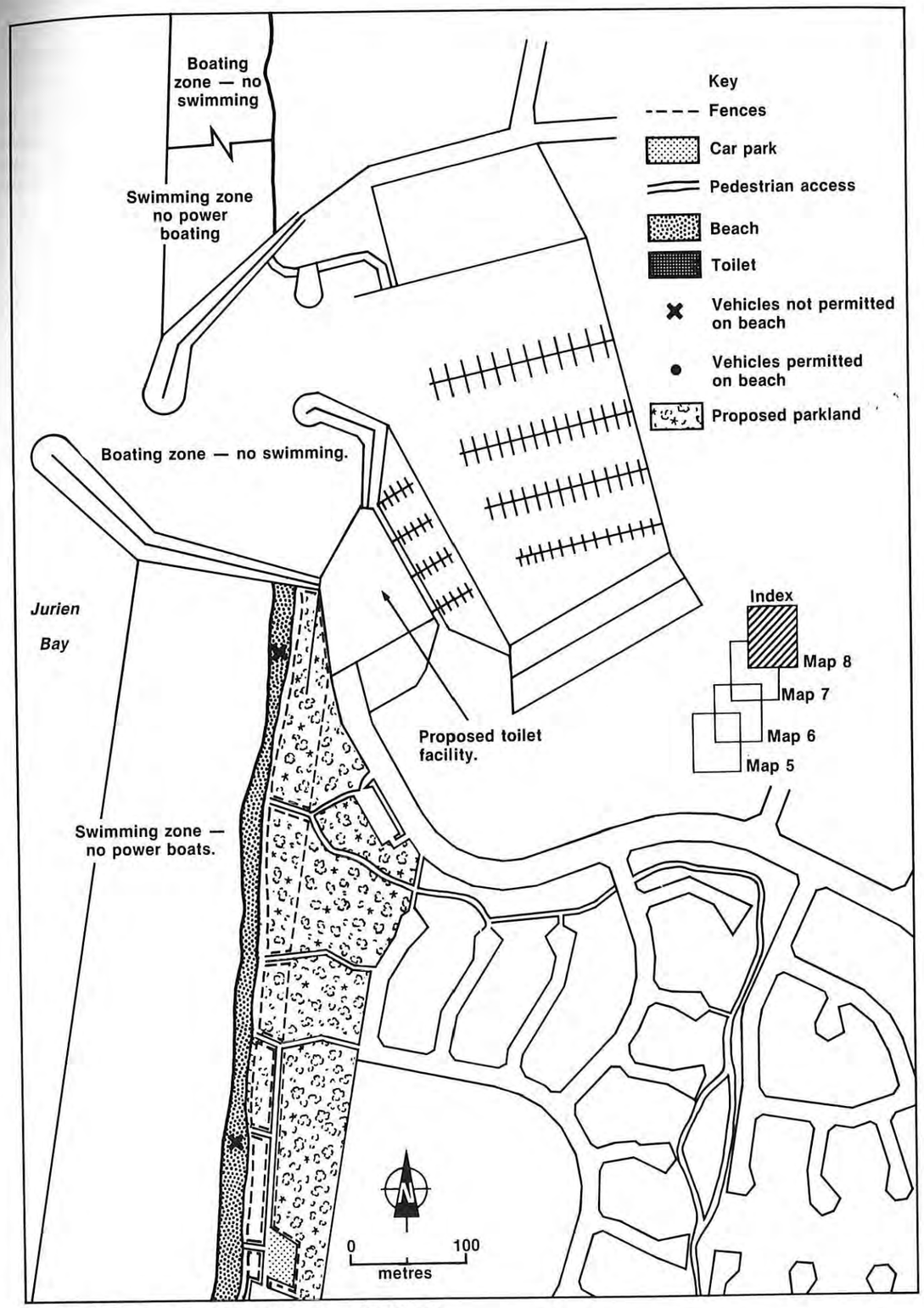
Map 5 Access and management recommendations.



Map 6 Access and management recommendations.



Map 7 Access and management recommendations.



Map 8 Access and management recommendations.

Management Proposals

Management is a series of activities undertaken to assist in achieving the town's purpose, and conserving and enhancing the urban environment. The management objectives provide a framework for conserving the area's resources, integrating the town into the region's environment and accommodating environmentally compatible public use. Recommended management activities include the following operations.

Access Management

The maintenance of roads, car parks, footpaths, tracks and trails is the responsibility of the Shire of Dandaragan.

Vehicle use of the area must be confined to designated roads and tracks to prevent damage to the vegetation and associated erosion, and to provide reasonable safety for pedestrians in the area. The proposed access system is shown on Maps 5 to 8.

The control of vehicles can be best achieved using a number of techniques.

- The provision of adequate access to popular points, which can be achieved by the staged development of the roads, tracks, car parks and footpaths shown on Maps 5 to 8.
- Education of the public by providing adequate information concerning the access system and the need to conserve the coastal environment.
- Implementation of the provisions of the Control of Vehicles Off-Road Areas Act 1978. The entire area should be declared a prohibited area for all motor vehicles, with an exception of the designated vehicle access roads, tracks and car parks.

Use of the access system should be monitored to enable an objective appraisal of existing and potential needs and compliance with regulations.

Jurien Bay Off-Shore Waters Management

As outlined on Pages to the waters of the Jurien Basin are used by commercial and amateur fishing boat operators, water skiers, yachtsmen, wind surfers, anglers and bathers. This multiple use of a relatively small area creates user conflicts, which would be best overcome by:

- Separating the launching facilities used by amateur and commercial boat operators, and this should be largely achieved when the proposed harbour is constructed.
- Zoning different sections of the bay for particular uses, which can be achieved under Navigable Water Regulations which are a part of the Western Australian Marine Act.
- Suggested aquatic use zones as shown on Map 3.

Construction of the proposed harbour will effectively separate the main groups of boat users. Council should approach the General Manager of the Department of Marine and Harbours seeking his assistance in the establishment of recommended aquatic use zones.

In view of the importance of the marine resources described in Pages 13 and 14 it may be appropriate to establish a marine reserve over portion of the bay if a legislative framework is enacted and a management capability is developed.

Wildlife Management

The most effective means of protecting the wildlife populations discussed above is to minimise disturbance of the animals and their habitats. While some changes associated with residential and industrial development are unavoidable, those associated with the careless use of fire, off-road vehicles, or trampling of vegetation by people should be reduced where possible. Fire is regarded as a particular threat because it can alter the structure of large areas of vegetation, which may eliminate or reduce species existing in marginal habitats.

The Department of Fisheries and Wildlife proposes to prepare a management plan for Boullanger and Favourite Islands, which will help reduce unnecessary disturbance to wildlife existing on them.

Soil Conservation

Soil erosion caused by the wind and the sea is a natural process which has occurred in the region for many thousands of years. This soil movement has been a major influence in the shaping of landforms which exist along the coast today. Man's activities also produce erosion because the sandy soils of the area lack structure and become mobile if the protective vegetation is removed.

Erosion degrades the landscape and creates engineering problems when roads become impassable because of drift sands and gullying. When the foredunes erode, beach sands become mobile and move inland, burying the vegetation and man's improvements. Poor soil fertility and the excessive drainage of drift sands makes revegetation of eroding areas difficult and expensive, therefore, the prevention of erosion is important.

Erosion can be prevented if the vegetation cover is maintained and roads, car parks and beach access systems are well designed and carefully constructed.

When vegetation is removed to allow development, areas of bare soil must be surfaced with gravel or revegetated. Where pedestrians require access from car parks or camping areas to beaches, properly designed beach access systems are required. Normally these will include clearly defined and fenced pathways which protect dune vegetation from trampling (Maps 5-8). When paths cross sandy slopes they should be surfaced with gravel, limestone rubble or a board and chain pathway. On steep slopes simple steps may be adequate.

Fences are best constructed of pine log rails which provide an effective but aesthetically acceptable barrier. Some situations may require a stronger barrier and agricultural type fences should be used. Details are shown in Appendices 5, 6 and 7.

The control of erosion in the area is the responsibility of the Shire of Dandaragan. The Department of Agriculture may provide advice if required.

Dieback Prevention

Dieback is a plant disease caused by the fungus *Phytophthora cinnamomi*, commonly known in this State as jarrah dieback. Introduced into Western Australia early in the century, the disease was not identified until the 1960s. By that time it had been spread unwittingly throughout much of the forest near Perth, particularly by the heavy machinery used after World War II to build roads, clear the way for powerlines or for logging operations.

At the time this plan was prepared there had been no report of dieback in the area. However, many of the plant species in the district are in the taxonomic groups considered susceptible to attack from the disease, and so dieback is considered a significant threat.

As there is no known cure for the disease on a broad scale it is important that the organism responsible is not introduced to the area. Infection is most likely to occur if soil or road building materials are imported from affected districts. Plant seedlings used for landscaping in the area should come from a nursery using sterilised materials. Previously used plant and equipment should be cleaned.

Exotic Flora and Noxious Plant Control

With the exception of some Australian trees and shrubs which may be brought into the town to form windbreaks and visual screens, introduced plants should be discouraged. The low nutrient status of the soil in the area makes establishment difficult for most introduced plant species, provided that bare areas which are suited to invasive species are kept to a minimum.

Noxious weeds should be eliminated immediately they occur. Advice concerning the control of noxious plants is available from the Agriculture Protection Board.

Public Education Programme

The public education programme should be part of a wider programme for the Jurien district. The objectives of the programme should be to orientate visitors, interpret the natural features and to influence the behaviour of people.

Visitors should be orientated by providing them with information about the natural and man-made attractions of the district and where to find them. This could be achieved by:

- the preparation of a pamphlet containing details of roads, paths, boat launching areas, fishing spots, caravan parks, beaches, wildflowers and picnic areas;
- the pamphlet should also contain information about the proper use of vehicles and boats in the district;
- erection of well-designed signs at appropriate locations;
- continuing contact between Shire staff and the public.

Interpretation of the natural features of the district is required so that the local people and visitors have a greater understanding of the environment and an increased sympathy for its conservation. This would be best achieved by:

- including relevant information in the pamphlet;
- continuing contact between Shire staff and the public.

Residents of Jurien may be encouraged to participate in the tree planting programme. Interpretive material should be made available to residents and other volunteers or participants to provide the following information:

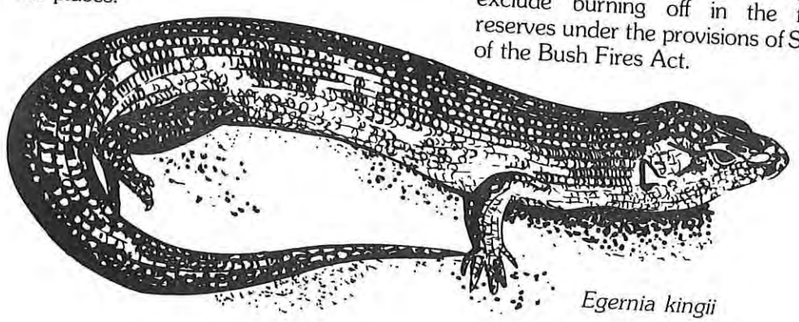
- the general design concepts and objectives of the scheme;
- the benefits to be had from such a scheme, in particular visual improvements to the landscape;
- how and when each person can participate (perhaps, based on a street by street approach);
- techniques involved in implementing the project;
- how and where to obtain further information on the scheme.

It would be advantageous in many respects to encourage the involvement of Jurien State School in both the planting and dune conservation programmes. Such involvement would have great educational benefits and would promote a sense of responsibility in the scheme. It would likewise be beneficial in nurturing an awareness to the problems and pressures exerted by man on the coastal environment and the means by which these problems can be solved. DCE will offer every possible assistance in environmental interpretation.

Fire Management

The vegetation of Australia has evolved in the presence of fire, and plants use a variety of strategies to survive burning. Some plants regenerate vegetatively from parts of their roots and stems, while others recover by means of seeds stored on the plant or in the soil. However sand dune communities recover slowly after fire and the erosion risk is high until the vegetation recovers, which may take several years. The danger of erosion is higher if the area is subject to intensive public use. As a result it is considered that management should attempt to exclude bushfire from the area, and if fire does occur it should be confined. The following programme is recommended to reduce the risk of widespread damage by fire:

- The lighting of fires in the reserve should be prohibited except in properly constructed fire places.
- The public education programme should include information concerning the danger of fire in the area, and the responsibilities of people in relation to the lighting of fires.
- The roads, tracks and car parks in the area can be used as fire breaks, and the appropriate location of fire breaks has been considered during the preparation of the Structure Plan.
- The Shire should develop its fire-fighting capacity by periodically obtaining and upgrading equipment. Provision should be made for training Council staff in fire-fighting techniques.
- A fire management plan for the Jurien townsite should be prepared in co-operation with the Bush Fires Board, and surrounding land holders. The plan should specifically exclude burning off in the foreshore reserves under the provisions of Section 21 of the Bush Fires Act.



Egernia kingii

Implementation

The implementation of this plan is primarily the responsibility of the Shire of Dandaragan, but various government authorities and other bodies may provide further assistance and advice. This section outlines the priorities, measures and sources of assistance required to undertake the plan's objectives.

Land Tenure

Alterations to the vesting or tenure of several areas of land would assist in the future management of coastal land in the Jurien townsite.

The area of vacant Crown land north of Hastings Street, and shown as a proposed reserve on Map 3 should be vested in the Shire of Dandaragan for foreshore conservation and recreation purposes. Council should approach the Under Secretary for Lands seeking an appropriate vesting of the area.

Privately owned land between the recommended coastal road alignment and the boundary of reserve 28541 would be best managed by the Shire. The future tenure of this area should be considered by Council and the Jurien Syndicate during negotiations concerning future subdivisions in location 8837.

The present vesting of reserve 26940 for caravan park purposes is not appropriate and it will be cancelled, and the land incorporated within foreshore reserve 28541. Similarly reserve 30805 presently vested in Council for slipway and boat building purposes will be cancelled and the land incorporated into reserve 28541. Reserve 26939 is currently vested in Council and used as a kiosk site. It would be appropriate to move the kiosk to the caravan park and incorporate the land in reserve 28541.

Residential Development

Council considers it would be desirable to achieve a balance between private and Lands Department subdivisions, which would assist in achieving development, both north and south of the existing built up area. In addition, it would result in a form of dual land tenure providing for speculative buyers (no building conditions) and buyers of lots with controlled development conditions.

Council wishes to encourage residential development which will consolidate the town and avoid ribbon-like development along the coast. This can be achieved if private and government subdivisions are staged as shown conceptually on Map 3. The development proposed by the Jurien Syndicate has been delayed pending preparation of this plan, to enable the consideration of coastal management issues in the design and development of the subdivision.

It is suggested that the Jurien Syndicate submit a staged structure plan to Council which considers:

- the coastal planning requirement to avoid development on the Parabolic Dune Unit, and the limit of development line recommended by the CDC and shown on Photograph 1;
- the desirability of developing the land closest to existing subdivisions first, as shown on Map 3;
- the need for a road to separate any subdivision from the recommended foreshore reserve; the road design will include traffic islands and cul-de-sacs, to limit vehicle movements.
- the recommended beach access points shown on Maps 5 to 8.

The future tenure of the land between the private subdivision and the boundary of reserve 28541 should be considered by Council and the Jurien Syndicate during negotiations concerning subdivision approvals.

The proposed Lands Department subdivision north of the town should occur in accordance with the staging shown on Map 3. The subdivision has been designed to provide:

- an adequate foreshore reserve;
- a road between all lots and the foreshore reserve;
- managed beach access and car parking.

The Lands and Surveys Department intends to use fill from the proposed fishing boat harbour to fill low areas of their subdivisions.

Foreshore Protection Works

The foreshore protection works outlined in Pages 29 and 39 and shown on Maps 5-8 should be undertaken with the following priority:

The area between White and Cook Streets
The area between Cook and Lindsay Streets
The area between the northern jetty and Hastings Street
The area between Lindsay Street and Shingle Avenue

The area between Hastings Street and the entrance to the fishing boat harbour should be stabilised and access provided in accordance with PWD and Department of Agriculture specifications at the time of construction of the harbour. It may be possible for a portion of this work to be funded from the harbour development project.

Any private development adjacent to the foreshore south of Coubrough Street should be accompanied by appropriate foreshore protection works.

Car Parking and Vehicle Access

Car and trailer parking will be provided in accordance with specifications in the following priority:

at the western end of Hastings Street (Map 7);
at the end of Lindsay Street (Map 6);
at the public boat launching ramp at the proposed harbour.

Control of Off-Road Vehicles

Rationalisation of access will be an important programme in the implementation of the plan. The Shire will write to the Chairman of the Ministerial Advisory Committee on Off-Road Vehicles requesting that portion of the Shire west of the proposed coastal road be made subject to the provisions of the Control of Vehicles Off-Road Areas Act 1978.

The whole of the study area will be declared a prohibited area with the exception of designated roads, tracks and parking areas. Council will inform the Chairman that:

- Road registered and unregistered vehicles are creating environmental problems and are a danger to the public.
- Council wishes to have control over vehicles in the area.
- Designated roads, tracks and car parks will be signposted.
- Shire staff will be made available to inform the public and enforce the provisions of the Act.

Off-Shore Waters Management

Council should approach the Manager of the Department of Marine and Harbours requesting that the Aquatic Use Zones shown on Map 3 and discussed on Page 44 be established under the Navigable Waters Regulations. The zones should be established in two stages.

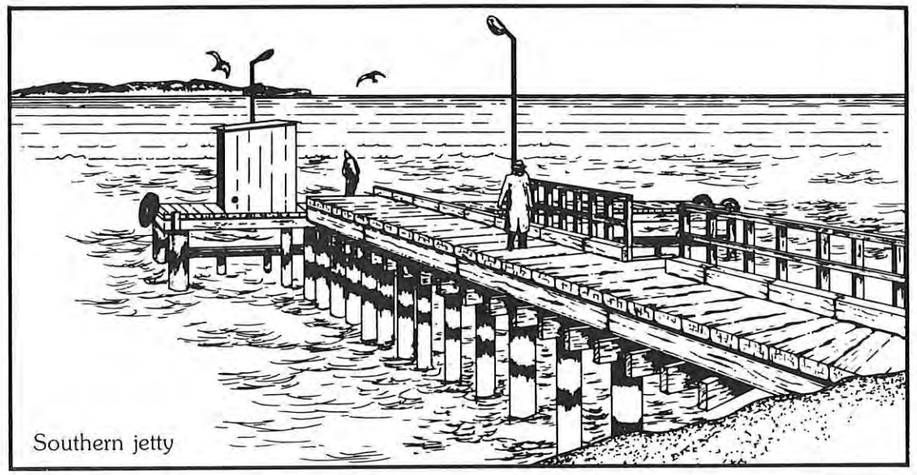
The zones south of Hastings Street can be established after the harbour has been completed.

Jetties Management

The control and maintenance of the jetties will remain the responsibility of the Fishermen's Co-operatives until they cease to use them for landing rock lobster catches and effluent disposal.

After the harbour is complete, the rock lobster catch should be landed at the new facility and it will become unnecessary to drive vehicles on the jetties. From that time, driving vehicles on the jetties should be prohibited, which will extend the life of these structures.

If the Fishermen's Co-operatives cease to use the jetties, they should be vested in Council for recreation purposes. If this occurs, Council should ask the Harbours and Rivers Branch to inspect the jetties as often as it is required to ensure they are safe for public use. Until the jetties are not needed by the fishing companies Council will liaise with the companies and the State Government to ensure they are not permitted to deteriorate beyond repair.



Southern jetty

Landscape — Phasing and Priority

The criteria used to ascertain priority for development of landscape works are essentially as follows:

- the projected impact on the landscape created by a particular treatment;
- the anticipated functional and aesthetic benefits of the treatment;
- the anticipated cost and cost-benefit of a particular treatment;
- the degree of maintenance required both during and after the establishment period for the scheme.

It is considered that the road verge planting scheme will provide greatest beneficial impacts on the use and appearance of the landscape. Added to this it has the advantage that it could be phased road by road and thus implemented over a period of several years. In this way problems in implementation may be faced and overcome in the early stages of the project before the same mistakes are repeated in other areas. The cost of implementation may be considerably reduced by the involvement of residents and 'busy-bees' alike. Maintenance costs will be minimal since watering over the establishment period and removal of stakes after two years will probably be the only maintenance required. For these reasons road verge planting deserves high priority for implementation.

The development of small well-located 'pocket parks' would considerably improve the recreational amenity of the town. Construction of the parks may be simply effected by extending dune or vegetation protection fences (post and rail) to delimit the area of the park (as suggested in Figure 9) and installing benches and barbecue facilities. Planting within the smaller parks would not be extensive since, ideally, the periphery would consist of the established swathe of natural vegetation, so a shade canopy would be the only further requirement from the planting scheme (see Figure 9).

In general these parks should be located in dune hollows wherever possible so as to minimise exposure to winds and therefore help to prevent deflation of sand from the enclosure. Some surfacing material such as crushed, rolled limestone may be appropriate to further minimise sand losses due to wind erosion.

The simple and quick construction of these parks as individual units is well suited to a phasing strategy in accordance with a master plan concept for their location (see Map 3). In relation to the whole landscape strategy for Jurien, the parks may be installed along with dune and vegetation protection works according to the phasing of each of these zones (as defined on Page 30).

Supplementary planting and the rationalisation of pedestrian access through areas such as the school grounds and larger parks need to be approached on a detailed design level as well as on a general conceptual level. It is considered to be beyond the scope of this report to reproduce the level of detail needed for this aspect of the programme, though it is an aspect which needs attention to avoid further degeneration of the existing landscape.

The recommended planting programme for Jurien is fairly extensive. To promote the 'Greening of Australia' movement, Alcoa offers assistance in the supply of trees along with advice and information on implementing such a programme.

Various sources of information concerning promotion, implementation and maintenance of landscape works are listed in Appendix 2

References

Beard, J.S. (1969). *The Vegetation of the Moora and Hill River Areas, Western Australia.* Vegmap Publications, Perth.

Chalmers, C.E. (1982). *Draft Foreshore Protection Plan, Jurien Jetties Area.* Department of Conservation and Environment, Perth.

Chapman, A., Dell, J., Johnstone, R.E. and Kitchener, D.J. (1977). *A Vertebrate Survey of Cockleshell Gully Reserve, Western Australia.* Records of the Western Australia Museum Supplement No. 4, 1977.

Commonwealth Bureau of Meteorology, (1962). *Average Annual Rainfall Map of Western Australia.* Govt. Printer, Perth.

Ford, J.R. and Teague, B.U. (1959). *Extension of Range of White-breasted Robin* in The Emu, Vol. 59, March 1959.

Ford, J.R. (1963). *The Reptilian Fauna of the Islands between Dongara and Lancelin, Western Australia.* The Western Australian Naturalist, Vol. 8, No. 6, January 1963.

Ford, J.R. (1965). *The Avifauna of the Islands between Dongara and Lancelin, Western Australia.* The Emu, Vol. 64, 1964.

Ford, J.R. (1966). *Taxonomy and Variation of the Chestnut-shouldered Wrens of Western Australia.* The Emu, Vol. 66, Part I, June 1966.

Lowry, D.C. (1974). *Dongara Hill River Western Australia. Geological Survey of W.A.* Australian Government Publishing Service, Canberra.

Lullfitz, G. (n.d.) *Plants for Seafront Gardens — West Australian Gardening.* Panorama Books, Perth.

Woods, P.J. and Gilkes, R.J. (1982). *Investigations into Sedimentation, Soil Development and Coastal History at Jurien.* University of W.A., Nedlands, W.A.

Appendix 1 —

Plants Species Suitable for Landscape Works at the Jurien Townsite.

(Adapted from Lullfitz)

* Suggested key species for the main planting theme.

Heavily Exposed Areas

TREES

Casuarina equisetifolia — dune sheoak
**Casuarina campestris* — native sheoak
Eucalyptus gomphocephala — tuart
**Eucalyptus platypus* var. *heterophylla* — coastal moort
Langunaria pattersonnii — Norfolk Island hibiscus
Melaleuca lanceolata — Rottnest Island tea tree
Metrosideros excelsa — New Zealand Christmas tree
Metrosideros excelsa variegata
Tamaris aphylla

SHRUBS

Acacia cyclopis — red-eyed acacia
Acacia pulchella var. *lasiocarpa* — sand-heath acacia
Acacia rostellifera — suckering dune wattle
Alyxia buxifolia
Calothamnus quadrifidus — one-sided bottlebrush
Eremophila glabra
Coprosma retusa — mirror plant
Coprosma picturata — mirror plant
Cortaderia selloana — pampas grass
Hemiandra pungens — snake bush
Leptospermum laevagatum — coastal tea tree
Myoporum insulare — boobyalla
Olearia axillaris
Pelargonium capitatum — native geranium
Phormium tenax — green NZ flax
Phormium tenax purpurea — red NZ flax
Phormium tenax variegata — green and white NZ flax
Pittosporum crassifolium
Pimelea ferruginea
Scaevola crassifolium
Senecio cimeria
Templetonia retusa
Westringia rigida
Melaleuca acerosa

GROUND COVERS

Arctotis stoechadifolia — Swanbourne daisy
Coprosma repens — mirror plant
Coprosma kirki (also variegated form)
Conostylis candicans
Calocephalus brownii — cushion bush
Gazania
Hibbertia scandens — snake vine
Hemiandra pungens — snake bush
Myoporium parvifolium — prostrate boobyalla
Myoporium parv. purpurea — red form
Rhagodia baccata
Tetragonia decumbens
Grevillea thelemanniana — spider net grevillea

Partially Exposed

TREES

**Agonis flexuosa* — weeping peppermint
Acacia longifolia — Sydney golden wattle
Callitris preissii — Rottnest Island pine
Eucalptus ficifolia — red flowering gum
Eucalyptus erythrocorys — illyarrie
Eucalyptus camaldulensis — river gum
**Eucalyptus gomphocephala* — tuart
Eucalyptus caesia — Gungurru
Pittosporum phyllyraeoides

SHRUBS

Acacia cuneata
Chamelaucium uncinatum
— Purple pride — Geraldton wax
— University
— Alba
— Newmarracara
— Wilsonii
— Munzii
— Dowellii
— White correa
Correa alba — white correa
Dodonea aptera
Dryandra sessilis — parrot bush
Eucalyptus tetragona — white-leafed marlock
Grevillea crithmifolia
Leptospermum sericeum — Esperance tea tree
Melaleuca nesophila
Melaleuca huegelii
Melaleuca globifera
Melaleuca megacephala
Melaleuca pentagona
Melaleuca diosmifolia — Windy Harbour form
Trachymene caerulea — Rottnest daisy, annual only

GROUND COVERS

Kennedya prostrata — red runner
Kunzea pomifera

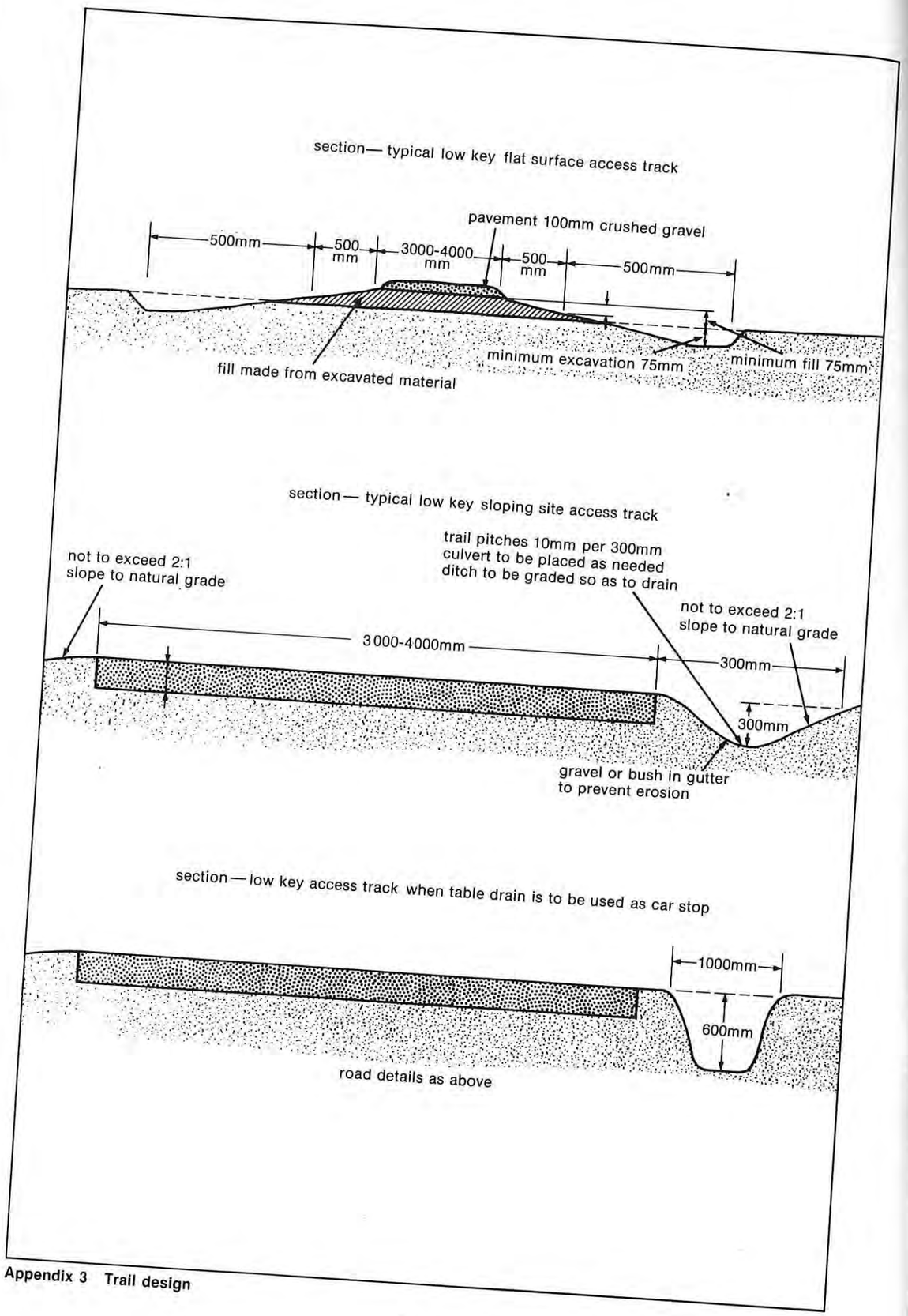
CLIMBERS

Kennedya nigricans — black coral pea
Kennedya rubicunda — dusky coral pea

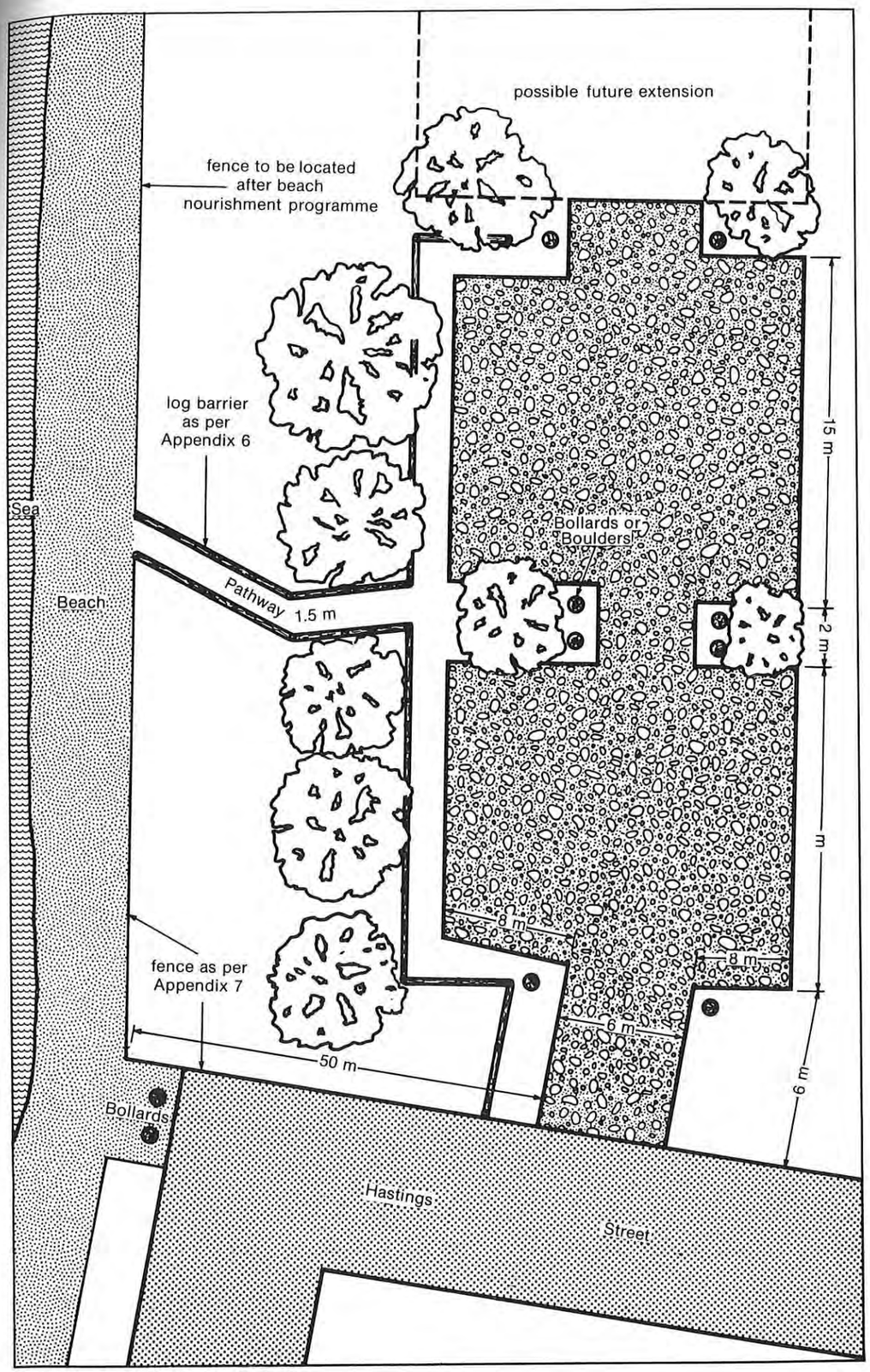
Appendix 2 —
Planting Techniques and Promotional Material

Examples of informative and promotional material available for a tree planting programme.

1. 'LEAFLET' produced by Alcoa — a series of information sheets on:
   - Tree planting projects throughout the State
   - The latest research results from the Forests and Agriculture Departments
   - Useful publications and articles on tree planting
   - Coming events, and
   - Timely reminders
2. 'Farmnote' — W.A. Department of Agriculture. A series of information sheets on specific environmental problems with recommendations on how to overcome them (see examples attached).
3. 'Facts to Get You Growing' — a Community Awareness Poster sponsored by Coca-Cola Bottlers, Perth. In association with the Committee for the Understanding of the Environment.
4. 'Greening of Australia' — series of posters.
5. 'The Year of the Tree' — poster — good for schools. Produced by Rosalind Benson and the Harper Seed Company for the Western Australian Nurserymen's Association.

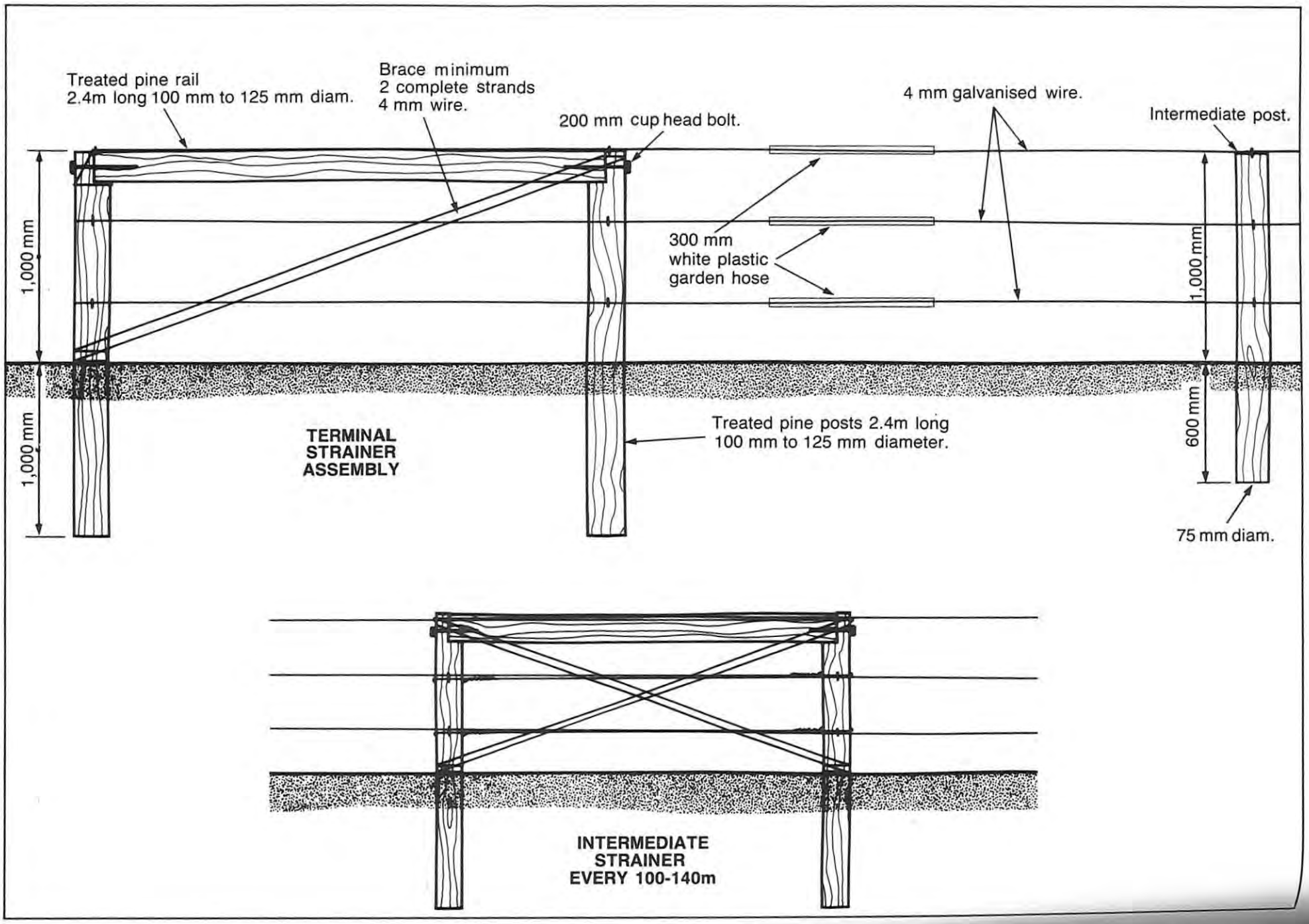


Appendix 3 Trail design

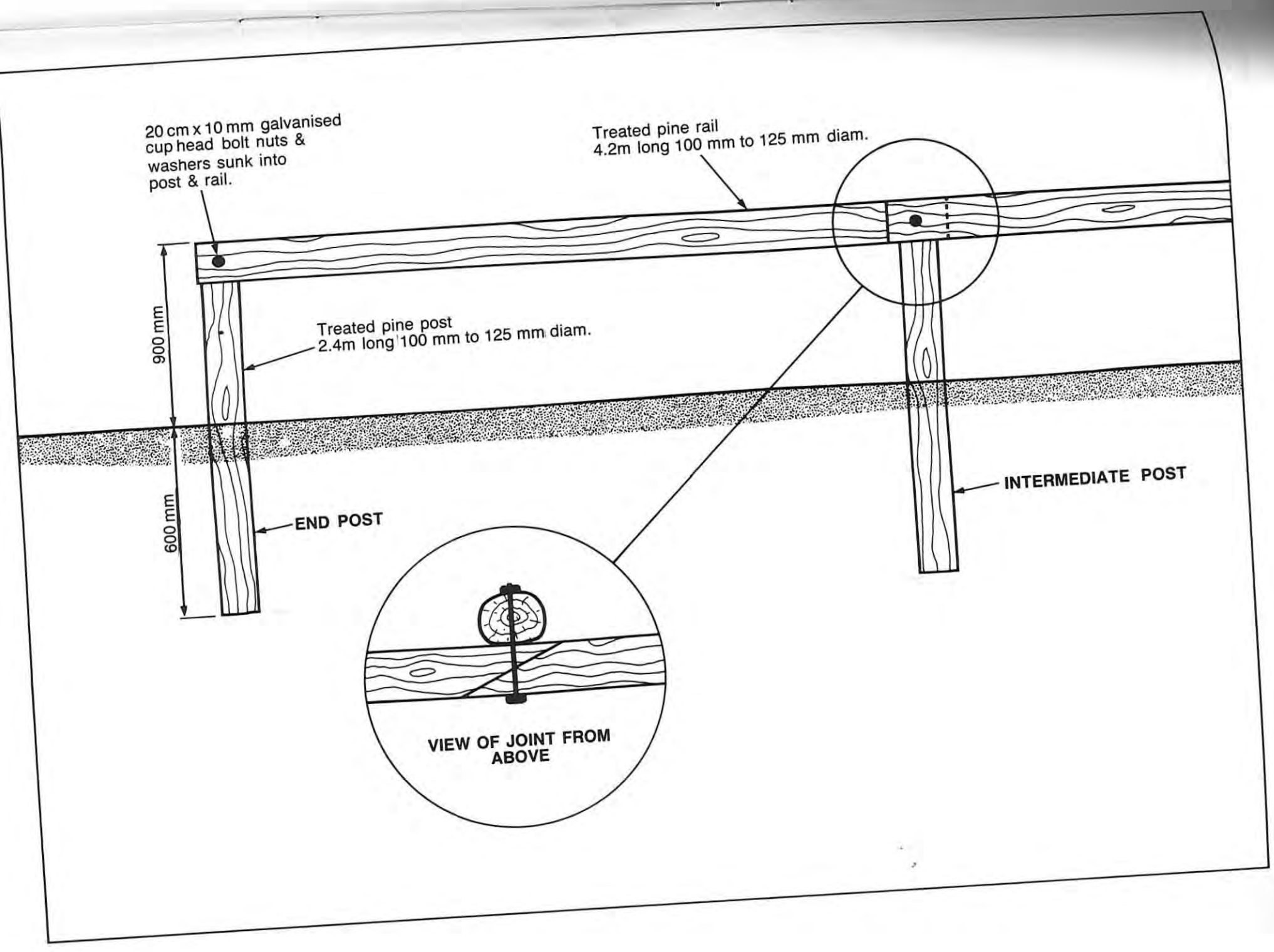


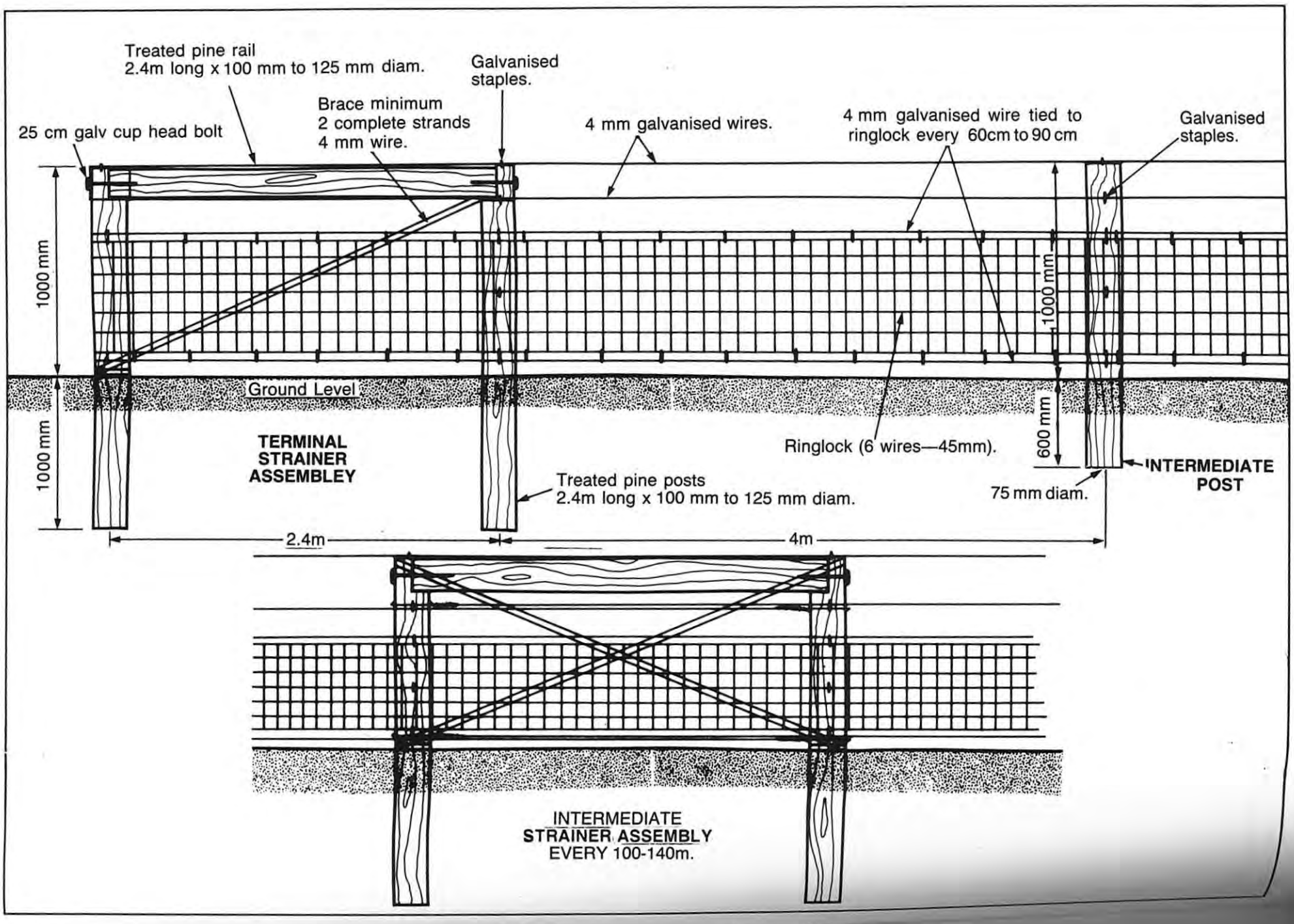
Appendix 4 Typical car park design.

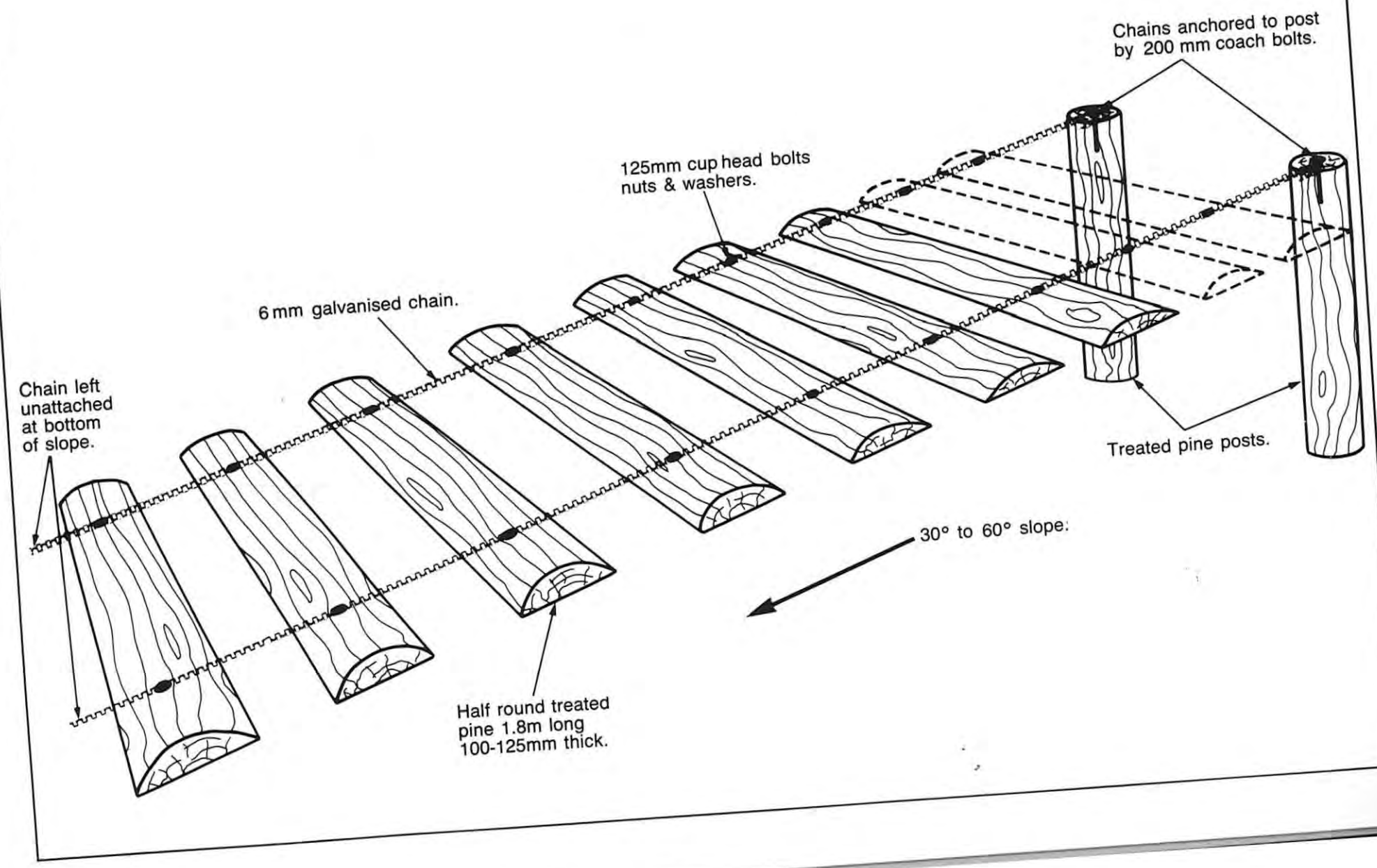
Appendix 5 Post and wire fence

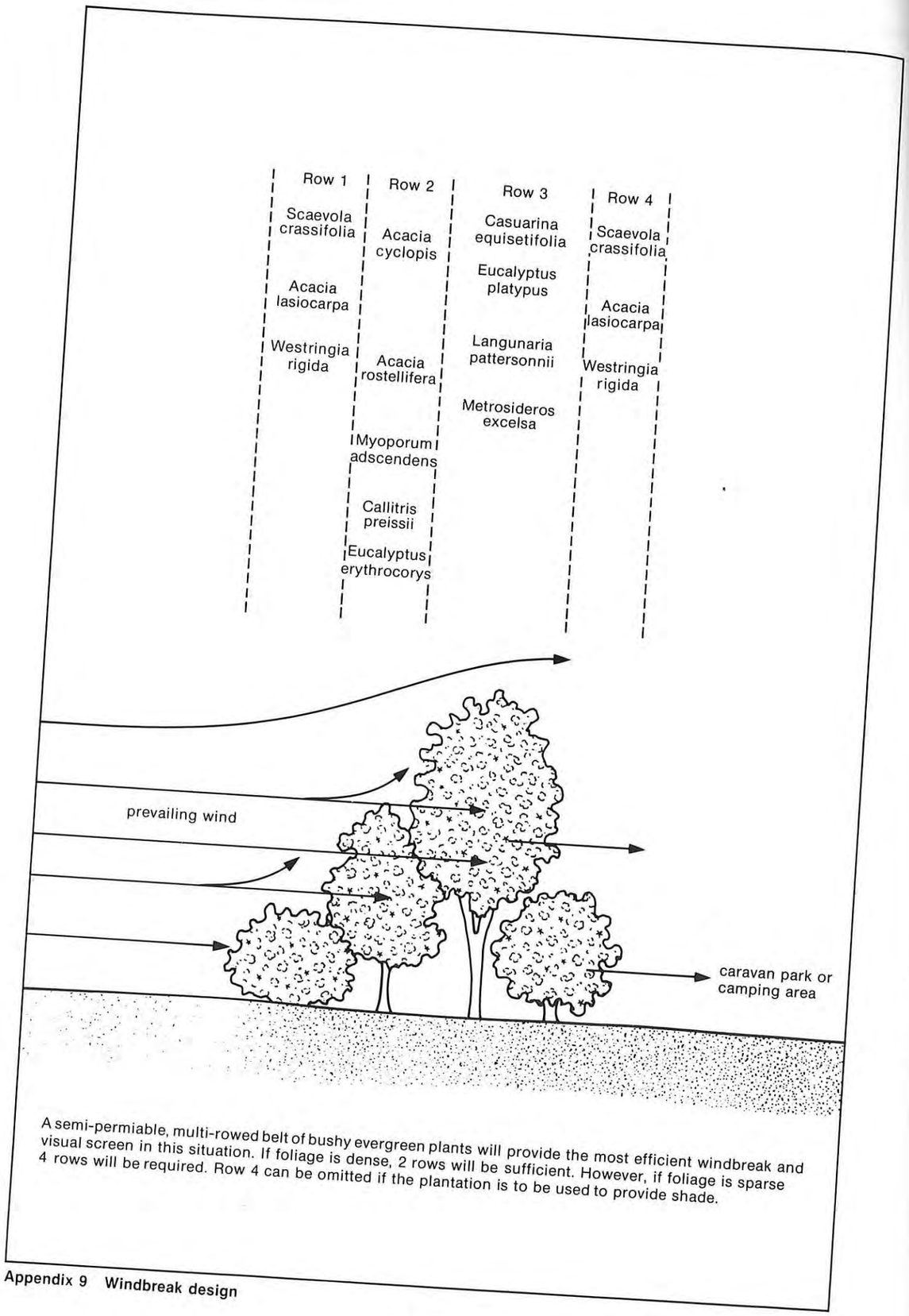


Appendix 6 Post and rail fence




Treated pine rail
2.4m long x 100 mm to 125 mm diam.
Galvanised staples.
Brace minimum
2 complete strands
4 mm wire.
25 cm galv cup head bolt
4 mm galvanised wires.
4 mm galvanised wire tied to ringlock every 60cm to 90 cm
Galvanised staples.
1000 mm
1000 mm
Ground Level
1000 mm
600 mm
TERMINAL STRAINER ASSEMBLEY
Ringlock (6 wires—45mm).
INTERMEDIATE POST
Treated pine posts
2.4m long x 100 mm to 125 mm diam.
75 mm diam.
2.4m
4m
INTERMEDIATE
STRAINER ASSEMBLY
EVERY 100-140m.


Chains anchored to post by 200 mm coach bolts.
125mm cup head bolts nuts & washers.
6 mm galvanised chain.
Chain left unattached at bottom of slope.
Treated pine posts.
30° to 60° slope.
Half round treated pine 1.8m long 100-125mm thick.



A semi-permiable, multi-rowed belt of bushy evergreen plants will provide the most efficient windbreak and visual screen in this situation. If foliage is dense, 2 rows will be sufficient. However, if foliage is sparse 4 rows will be required. Row 4 can be omitted if the plantation is to be used to provide shade.

Appendix 9 Windbreak design