Chapter 3

DESCRIPTION OF THE REGION

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Abstract

Geology and landforms

Permian to Mesozoic sedimentary rocks are overlain by thin layers of Triassic and Jurassic sandstones in the Lesueur uplands and by Quaternary and Recent sediments on the coastal plain. The ancient sediments have been distorted by a series of roughly north-south trending fault lines, exposing examples of Triassic and Jurassic rocks. Thus the rugged uplands have a variety of interbedded rock types, including sandstones, siltstones, shales and coal. Laterite formed as a fossil soil horizon over undulating land surfaces during the Tertiary and Quaternary, which have been eroded leaving lateritic upland residuals, some in the form of flat-topped mesas (e.g. Mt Lesueur, Mt Michaud). The Coastal Belt has a series of dunes of varying ages, some underlain by limestone, and with a chain of salt lakes and freshwater springs parallel to the coast.

A sequence of landforms in the Lesueur Area may be recognised from the coast inland: Quindalup Dunes bounded by a Salt Lake Complex, Spearwood Dunes, Bassendean Dunes bounded by the Gingin Scarp, Peron Slopes, Lesueur Dissected Uplands, Gairdner Dissected Uplands, Banovich Uplands, and Bitter Pool Rises.

Soils

Soils on the uplands are an extremely complex mixture of siliceous sands, lateritic gravels, yellow duplexes, yellow massive earths and brown mottled cracking clays. The Coastal Belt has yellow and brown siliceous sand, sometimes over aeolinite, with shallow calcareous and gypsiferous soils on the salt lakes.

Climate

Lesueur has a typically Mediterranean climate of hot, dry summers and cool wet winters, with a moderately reliable rainfall (550 mm at Jurien, 620 mm at Mt Lesueur).

Drainage

Three major youthful drainage systems have their headwaters in the Lesueur Area - the Hill River (with Munbinea Creek as the major tributary), Cockleshell Gully and Stockyard Gully. In addition, one arm of Coomallo Creek (also a tributary of the Hill River) has mature tributaries arising in the eastern end of the Lesueur. The Lesueur Area protects the upper sections of these catchments in a natural state, allowing them to be used for "bench mark" studies applicable to catchment management issues. Flow in these drainage lines is seasonally intermittent, but permanent water occurs in some pools.

3.1 LAND TENURE

The Lesueur Area straddles the boundary between the Shires of Dandaragan and Coorow. It consists of land with the following tenures (Figure 3.1).

Reserve no. 15018, "Horse Breeding", not vested, excluding the coastal section west of the proposed coastal highway, approx. 15 000 ha.

Part reserve no. 24496, "Protection of Flora" (The "Beekeepers reserve"), not vested, approx. 3 600 ha

Reserve no. 24275, "Educational Purposes (University of Western Australia)", not vested, 789.5 ha.

Reserve no. 1223, "Water and Stopping Place", vested in the Shire of Dandaragan, 259 ha.

Reserve no. 968, "Stopping Place for Travellers", vested in the Shire of Dandaragan, 239 ha.

Part Stock Route (Road no. 301), approx. 1050 ha.

Part reserve no. 35593, "Gravel", vested in the Shire of Dandaragan, 348 ha. Much of this reserve is not required for gravel extraction and a boundary needs to be negotiated.

Reserve no. 35594, "Protection of Flora", not vested, 55.7 ha.

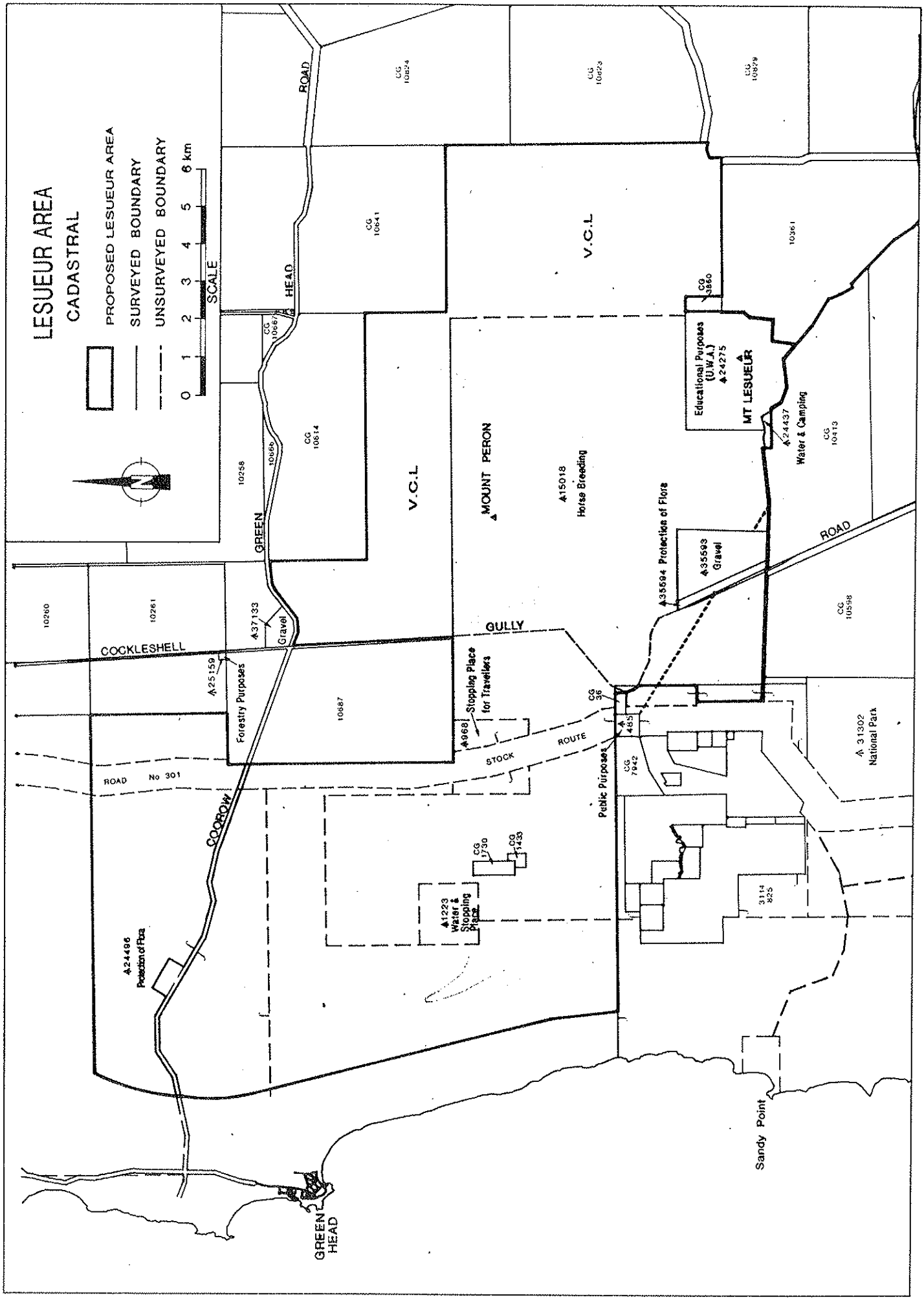

Figure 3.1
Cadastral map of the Lesueur Area

Reserve no. 24437, "Water and Camping", not vested, 22 ha.

Vacant Crown land to the north and east of reserve 15018, approx. 5 400 ha.

Victoria Locations 1433 and 1730, freehold land, 60.7 ha. The owner of this land has agreed to swap it for Crown land outside the Lesueur Area.

Parts of pastoral lease 3114/825 (Cockleshell Gully), 200 ha, (the owner has agreed to swap this land for Crown land outside the Lesueur Area) and vacant Crown land between Victoria location 10598 and pastoral lease 3114/825, 20 ha. This land will connect the Lesueur Area with the small Drovers Cave National Park of 2 680 ha.

The total area of the Lesueur Area is about 27 493 ha.

3.2 GEOLOGY

The Lesueur Area occupies part of the Perth Sedimentary Basin, the geology and geomorphology of which were described by Playford *et al.* (1976). The surface geology of the Hill River 1:250 000 Sheet has been mapped by Lowry (1974). The underlying sediments are Permian to Mesozoic. These ancient sediments have been distorted by a series of roughly north-south trending fault lines and mostly down thrown to the east as much as 2000 m each. Subsequent erosion has exposed examples of most Mesozoic rocks that were laid down in this area. A transect from west to east crosses progressively younger sediments, which are, to varying degrees, weathered or covered by shallow Quaternary deposits.

None of the Permian sediments is exposed in the Lesueur Area, being covered by thin layers of Triassic rocks and Quaternary and Recent sediments of the Coastal Plain. The Beagle Fault, which can be recognized at the surface near Diamond of the Desert Spring, divides the Permian deposits from the Triassic Lesueur Sandstone. The latter, a generally coarse grained sandstone, is exposed in the Lesueur Area, especially on some breakaway slopes south of Mount Peron.

The Lesueur and Peron Faults divide the Lesueur Sandstone from the Jurassic Cockleshell Gully Formation. Both of the latter's Members, the Cattamarra Coal Measures Member and the Eneabba Member, are exposed in the Lesueur Area. A variety of interbedded rock types occur here, varying from sandstones, siltstones and shales to coal. Relatively fresh exposures of all, especially sandstone, are common. Further to the east, the Warradarge Fault separates the Cockleshell Gully Formation from the lower Jurassic portion of the Yarragadee Formation. This mainly sandstone and siltstone Formation is only sparingly exposed in some breakaways, both inside and outside the Lesueur Area.

Laterite, an apparently fossil soil horizon, formed over an undulating but subdued land surface during the Tertiary and Quaternary Periods. The remains of this are to be seen as lateritic upland residuals. Erosion of the intervening areas has contributed towards alluvial, colluvial and swamp deposits. The majority of the sediments in the Lesueur Area are beach or marine deposits. In the Coastal Belt (Figure 3.2) there is a series of dunes of different ages which have undergone varying degrees of leaching since deposition.

3.3 LANDFORMS

Playford *et al.* (1976) recognised two major physiographic regions in the Lesueur Area; the Swan Coastal Plain and the Arrowsmith Region (Figure 3.2). For the Lesueur Area we have divided these two into nine landforms, described here from west to east.

The Swan Coastal Plain has been divided into four units.

1. The Quindalup Dune System (McArthur and Bettenay 1960), comprises Holocene shorelines and dunes, extending inland for about 2 km. The Quindalup dunes are calcareous and some are mobile.

2. The boundary between the Quindalup and Spearwood Dune Systems is generally marked by a series of lakes, termed here the Salt Lake Complex. These are essentially saline but also include gypsiferous and calcareous deposits. On their eastern margin, freshwater springs and swamps occur.

3. The Spearwood Dune System (McArthur and Bettenay 1960) is carbonate rich, Pleistocene, and probably of marine origin. These dunes have lithified in places, forming Pinnacles or Tombstones (Tamala Limestone) covered by varying thickness of leached, yellow and brown quartz sand. Numerous caves have developed in this Limestone. The most well known (Drover's Cave, Stockyard Gully Cave and Weelawadji Cave) occur in other conservation areas.

4. The Bassendean Dune System (McArthur and Bettenay 1960) is situated to the east of the Spearwood Dunes. In this area it is very narrow (about 2 km at its widest) and at its northern limit. It is a Pleistocene shoreline deposit and comprises dunes with some small swamps. The Gingin Scarp, a Pleistocene marine erosion feature, has been considerably deflated in this area, and the

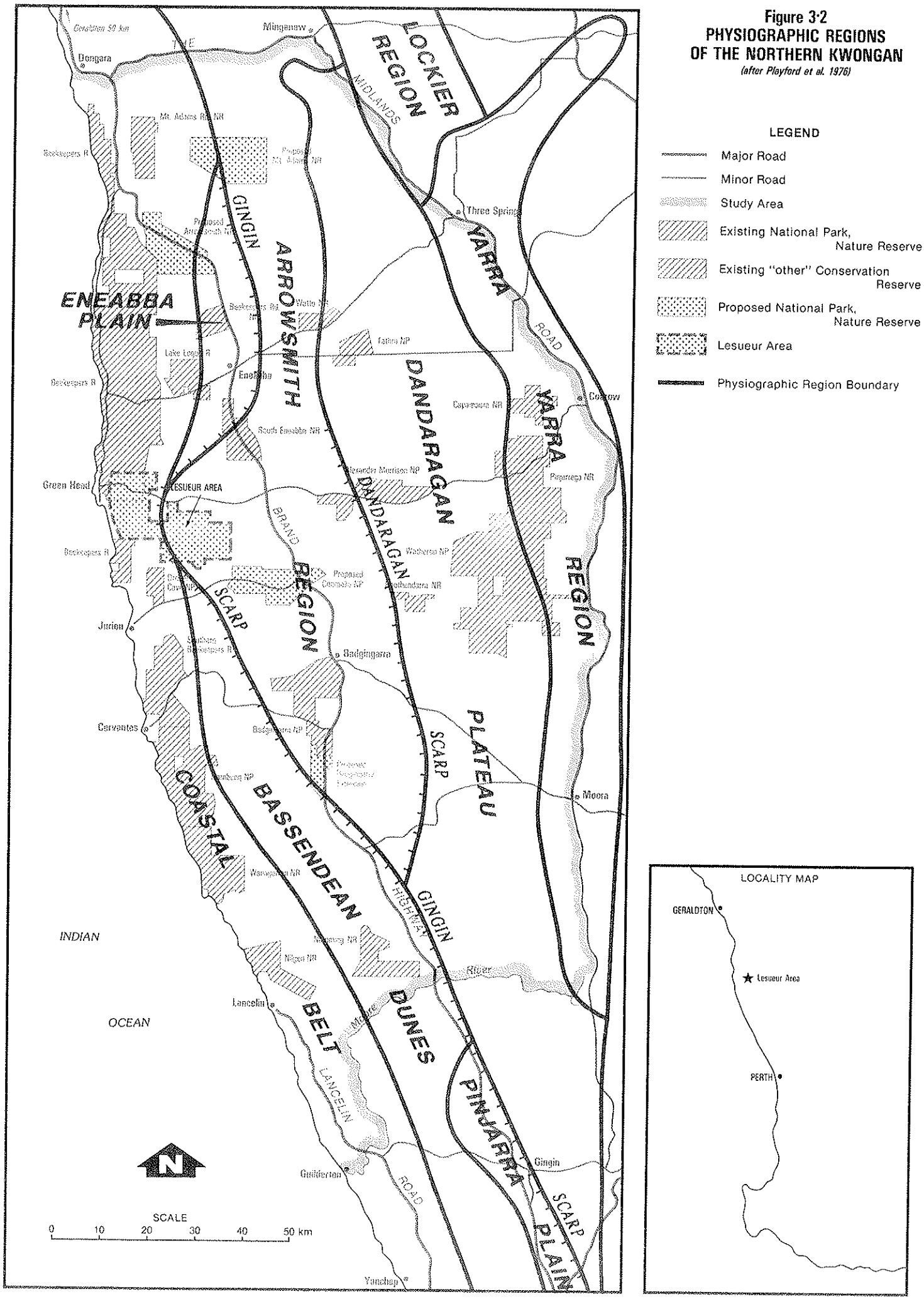

Figure 3·2
PHYSIOGRAPHIC REGIONS OF THE NORTHERN KWONGAN
(after Playford et al. 1976)

LEGEND

- Major Road
- Minor Road
- Study Area
- Existing National Park, Nature Reserve
- Existing "other" Conservation Reserve
- Proposed National Park, Nature Reserve
- Lesueur Area
- Physiographic Region Boundary

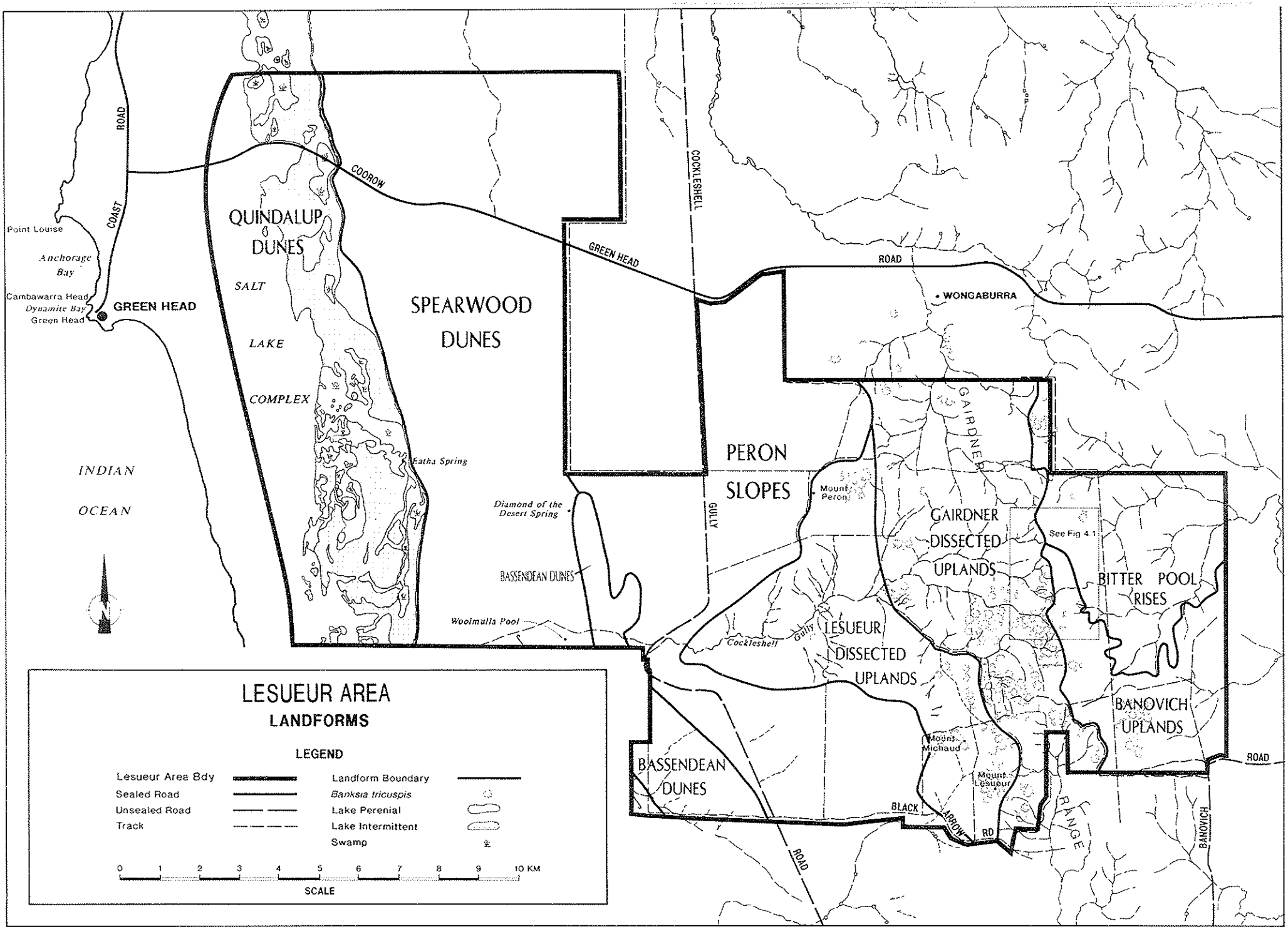

Figure 3.3
Landform map of Lesueur Area

products have contributed to the Bassendean Dune System. In this area dunes development is only slight.

The Arrowsmith Region is separated from the Swan Coastal Plain by the Gingin Scarp. Generally speaking, the Arrowsmith Region is the eroded remnants of the Tertiary land surface. It has residual laterite and sand covered uplands with mainly mature valley forms incised into it. Finkl (1979) described this type of land surface as an Incipient (Lateritic) Etchplain. Several distinct units can be recognized here, relating mostly to the unique local landscapes.

Within the Lesueur Area, the Arrowsmith Region has been divided herein to five units (Figure 3.3). The soil associations of Martinick and Associates (1989a) were used in part as a basis for this division.

5. The Peron Slopes occupy the western slopes of the uplands and include the deflated Gingin Scarp. Exposed are a complex of laterites, sands and colluvium. This is typical of much of the Arrowsmith Region outside the Lesueur Area.

6. The Lesueur Dissected Uplands, which include the prominent breakaway slopes of Cockleshell Gully, lie west of the Peron and Lesueur faults. The sandstones, and occasionally siltsones of the Lesueur Sandstone, are exposed in places. The breakaways here are up to 100 m high and, together with the conspicuous mesas (Mount Lesueur and Mount Michaud), flank the mature, U-shaped Cockleshell Gully.

7. The Gairdner Dissected Uplands are a heavily dissected landscape associated with erosion by Cockleshell Gully and Munbinea Creek. The character of the area owes much to the rapid transition of rock types and the generally steeply dipping sediments. The margins are frequently formed by steep cliff faces and breakaways, and there are prominent hills and ridges of resistant sandstone above the central drainage lines which have been incised into softer sediments. This has created a diverse topography (Figures 3.3 and 3.4). Dissected laterite-capped hills and youthful valleys are a feature of this area. Laterite-capped hills are of limited area in this unit but the Jurassic sandstone, having resisted erosion, forms characteristic breakaways. The uplands are clothed with shallow lateritic gravels and duricrust and have few areas of grey or yellow sand. Most drainage lines are youthful and V-shaped. Upper tributaries are mainly formed by upstream creep. Here, especially, they have exposed Mesozoic sediments.

8. The Banovich Uplands lie to the east of the Gairdner Dissected Uplands and south of the Bitter Pool Rises (Figure 3.3). They consist of old undulating lateritic uplands, including mesas, cuestas, and their slopes. Mature U-shaped valleys with their sandy flanks are prominent.

9. The Bitter Pool Rises are situated to the north of the Banovich Uplands and to the east of the Gairdner Dissected Uplands. They have a gently undulating landscape of low hills and rises. There are few prominent upland areas. Drainage by a mature tributary of Coomallo Creek is sluggish.

3.4 SOILS

The soils of the Lesueur Area will be described in the context of the landforms identified above (Figure 3.3). Sources of information are Northcote *et al.* (1967), who described the soils of south west Australia in very general terms, and E. Bettenay (for Martinick and Associates 1989a) who described the soils of part of the Arrowsmith Region.

1. Quindalup Dune System soils are calcareous sands in the dunes with some acid peaty soils in swales.

2. The Salt Lake Complex includes shallow calcareous and gypsiferous soils over aeolinite.

3. Spearwood Dune System soils are mainly grey, yellow and brown siliceous sand over aeolinite.

4. The Bassendean Dune System has leached siliceous sands with an organically enriched surface layer; a pan may be present near the surface.

5. The Peron Slopes were mapped as Banovich Association by Martinick and Associates (1989a).

6. The Lesueur Dissected Uplands landform was also mapped as Banovich Association by Martinick and Associates (1989a). It has, however, few upland residuals. Consequently the soils are mainly shallow colluvial sands and gravels with some areas of yellow sandy clays over weathered sandstone.

7. The Gairdner Dissected Uplands landform is virtually equivalent to the Gairdner Soil Association.

8. The Banovich Uplands is part of the area mapped as the Banovich Association.

9. The Bitter Pool Rises landform is equivalent to the Bitter Pool Association.

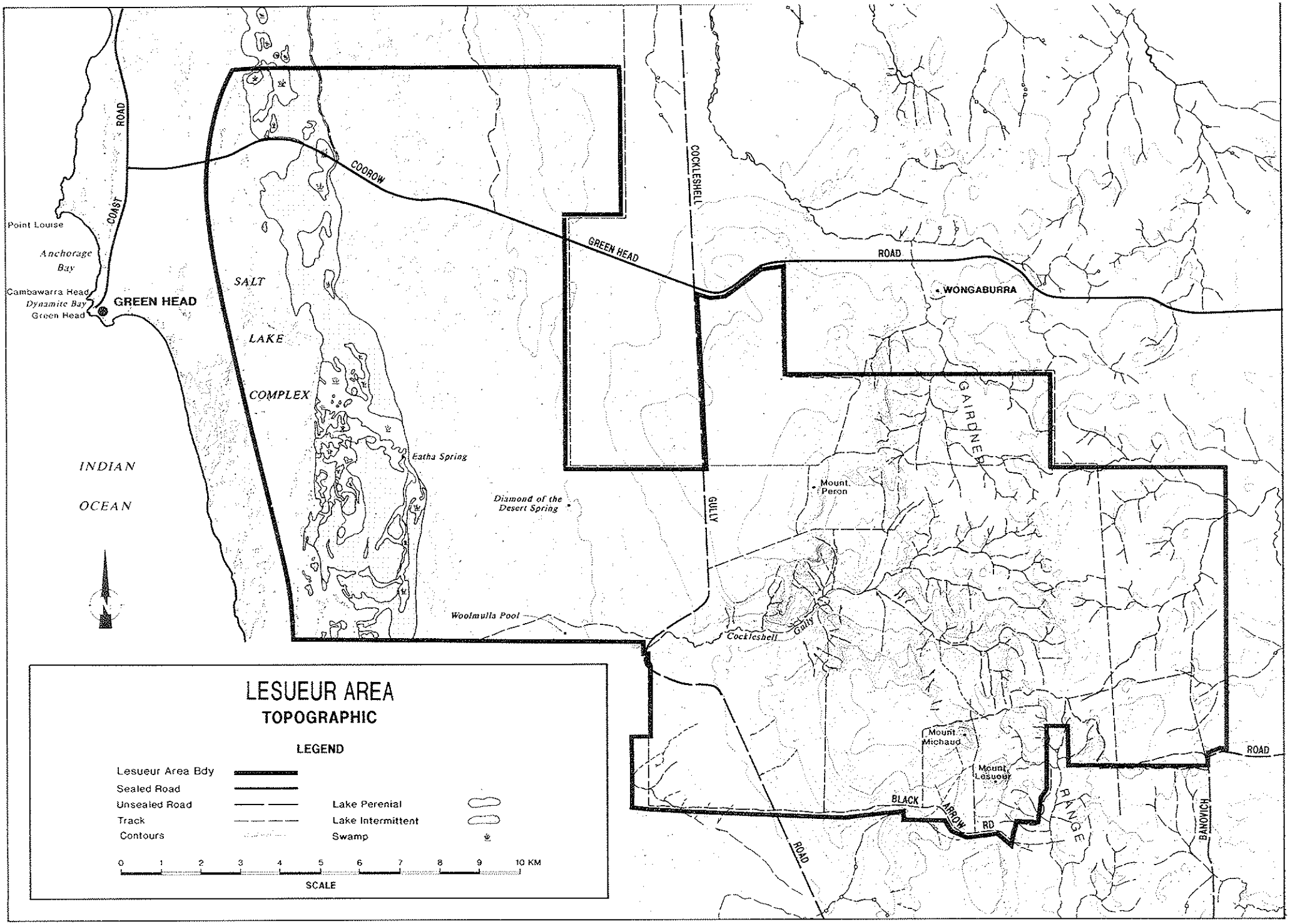

Figure 3.4
Topographic map of Lesueur Area

The following is a brief description of the soil associations of Martinick and Associates. (1989a).

1. The Banovich Association occurs on the old, undulating lateritic uplands, including mesas (such as Mt Lesueur), cuestas, and their slopes. Predominantly it consists of lateritic gravelly soils. Bleached sands with gravel pans are common on the lower margins where colluvial quartz sands have accumulated over lateritic materials. The main depressions and sandy drainage lines have bleached sands with a coloured B horizon. Shallow yellow duplex soils occupy pediments and backslopes.

2. The Bitter Pool Association occurs in the headwaters of Coomallo Creek on a gently undulating landscape. It consists of gravelly, yellow duplex soils on low hills and rises. On lower slopes and in broad drainage lines sink holes and linear gilgais are developed and there is a complex of soils including yellow duplex soils, yellow massive earths and brown, structured cracking clays.

3. Very little of the Coomallo Creek Association occurs within the boundaries of the Lesueur Area. It occurs on a tributary of Coomallo Creek. The landscape is generally subdued with drainage incised into a low lying area with some low north-south trending gravelly or stony ridges. The main soils are hard, yellow duplex soils.

4. The Gairdner Association occurs in a dissected landscape associated with erosion by Cockleshell Gully and Munbinea Creek. The margins are frequently formed by steep cliff faces and breakaways, and there are prominent hills and ridges of resistant sandstone above the incised central drainage lines. Because of this diverse topography, soils also vary considerably in their morphology. Shallow stony brown siliceous sands occur on sandstone ledges and ridges, with shallow ironstone gravelly sands on the upper pediments below breakaways. Some deeper, bleached sands with a coloured B Horizon have accumulated in pockets. In the lower areas there is a complex of soils ranging from duplex soils to yellow massive earths and brown, mottled cracking clays. This complex is associated with sink holes and gilgais, and some tunnel erosion occurs near incised drainage lines. Stones and gravels occur throughout the soils and stone lines are frequently present in the bleached and hard setting zone immediately above the clayey subsoils.

3.5 CLIMATE

The Lesueur Area has a Mediterranean climate of hot, dry summers and cool, wet winters with a moderately reliable rainfall. Climatic data for the district are limited because there are few recording stations.

At Jurien, on the coast about 18 km south west of the Lesueur Area, the annual average rainfall is 550 mm, occurring mostly (57.1%) during June to August. The Gairdner Range appears to have an oreographic effect on rainfall since the annual average at Padbury Farm, on Cockleshell Gully just outside the proposed reserve, is 622 mm (records from 1951 - 1974, Chapman 1977). Isohyets from the Bureau of Meteorology 1968 climatic survey of the region suggest an annual mean rainfall at Mt Lesueur of around 620 mm.

The mean maximum temperature for the hottest month varies from 30.5° near the coast to 32.5°C at the inland edge of the Lesueur Area, while the mean minimum for the coldest month varies from 9° to 10°C. Annual average potential evaporation is about 1780 mm (Froend 1987).

As a consequence of the dissection of the landscape, particularly in the eastern part of the Lesueur Area, there is considerable variation in microclimates. Data in Griffin and Hopkins (1985a) show that the north facing slopes of Mt Lesueur receive more direct sunshine than southern facing slopes. They are therefore drier and do not support the same relict plant populations that are found on southern slopes.

3.6 DRAINAGE

The drainage pattern in the Lesueur Area is intricate and complex. It appears that there have been significant changes in drainage patterns since the Pleistocene. Some of the ancient drainage lines have been truncated, and in some the flow has even been reversed. The youthful patterns are clearly a product of rejuvenation.

Three drainage systems have their headwaters in the Lesueur Area (Figures 3.4 and 3.5). These are the Hill River (with two tributaries), Cockleshell Gully and Stockyard Gully. Cockleshell Gully, Stockyard Gully and Munbinea Creek (a tributary of the Hill River) have similar characteristics. They all have youthful upper tributaries and flow through broad mature valleys which have narrow incised drainage channels. One arm of Coomallo Creek (also a tributary of the Hill River) rises in the area. Unlike the others, the upper tributaries are predominantly mature. Beyond the Lesueur Area the drainage channels are incised. Another similar, but minor, drainage line rises between

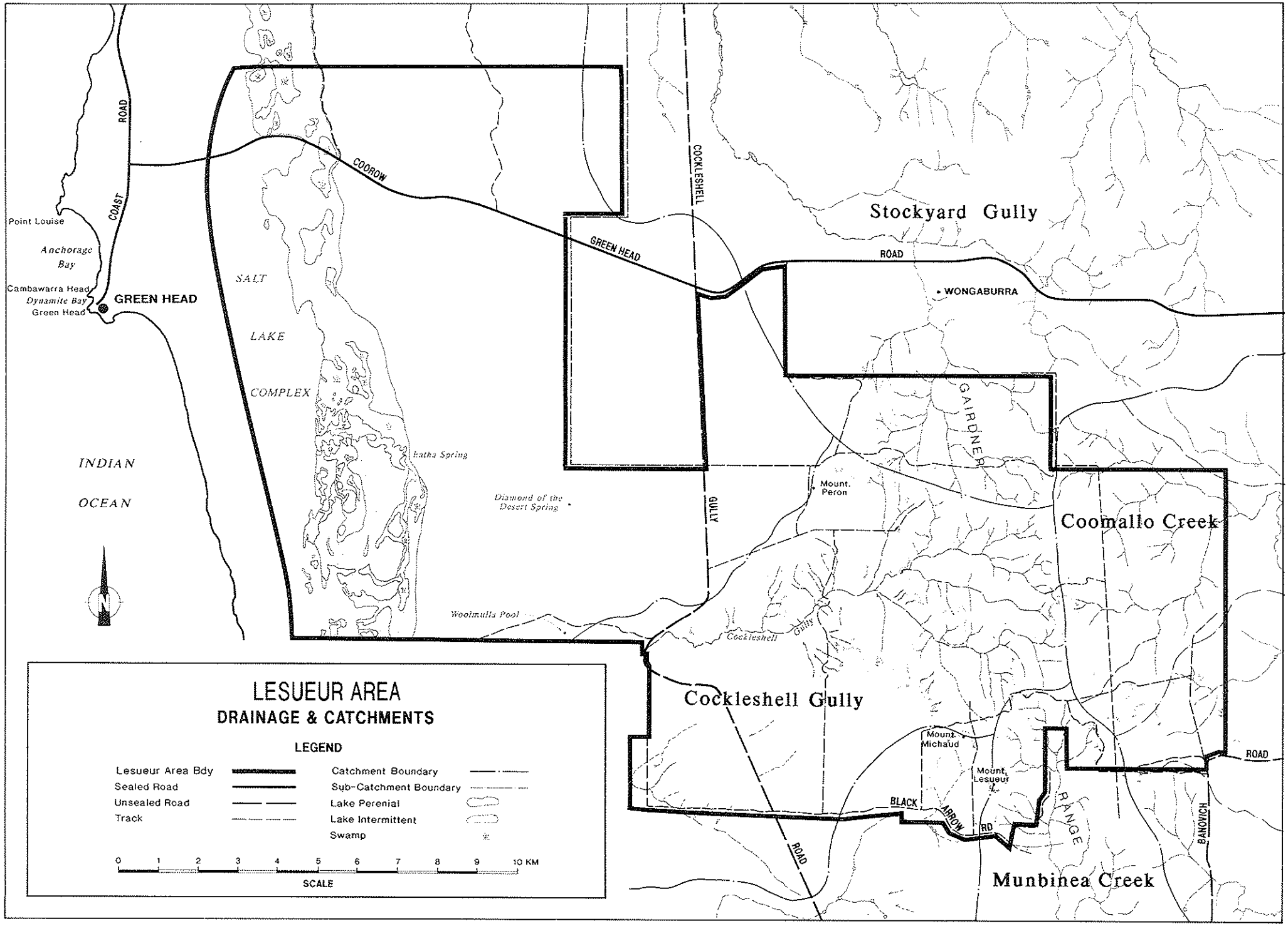

Figure 3.5 Drainage and catchments map of Lesueur Area

Mt Lesueur and Mt Michaud and flows through Bere Bere Spring to the south west.

The flow in these drainage lines is seasonally intermittent. Permanent water occurs in some pools.

An important feature of the Lesueur Area is that it protects the upper portions of four catchments in an undisturbed state. Such protection is valuable in studies of catchment hydrology and management, providing "bench marks" for disturbed or degraded catchments.

Neither Cockleshell Gully nor Stockyard Gully discharge into the sea. The former flows into salt lakes and the latter into a cave (Stockyard Gully Cave) and, it is believed, eventually into the sea via an underground route. The Hill River flows into the sea south of Jurien.