MULGA ROCK
FLORA, FAUNA AND RADIOECOLOGY SURVEY

REPORT PREPARED FOR
PNC EXPLORATION (AUSTRALIA) PTY LTD

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1.0 SUMMARY AND RECOMMENDATIONS

The vegetation, vascular flora and vertebrate fauna of PNC (Australia) Pty Ltd's Mulga Rock project area was surveyed between 17 June and 2 July 1985. Although many identifications were based upon field recognition, most were based upon specimens collected in the biological survey area which were then identified in Perth, and elsewhere, by members of the survey team and by specialists in particular groups. Samples for radionuclide and heavy metal analyses were collected and subsequently prepared for analyses and stored.

Four formations, comprising a total of 28 plant associations, and three vegetation complexes were identified in the survey area. The dominants in the formations – woodlands, mallees, scrubs and steppes – are marble gum (*Eucalyptus gongylocarpa*), narrow-leaved mallee (*Eucalyptus leptophylla*), *Acacia jutsonii* and porcupine grass (*Triodia basedowii*); their associations constitute more than 80% of the vegetation in the survey area.

The rarest vegetation in the survey area, i.e. associations represented by only one, two or three small stands, include black oak woodland (WO), *Eucalyptus* sp. woodland (WE), varnished claypan complex (V) and saltbush dwarf scrub (S7). Only the saltbush dwarf scrub occurs in a major orebody area, at Site 10.

One hundred and fifty-seven species, subspecies and varieties of vascular plants are recorded for the survey area. They include four species regarded as rare, geographically restricted or poorly collected : *Thryptomene* sp., *Persoonia* sp., *Dicrastylis nicholasii* and *Pityrodia loricata*. None of the species is gazetted as rare.

Twenty-eight species of birds were recorded, eight species of reptiles were collected in the trapping sites, 11 species of small mammals were collected and four species of larger mammals were identified in the survey area. All but one species of small mammals which might be expected to occur in the region were caught. *Antechinomys laniger* was the species not trapped. In addition, one species not previously recorded in Western Australia, the Sandhill Dunnart (*Sminthopsis psammophila*) was also caught. This species and one other, the Mulgara (*Dasycercus cristicauda*), are gazetted as rare or otherwise in need of special attention.

Thirteen additional species of reptiles were recorded during a subsequent survey by Dr. D. King.

Eighty-six samples of 14 species of plants and 96 species of small mammals were collected in the 14 Trapping Sites for preparation for radionuclide and heavy metal analyses. Ten Grey Kangaroos were also collected in the survey area for analyses. The plant samples were oven-dried, ground and stored in sealed plastic bags, while the mammal samples were ashed and stored. The samples collected for radionuclides and heavy metal analysis should be stored and not analysed yet because analytical methods are likely to improve. All samples should be analysed simultaneously, but this is not necessary until there is a more definite proposal to commence mining.

It is recommended that if and when a decision is made to proceed with mining, the following field work be undertaken before mining begins. Seasons with favourable conditions provide the ideal time to carry out this work, but it will not be essential until there is a definite proposal to commence mining. However, delaying this work introduces the possibility that bad seasons will make the smaller animals and plants in flower very difficult to find.

- As the condition of flowering at the time of the June 1985 survey was unexpectedly poor, the completeness of the vegetation and flora survey should be improved by collecting flowering herbarium specimens and thorough field notes of most eucalypts and species that do not seem to be on the current list of species. Such a survey should be done during a period of good flowering.

- Further work is required to better assess the rarity status of the four species of possibly sensitive plants. Ideally, this work should be undertaken during a period of good flowering and, preferably, before mining begins. Surveys for the plants should be done in the areas where they were found during the June 1985 surveys, in the proposed mining operations sites and in other, similar habitats that will not be affected by the mining, preferably both in the survey area and in the Queen Victoria Spring Nature Reserve, nearby.

- No further work is required on birds, but any additional observations and collections of amphibians and reptiles, particularly snakes, would be useful. No specific study is required.

- Further work is required to demonstrate that the very rare Sandhill Dunnart (*Sminthopsis psammophila*) is widespread away from any proposed mine, preferably in a secure reserve such as Queen Victoria Spring Nature Reserve. It is also important to establish whether or not the preferred habitat of the species is wide-spread.

- Further work is required to establish the relative abundance of the various small mammal species in absolute numbers and in relation to the different habitats. This will be required to select the most appropriate monitoring species.

2.0 OBJECTIVES

W.G. Martinick & Associates Pty Ltd undertook to carry out a survey of the PNC Exploration (Australia) Pty Ltd Mulga Rock lease area that would include the:

- provision of biological samples for sampling as a baseline against which any future dispersal of radionuclides and heavy metals can be measured, and, as necessary prerequisites and concomitants,
- mapping of the area into plant communities and identification of the plant species present, and
- identification of the animal species present and establishing of which animal communities are present.

In accordance with the brief the report was to contain:

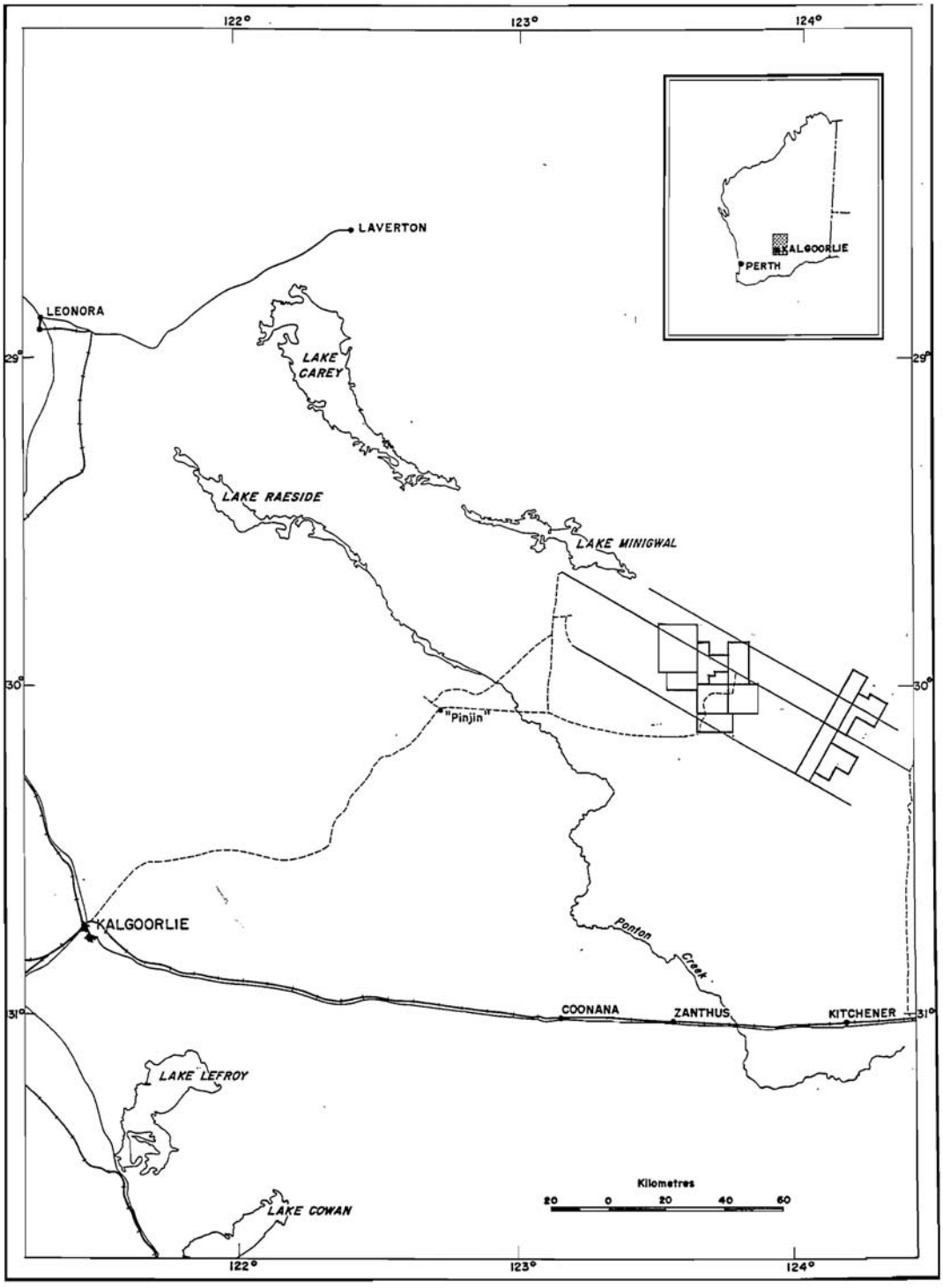
- vegetation maps drawn at scales of 1:50,000 and 1:10,000, the former for areas of lesser interest but covering the entire project area, and the latter for areas of greater interest within the exploration leases,
- lists of the species of plants and animals found and identified,
- discussions, in local and regional contexts, of the species and communities, their conservation significance and their ecological relationships to fire history, soils and topography, and
- a detailed review of the ecological basis of the radioecology study, the sites sampled, the methods used and recommendations for storage of samples.

3.0 INTRODUCTION

3.1 Location

The Mulga Rock project area is about 230km east-north-east of Kalgoorlie, in the south-western corner of the Great Victoria Desert. The biological survey area is roughly rectangular and is about 15km north of Queen Victoria Spring Nature Reserve at their closest points (Figure 1).

Figure 1: Mulga Rock Project Location Map



3.2 Climate

There are no long-term temperature and rainfall records for the survey area or its vicinity, but Beard (1975) concluded that records from the goldfields, sheep stations and points along the Trans-Australian Railway provide a general description of the area's climate. His maps place the survey area in the 150mm-200mm rainfall belt, with a desert climate having a non-seasonal rainfall. Temperatures probably range between approximately -3° C and 48° C, with the highest temperatures being in January and February and the lowest in July and August.

Weather data being recorded at the site by PNC Exploration (Australia) Pty Ltd will eventually provide much more local, specific and accurate information about the climate.

3.3 Physiography

Current exploration by PNC geologists is providing a large scale, though unpublished, record of the topography and geology of the survey area. Beard (1975) summarised earlier physiographic accounts and 1:1,000,000 to 1:250,000 scale geological maps that have been prepared for the region. According to Beard (1975) the survey area is near the eastern edge of the Yilgarn Block, west of the Eucla Basin.

The survey area is, basically, an undulating sand plain broken up by series of sand ridges or dunes. Some of the dunes, seif dunes, are solitary, linear, long and directional. At the other end of a more or less continuous scale there are clusters of short, non-linear, often lunette dunes. To the north the sand plain merges with a laterite or sandstone upland, and in the western part there are a few small outcrops of sandstone and gneiss. Gypsum-rich pockets occur in the western part, in areas east of the outcrops. Calcrete mounds and small, loamy to clay depressions that frequently have calcrete are widespread throughout the survey area. The depressions are often associated with dunes.

4.0 METHODS

The biological survey of the Mulga Rock project area was based upon the methods described by Weston (1980) and Harold (1981) for the Argyle Diamond Project and by the Biological Surveys Committee Western Australia (1984) for the Eastern Goldfields Survey. It was modified, to fit the particular circumstances of the Mulga Rock survey, namely:

- the time available for field work (approximately 2 weeks),
- the season during which field work was done (early winter),
- the poor condition of the flora and vegetation,
- the state of knowledge of the biota (also poor), and
- the objectives of the survey (described in Section 1).

Sampling and observations were carried out in most parts of the survey area, but sites and traverses were concentrated on three orebodies: Emperor, Shogun and Ambassador. Vegetation and trapping sites are shown in the vegetation maps (accompanying figures).

4.1 Vegetation

Prior to undertaking field work, existing small area and small scale maps and descriptions of vegetation covering the survey area or other probably similar areas were studied. These included maps and reports by Beard (1974, 1975, 1981b), Boomsma (1981), Boomsma and Lewis (1980), O'Connor (1984), Newbey and Hnatiuk (1984), Burbidge et al. (1976), McKenzie and Burbidge (1979) and Davies (1982).

Associations and association dominants that were considered likely to occur in the survey area were then listed and noted on colour aerial photographs flown at scales of 1:50,000 and 1:10,000. Unusual and anomalous areas were also noted on the aerial photographs, and potential vegetation sites were marked.

The 80 actual vegetation sites referred to in this report as "Vegetation Sites" were chosen in the field, mostly from the array of potential vegetation sites, and were observed between 17 and 26 June 1985.

Vegetation sites were selected subjectively, not randomly, so as to:

- sample the range of variation in the vegetation in terms of structure and dominant species,
- sample vegetation regenerating after fire or other disturbance as well as mature vegetation,
- replicate samples in the more widespread and diverse types of vegetation, and
- document the vegetation of fauna sample-sites, particularly the pit-trap-lines.

At most vegetation sites a partial list of plant species was compiled together with subjective estimates of height and percentage canopy cover of the dominant species and a brief description of the physical environment. Photographs were taken at most sites.

Most sites were situated along exploration tracks and were visited in a 4-wheel drive vehicle during traverses along the tracks. A few sites were situated between tracks and were visited by foot.

4.2 Flora

Herbarium specimens were collected during the field work, between 17 June and 26 June 1985, as vouchers for vegetation descriptions and as the basis for the list of plant species. Collecting was concentrated on plant community dominants, on species in flower and on species that might be rare or have restricted geographical distributions. In most cases duplicate sets were collected. The specimens were pressed in the field but were dried at the Western Australian Herbarium in South Perth.

Most of the specimens were determined by the collector by comparing them with collections in the Western Australian Herbarium, but specimens in particular groups, such as *Eucalyptus*, *Thryptomene*, *Baeckea*, *Acacia*, Epacridaceae and *Eremophila*, were identified by specialists in those groups.

4.3 Fauna

4.3.1 Site selection

Fauna collecting and observations were carried out primarily on 14 sites, referred to in this report as "Trapping Sites" in order to distinguish them from vegetation sample sites. These were selected to be representative of the range of vegetation types identified on and near the orebodies. Other factors, including soil and topography, were considered if they were thought to be useful in identifying the full range of habitats. The major types were replicated. The selection of sites was restricted by the requirements that they be on or near the orebodies and divided approximately equally between the orebodies, as this was part of the design of the radionuclide and heavy metals study. Some other general areas were rejected because they were too distant from the orebodies.

4.3.2 Capture of Amphibians, Reptiles and Mammals

Small animals were caught in pit traps and Elliot traps. The pits were PVC pipes (160 x 550mm) buried to surface level along a drift fence 45m long. Seven small Elliots and pits were used at each site. Three large Elliots or cage traps were also used at each site.

Large animals were collected by shooting if they were required for radionuclide analyses; otherwise they were recorded as observations. Bats were collected by mist-netting.

Opportunistic collecting and observations were carried out by driving (day and night), by digging (in burrows and under litter) and by searching for other evidence such as bones, tracks, diggings or faeces. Calls of animals were also recorded if they could be identified.

4.3.3 Birds

Birds were recorded opportunistically and on standardised transects (Biological Surveys Committee Western Australia 1984). The transects represented five observation periods of approximately 30 minutes at each site on five different days. No birds were collected.

4.3.4 Identification and Disposal of Specimens Collected

Birds and kangaroos were recorded by observation only and were identified in the field. All reptiles and small mammals were collected and final identifications of the collected specimens were made by Museum. These specimens were either retained by the museum or were prepared for radionuclide analyses. In the latter case, the unused portions of all specimens were also donated to the museum.

4.4 Collection and preparation of samples for radionuclide and heavy metal analyses

Vascular plants, small mammals and large mammals provided samples for radionuclide and heavy metal analyses. The methods used for collecting, preserving and preparing the specimens are described below.

4.4.1 Plants

Leaf samples were picked from vascular plants at each of the 14 trapping sites. Of the species sampled, six were common to most of the trapline sites (Table E-1) and four were particularly common at a few sites. Four showed signs of having been browsed, an indication that they were important food sources for mammal herbivores.

Approximately 500g of fresh leaf blade material was collected for each species at each site. Each 500g sample was a composite of collections from between five and 20 plants, usually growing close to the trapline but in a few cases as far as 200m from it. The sources of the leaves ranged from ground level herbaceous plants to mallee branches 3-4m above ground. The collections were put into paper bags, then dried at the PNC campsite the same day.

The samples were air-dried in on-site rooms with air-conditioners set on the hot cycle. They were subsequently oven-dried in Perth in CSIRO plant-drying ovens. The samples were then ground in a stainless steel mill, re-dried and sealed in plastic bags.

4.4.2 Small Mammals

One hundred and thirteen small mammals, belonging to 11 species were caught, killed and frozen whole in the field. Nineteen specimens, belonging to eight of the species, were donated to the Museum entire. Ninety-four animals belonging to nine species were prepared for ashing by skinning and by removing the intestinal tract posterior to the oesophagus. The limbs were severed transversely at the distal joints of the humerus and femur. The head was removed at the posteria margin of the skull, and the tail was removed by cutting transversely along the line of the posteria edge of the hind limbs. The remaining carcase was used as the sample.

The carcases were ashed at 400° C by Analabs in Perth and stored. They are suitable for analysis of heavy metals and radionuclides other than Po210 which has a half life of 138 days and a melting point of 254°C. Polonium levels only need to be measured if other radionuclides are present in high concentrations.

4.4.3 Kangaroos

Ten Grey Kangaroos were collected by shooting in the head or neck. Samples of heart, liver, kidney and skeletal muscle from around the femur were dissected out and frozen in the field and subsequently ashed as described for the small mammals.

5.0 VEGETATION AND HABITATS

5.1 Introduction

The habitat of any plant or animal, or population of organisms, is the site or type of site it occupies. The fundamental components of a habitat are edaphic, physiographic, climatic and vegetational. This section describes the vegetation of the survey area.

In classifying and describing vegetation two different though compatible approaches are generally taken. The first approach emphasizes physiognomic characters, especially the height and canopy density of the tallest stratum or layer, and is commonly used in small scale mapping and description without reference to the species component. The second approach is based upon the characteristic or dominant species in the vegetation and uses the names of those species or, in some cases, characteristics of their habitats. This approach is taken in large scale mapping and description and is often combined with the first approach, as in Beard's Vegetation Survey of Western Australia series.

In Western Australia two systems of physiognomic classification are widely used in the mapping of vegetation. The earlier system was devised by Specht (1970) and Specht, Roe and Boughton (1974); the slightly more recent system, by Beard (1974), is described by Beard and Webb (1974) and, more recently, by Beard (1981a). The earlier system maps the tallest stratum of vegetation without regard to the understorey, while the more recent system maps the ecologically dominant stratum (i.e. the stratum that is most abundant, densest or most productive in terms of biomass) along with reference to the taller stratum. Beard's system of classification and description has been elaborated upon by Muir (1977) and Newbey (1984), who give greater weight to understorey strata in wheatbelt and goldfields vegetation in recognition of their importance in faunal habitats.

In the Great Victoria Desert, where the porcupine grass (spinifex) hummock grass and low shrub layers are of outstanding importance and where the tree layer is usually very open, the use of Beard's system is more appropriate than the use of Specht's. Furthermore, Beard is the only one who has published maps and descriptions of the vegetation of the Great Victoria Desert (Beard 1974, 1981b), and consequently, his system is used in this report.

5.2 Vegetation Descriptions

The characteristic vegetation of the survey area is tree steppe and shrub steppe of the types that are most typical of the Great Victoria Desert (Beard 1974). The two types of vegetation grow as intergrading mosaics on the sandy plains and low profile sandridge country that constitute the dominant landscape of the Great Victoria Desert.

The components of the tree steppe are porcupine grass (*Triodia basedowii*) and marble gum (*Eucalyptus gongylocarpa*; also known as bara gum and desert gum), an attractive tree with smooth, whitish trunks mottled with patches of rough brown, flaking bark. The trees grow to 9m and more in height and are irregularly dispersed over the landscape.

The shrub steppe porcupine grass is also *T. basedowii*, but the dominant shrubs comprise a variety of species of mallees and wattles. The most common and widespread mallees are *Eucalyptus leptophylla* and *E. youngiana*. In the western part of the survey area the shrub steppe is generally distinct, but in the eastern two-thirds the shrub steppe generally merges with the tree steppe, in which the mallees and wattles occur discontinuously as layers or patches between 1m and 4m tall.

These communities and others occurring in the survey area can be grouped into six of the plant formations defined by Beard (1974). The numerical parameters that define each of the six formations, i.e. height and canopy cover density of the dominant or tallest species in the formation, are shown in Appendix A and in the section below with the names of the formations at the beginning of each. The associations in each formation are listed in Table A-1, along with photographic plate numbers and the vegetation sites (VS) and trapping sites (TS) in the survey area at which the associations were recorded (the pit-trap line vegetation at each trapping site is summarised in Appendix C). Examples of most of the associations are illustrated and described in the plates in Appendix A.

All of the major associations in the survey area, and most of the minor ones, are described below, by formation. Some vegetation complexes are also described.

The terminology used in the text below, as well as in Table E-1, is consistent with that of Beard (1974, 1981).

5.2.1 Low Woodlands

Canopy Cover: (1-) 10-30(-70)%; Dominants Height: 4->10m

Low woodlands are very minor elements, in terms of area covered, in the project area's vegetation. Some, such as mulga and the black oak low woodlands, cover extensive areas outside the survey area. Others, such as redwood, *Eucalyptus* spp. and kopi low woodlands, are poorly known. Cypress pine low woodland is widespread as small enclaves in marble gum steppe and the rarer marble gum low woodland.

5.2.1.1 Mulga (*Acacia aneura*) Low Woodland

Mulga is the predominant species in Central Australian low woodlands south of the Tropic of Capricorn (Beard 1981b), but in the survey area, as elsewhere, these "low woodlands" encompass a structural range from open forest to open scrub. The range of habitats and the variation in understorey structure and species composition are also extensive. Because mulga is often killed by fire, it has been eliminated from large areas by repeated fires.

Mulga low woodlands in the survey area are now largely restricted to a few breakaways, sandstone hills and plateaux and alluvial plains, though they were apparently once more extensive. Mulga commonly occurs as regenerating, 5m tall low woodlands and low forests, usually with the shorter, greener bastard mulga (*Acacia stowardii*). There is very little porcupine grass (*Triodia basedowii*) or any other grass or herbaceous plant in the understorey, particularly in the denser stands.

Species of *Erempohila* are more common in mulga woodland and bastard mulga scrub than in other associations in the survey area.

5.2.1.2 Black Oak (*Casuarina cristata*) Open Low Woodland

Black oak woodlands range over an extensive area in the Great Victoria Desert and eastward through South Australia into New South Wales and Queensland. They usually occur as patches or groves in mosaics with mulga communities and treeless vegetation, commonly on wide interdunal areas. Like mulga, black oaks form communities that cover wide ranges of height and density along with great variation in species composition and diversity.

Within the survey area, black oak woodlands appear to be restricted to calcareous, red loamy soils in the southwestern part. The only stand observed during the field work was at VS72, a small open woodland on hard red earth and calcrete about 1.3km east of the intersection near PNP567.

The mature black oaks in the stand are over 8m tall. The understorey is very open, with *Eremophila decipiens*, *Alyxia buxifolia*, *Acacia colletioides*, *Scaevola spinescens*, *Olearia muelleri,* and pruinose *Cassia nemophila*. Porcupine grass is absent from the stand. The understorey is more depauperate than in the extensive black oak woodland photographed by Burbidge et al (1976) in the Plumridge Lakes Nature Reserve, east of the survey area.

5.2.1.3 Cypress Pine (*Callitris* spp.) Low Woodland

Cypress pine (*Callitris columellaris*) is a common small tree component of marble gum tree steppe, and in some parts of the survey area that have escaped burning for extended periods it forms stands of low woodlands and forests. These stands are invariably small and frequently comprise the she-oaks *Allocasuarina corniculata* and *A. acutivalvis* as well as cypress pine.

The she-oak associates are most common with cypress pine (*Callitris preissii* ssp. *verrucosa*) on sand ridges, where cypress pine woodlands or scrubs tend to merge with the scrub communities on the crests of the ridges.

5.2.1.4 Marble Gum (*Eucalyptus gongylocarpa*) Open Low Woodland

Marble gum, a beautiful shapely tree resembling wandoo, is the tree most typical of the Great Victoria Desert. On favourable sites it can be a majestic tree reaching heights of 20m while on adverse sites it may be no more than a 5m tall mallee (Boomsma 1981; Boomsma and Lewis 1980). Its density is also variable but generally steppe-like. Where density of trees is close enough to be considered open woodland, the relatively high density is usually restricted to small groves, which may be hundreds of metres from neighbouring groves or individuals.

Beard (1974) treats all Great Victorian Desert marble gum vegetation as tree steppe. Marble gum stands in the survey area are discussed in more detail below, in the section on tree steppes, Section 5.2.4.1.

5.2.1.5 Redwood (*Eucalyptus* aff. *transcontinentalis*) Low Woodland

On the red earths of the upland plains along the central northern boundary of the survey area and extending north and west, there are patches of low woodland dominated by a tall eucalypt resembling redwood (*E. transcontinentalis*) but probably undescribed. The eucalypt is 12m tall and taller.

The woodland has a tall, sparse stratum of mulga, a ground layer of porcupine grass, and shrubs of various species.

Eucalyptus transcontinentalis, as it is currently recognised (Chippendale 1973), covers an extensive area south-west of the Great Victoria Desert, through much of the wheatbelt and the goldfields.

5.2.1.6 *Eucalyptus* spp. (ASW 14938) Low Woodland

On a claypan with calcrete at VS75, PNP1140, there is a mallee woodland that is exceptionally tall and dense. The two dominant eucalypts in the stand are more than 8m tall and provide a canopy cover probably in excess of 30%. Some of the dominant plants are few-stemmed mallees; others are thin-stemmed trees. One of the eucalypts is probably *E. comitae-vallis*; the other, an undescribed species.

The understorey comprises *Acacia colletioides*, *Scaevola spinescens*, *Cassia nemophila*, *Olearea muelleri* and *Santalum* sp. There is very little, if any, porcupine grass.

5.2.1.7 Kopi Mallee (*Eucalyptus leptophylla* var. *leptophylla*) Low Woodland

Gypsum or kopi pans both flocculated and firm, and the low gypsum-rich ridges bordering them characteristically have a low woodland or tall scrub of mallees or trees of the kopi mallee, *Eucalyptus leptophylla* ssp. *leptophylla,* that grow to more than 8m tall. Often the ground cover under the mallee woodland is sparse porcupine grass or absent. Conical tall shrubs of *Acacia* ? *rigens*., 2.5m to over 3m tall, occur in patches.

At VS9 other associated species include *Grevillea* cf. *stenocarpa*, *Lachnostachys* ? *bracteosa*, *Senecio magnificus* and *Acacia colletioides*. On a similar, reddish gypsum substrate nearby the eucalypts are smaller and scattered, in a shrub steppe with the *Lachnostachys*, *Persoonia* sp. nov. to over 1m tall and a few small *Adriani hookeri* shrubs.

At VS10 kopi mallee is the co-dominant species with *Eucalyptus yilgarnesis*, over concentric belts of understorey vegetation around a gypsum pan bearing *Atriplex stipitata* dwarf scrub. The understoreys in the belts have zones of overlap or replacement and comprise *Acacia colletioides*, *Atriplex stipitata*, *Eremophila decipiens*, *Rhagodia drummondii* and *Olearia* cf. *cassiniae*.

*5.2.2 Mallee (*Eucalyptus*) Shrublands*
Canopy Cover: (1-)10-30(-70%; Dominants
Height: 2-4(-8)m

Mallee communities occur throughout the survey area, in a wide range of heights and densities and comprising a wide range of species. Several species are characteristic emergents in scrubs and complexes, such as *E. trivalvis* in *Acacia jutsonii* scrub and *E. incrassata* in sand ridge complexes. Several species that are difficult to distinguish when not in mature bud, flower and fruit form open to dense stands on heavier, redder soils that are often associated with calcrete or gypsum, usually in depressions. These species include *E. leptophylla*, *E. rigidula*, *E. gracilis*, *E. cylindrocarpa*, *E. cylindrophylla*, *E. mannensis*, *E. platycorys* and *E*. sp. (ASW 14854). Narrow-leaved mallee (*E. leptophylla*), *E. cylindrocarpa* and *E. youngiana* are common both in low and high densities in marble gum tree steppe.

5.2.2.1 Narrow-leaved Mallee (E. *leptophylla* sens.lat.) Shrubland

Narrow-leaved mallee shrubland, the most widespread mallee shrubland in the survey area, occurs on an estimated 60% of the red sandplain soils and 40% of the entire survey area. It is a common component of marble gum tree steppe and often replaces it as shrubland or mallee steppe after fire, as at VS4 and TS7. At VS4 it has an "understorey" of porcupine grass and the sedge, *Chrysitrix distigmatosa*.

5.2.2.2 Flowery Mallee (E. *leptophylla* var. *floribunda*) Shrubland

Flocculated red earths intermediate between the strongly gypsum soils around gypsum or kopi pans and the sandplains that support marble gum tree steppe have vegetation similar to the typical narrow-leaved mallee shrubland, but with a different form of *Eucalyptus leptophylla*, which is 3m to 5m tall, at least at VS9A. Associated species include *Melaleuca eleuterostachya*, ? *Daviesia* sp. (ASW 14851) and porcupine grass.

5.2.2.3 Stiff-leaved Mallee (*Eucalyptus rigidula*) – Narrow-leaved Mallee (*E. leptophylla*) Shrubland

Islands of finer-grained sand and silt with calcrete that are slightly above the surrounding sandy plain generally support groves of mallee that are often more than 4m in height, with canopy covers in excess of 30%. The dominant mallees are usually *Eucalyptus gracilis*, a form of *E. leptophylla* or *E. rigidula* and, sometimes, *E. mannensis*. The usual diagnostic feature of this vegetation is a lower shrub layer of the she-oak *Allocasuarina helmsii*, generally less than 2m tall. The most common understorey shrub on many calcrete pockets is *Olearia muelleri*, a 50cm tall daisy bush. Other, less common, associated shrubs include *Dodonaea stenozyga*, *Santalum acuminatum*, *Scaevola spinescens*, *Acacia ligulata*, *A. hemiteles*, *A. helmsiana*, *Grevillea acuaria*, ?*Daviesia* sp. and *Olearia* cf. *revoluta*. The ground layer is sparse and comprises little porcupine grass.

Where this community occurs on clay depressions next to calcrete rises, as at VS8, the *Eucalyptus leptophylla* mallee occurs as a small, dense, almost monospecific stand with a height that may exceed 8m. At VS8, 2m tall *Acacia colletioides* is common around the margins of the mallee.

Chippendale (1973) notes that *E. rigidula*, a close relative of *E. leptophylla*, is scattered through the wheatbelt and goldfields, usually on lateritic sand.

5.2.2.4 Woodline Mallee (*E. cylindrocarpa*) Shrubland

Woodline mallee 2m to 4m tall characterises mallee shrubland on dark, loamy soils west and south of PNP 1782. There are several species of shrubs in the understorey, especially at the lower margin of the stand at VS17, but no porcupine grass. The shrubs include *Acacia tetragonophylla*, *Olearia muelleri*, *Cassia nemophila*, ? *Santalum* sp. and *Melaleuca* ? *eleuterostachya*.

Chippendale (1973) records Woodline mallee from the Eucla Botanical District (Nullarbor Region) of Beard (1975), south of the Great Victoria Desert, on sand and sandy loam.

5.2.2.5 *E. mannensis* Mallee Shrubland

The tall, rough-stemmed mallee, *Eucalyptus mannensis*, is widespread but not common in the Great Victoria Desert. The species occurs mainly at low densities on low, undulating, red-brown loamy sand substrates (Boomsma and Lewis 1980) that are often calcareous. It is associated with other mallees and smaller shrubs, such as *Hakea minyma*, which occur as patches within the shrubland.

In the survey area *E. mannensis* stands are most commonly found as enclaves in marble gum tree steppe, with understoreys comprising *E. youngiana*, *Santalum acuminatum*, *Acacia rigens*, *Acacia helmsiana*, *Bertya dimerostigma*, *Hakea minyma* and porcupine grass. At VS28 the sedge, *Lepidosperma viscidum*, uncommon in the survey area, was also found.

5.2.2.6 Tammin Mallee (*E. leptopoda*) Shrubland

Tammin mallee is the dominant species in a mallee shrubland community on relatively shallow sandy soils south of the laterite uplands in the northern part of the survey area. Tammin mallee communities extend westward across the northern goldfields and wheatbelt on sandy soils in flat country (Chippendale ,1973).

Ooldea mallee and *Allocasuarina acutivalvis* are common associates, while porcupine grass, *Acacia* ? *sibirica*, *Baeckea cryptandroides* and the *Chrysitrix* are the principal smaller plants.

Tammin mallee scrub merges with *Acacia* ? *sibirica* and *A. jutsonii* scrubs on shallower sandy soils.

5.2.2.7 Oldfield's Mallee (*E. oldfieldii*) Shrubland

Oldfield's mallee shrubland was found on pale sand with scattered laterite gravel bordering Tammin mallee shrubland in the northern part of the survey area. This is the eastern known limit of Oldfield's mallee, which extends across the northern parts of the goldfields and wheatbelt to Sharks Bay, usually in association with heathland vegetation (Chippendale 1973).

In the survey area Oldfield's mallee grows to 2.5m tall in open stands with *Allocasuarina acutivalvis*, *E. youngiana*, *Acacia* ? *jutsonii*, *A. acanthoclada*, *A. ligulata*, *Calothamnus* sp., ?*Baeckea* sp., *Micromyrtus flaviflora*, *Grevillea* ? *armigera*, *Chrysitrix distigmatosa*, *Banksia elderiana*, *Exocarpus sparteus* and porcupine grass. Most of the stand was burnt within the last few years. It borders and merges with *Acacia jutsonii* scrub and Tammin mallee shrubland which is also regenerating after being burnt.

5.2.2.8 *Eucalyptus* sp. (ASW 14854) Mallee Shrubland

An unidentified stockinged mallee forms relatively dense mallee shrublands over 4m tall at VS15C and southwards on dark loamy or sandy loamy soils with calcrete and some gypsum. VS15C is an elevated, sloping site with very little porcupine grass. The few, scattered understorey plants include *Santalum* sp., *Acacia* ? *tetragonphylla*, *Scaevola spinescens*, *Grevillea acuaria* and *Cassia nemophila*. A gully running through the centre of the stand has *Allocasuarina* ? *helmsii* 2m, tall, and a species of ?*Daviesia* along it at the northern edge of the mallee.

5.2.2.9 Boorabbin Mallee (*E. platycorys*) Shrubland

Boorabbin mallee is scattered southward and eastward from Boorabbin, in the north-eastern wheatbelt (Chippendale 1973), to the Great Victoria Desert. It is recorded from sandy soils, sometimes near salt lakes.

Boorabbin mallee communities in the survey area are recorded on red loamy sand, possibly calcareous, soils. The open, 5m tall stand at VS41 has *E.* ? *rigidula* as a co-dominant and a low, open shrub understorey comprising *Acacia rigens*, *Acacia* sp., *Bertya dimerostigma*, species ASW 14874 and scattered hummocks of porcupine grass.

5.2.3 Thickets and Scrubs

Canopy cover: (1-)10-30(->70%);
Dominants Height: <2m

Thickets and scrubs, like mallees and steppes, are widespread through the survey area, often as components of woodlands, mallee shrublands, steppes and complexes.

5.2.3.1 *Acacia sibirica* Scrub

On low-lying flats with hard, fine-textured, red-brown soils and on some lateritic gravel between sand-ridges and lateritic uplands near the northern edge of the study area there is mixed scrub with a pungent, terete-needled *Acacia*, *A. sibirica*. The mallee *Eucalyptus leptopoda* is a common associate of the *Acacia* at VS8B and extends beyond it onto shallow sandy soils. *Hakea minyma*, *Callitris preissii* ssp. *verrucosa* and *Bertya dimerostigma* are locally common shrubs at VS8B. Mulga (*Acacia aneura*) also occurs there, but only locally; it probably was more extensive before the area was burnt sometime in the past. *Dianella revoluta* is occasional. Otherwise there is little ground cover, including porcupine grass.

5.2.3.2 *Acacia jutsonii* Scrub

Acacia scrub that is head-height and lower is common on relatively firm, yellow to reddish sandy substrate in low-lying areas. The scrub is often quite variable in terms of the species composition, height and density of each vegetation stratum.

At VS1 the *Acacia* overstorey comprises three species, *A. jutsonii*, *A. rigens* and *A. sibirica*. This overstorey is a regenerating stand approaching 30% canopy cover and about 1m tall, with skeletons killed by fire that are around 2m tall. Shrubs of *Baeckea cryptandroides* less than 50cm tall are common among hummocks of *Triodia basedowii* and patches of the sedge *Chrysitrix distigmatosa*. Scattered individuals of *Hakea francisiana* and *Banksia elderiana* around 2m tall are conspicuous in the stand.

At VS1A (=TS1) the sole dominant *Acacia* is *A. jutsonii*, of patchy dispersion and low canopy cover. *Triodia basedowii*, *Chrysitrix distigmatosa* and *Baeckea cryptandroides* are as at VS1, common, and *Banksia elderiana* is conspicuous. Other, less common, species in the stand include *Wehlia thryptomenioides*, *Schoenus brevisetus*, *Leptospermum fastigiatum*, *Ptilotus* ? *obovatus* and *Acacia sibirica*. The she-oak *Allocasuarina corniculata* was once common in the stand but was decimated by the same fire that appears to have badly damaged the stand.

Two features at VS35 are typical of many stands of *A. jutsonii* scrub in the survey area. First, the stand surrounds a depression occupied by a *Chrysitrix distigmatosa* sedge steppe community. Second, the *A. jutsonii* itself is dotted with 3m tall mallees of *Eucalyptus trivalvis*.

At VS47A the extensive *A. jutsonii* scrub merges into marble gum tree steppe and Oldfield's mallee shrubland. *Acacia jutsonii* scrub is the most common type of scrub in the survey area, and in some low-lying, flat or gently sloping areas of sandy loams it is extensive. *Acacia sibirica* scrub is similar in appearance to *A. jutsonii* scrub, with which it intergrades, but restricted in distribution.

5.2.3.3 Bastard Mulga (*Acacia stowardii*) Scrub

Bastard mulga, closely related and similar to witchetty bush (*A. kempeana*), ranges widely across the Great Victoria Desert and the Northern Territory and into South Australia, New South Wales and Queensland (B.R. Maslin in Jessop 1981). It occurs in the survey area principally as a dull-green leaved associate of mulga, as at VS34, and with *Acacia acuminata*, as at VS53 and VS34.

At VS34, near the northeast corner of the survey area, bastard mulga is regenerating after fire in a heterogeneous community that contains marble gum, mulga, *Acacia ligulata*, *A. acuminata*, *Santalum acuminatum*, *Alyxia buxifolia*, *Hakea* ? *minyma* and several species of *Eremophila* and other smaller shrubs.

At VS53 the 3-7m tall stand is principally *A. stowardii*, *A. grasbyi*, *A. acuminata*, *A.* ? *kempeana*, *Callitris* ? *columellaris*, *Santalum acuminatum* and *Grevillea* aff. *hakeoides*.

5.2.3.4 *Acacia acuminata* Scrub

The broad-phyllode form of *Acacia acuminata* commonly known as "jam" is endemic to Western Australia west of the Great Victoria Desert. Whibley (1980) refers the narrow phyllode form, found in the survey area, to *A. burkittii*, a species that ranges eastward across South Australia into western New South Wales. He notes that the species is mainly on shallow compact loam, brown calcareous earths and crusty alkaline neutral red duplex soils. In the survey area it is also in communities on kopi soils, as at VS19.

The best-developed stands seen in the survey area were at VS19, where the bowgada-like shrubs reach 4m in height and occur with *Grevillea sarissa*, *Acacia* ? *tetragonophylla*, *A. colletioides*, *Lachnostachys bracteosa*, *Eremophila decipiens* and *Senecio magnificus*. There is no porcupine grass in the stand. There is a stand of kopi mallee nearby.

5.2.3.5 *Acacia helmsiana* Mixed Scrubs

In and between some stands of marble gum steppe there are enclaves of scrub dominated by *Acacia helmsiana*, *Beyeria brevifolia*, Species ASW 14874, *Bertya dimerostigma*, *Phebalium tuberculosum* and other low shrubs that are neither acacias nor mallees. Porcupine grass and the *Chrysitrix* are usually sparse in the ground layer.

At some sites some species are missing from the suite of shrubs. At a few the shrubs are not mixed; they occur as monotypic stands, most commonly of the *Phebalium* or another species in the same genus.

5.2.3.6 Broombush (*Melaleuca uncinata*) Thicket/Scrub

Broombush thickets and scrubs to 3m high are found on compact red earth soils in a few localities in the survey area. The most distinctive, undiluted thicket seen is at VS38, where there is little else besides the broombush and scattered porcupine grass. Marble gum and three mallees, *E. concinna*, *E. leptophylla* var. *floribunda* and *E.* ? *platycorys* are common around the margins. Elsewhere, broombush, these mallees and marble gum form a single heterogeneous community.

5.2.3.7 Saltbush (*Atriplex stipitata*) Dwarf Scrub

Although most white kopi pans in the survey area are virtually bare of vegetation, the VS10 pan contains an *Atriplex stipitata* dwarf scrub to about 50cm tall. The dwarf scrub has no trees and no other species of significance, if any species at all) but the *Atriplex* continues into the surrounding kopi mallee low woodland as one component of the understorey.

5.2.3.8 *Allocasuarina acutivalvis* Scrub

Small stands of *Allocasuarina acutivalvis* scrub, shrubland, heathland or thicket were observed at VS30 and several other vegetation sites and along traverses where the vegetation had not been burnt for many years. These stands often included *Callitris* sp., *Banksia elderiana*, mallees, wattles and porcupine grass. A few stands also had *Melaleuca uncinata*.

This type of scrub was probably more extensive in the survey area when the vegetation had not been burnt for periods of ten years and much longer.

The *Allocasuarina acutivalvis* scrub is similar to the thicket kwongan described by Beard (1984) except that it tends to be more open, infrequently has species of *Acacia* and *Melaleuca* as codominants with *Allocasuarina* and has *Triodia* as the dominant ground layer.

5.2.4 Steppes
Trees or Shrubs with <1% Canopy Cover

Most of the sandy country in the survey area, i.e. most of the survey area, supports a mosaic of tree steppe, shrub steppe and grass steppe that either grade into each other or are coincident.

5.2.4.1 Marble gum (*Eucalyptus gongylocarpa*) Tree Steppes

The principal type of vegetation in the survey area is variable marble gum (*Eucalyptus gongylocarpa*) tree steppe, the characteristic plant community on deep, fine, reddish to yellow sand of the sandplain and slopes of sand-ridges. Marble gums range in height from 4m to more than 12m, usually occur as trees but sometimes as mallees and, though generally solitary, are sometimes clustered. Some stands contain few plants other than marble gums and the porcupine grass or spinifex *Triodia basedowii*, but most have various species of mallees, acacias and other shrubs. The shrubs include *Acacia helmsiana*, *A. rigens*, *Eremophila platythamnos*, *Cassia nemophila*, *Choretrum glomeratum*, *Hakea francisiana*, *Bertya dimerostigma*, *Alyxia buxifolia* and *Santalum acuminatum*. Cypress pine (*Callitris columellaris*) is common in some stands. Scattered mallees of *Eucalyptus youngiana*, with their large flowers that are red on some

plants and yellow on others, occur in most marble gum tree steppes. Thickets of *E. mannensis* are common in some while narrow-leaved mallee (*E. leptophylla*) forms thickets or isolated plants in many others. The desert grass-tree, *Xanthorrhoea thorntoni*, is in a few areas, towards the south-west corner.

Beard remarks that marble gums congregate especially on rises in undulating sandplains, probably because the sand is deeper there. In the survey area marble gums occur on virtually all sand substrates, from the crests of ridges to interdunal areas and plains.

5.2.4.2 Shrub Steppes

Where marble gums have been eliminated from the tree steppe by fire and in other places where they are absent but porcupine grass is present, there are sometimes mallees or other large shrubs that are scattered through the grassland as individuals or groups. These are shrub steppes.

5.2.4.3 Grass Steppe

The distinction between grass steppe and tree steppe is arbitrary. For instance, Boomsma and Lewis (1980) appear to regard all occurrences of marble gum as open woodland, even where clumps of trees are kilometres apart while Beard (1974) regards all occurrences as tree steppe. Some extensive areas of treeless, malleeless porcupine grass hummock grassland could be regarded as grass steppe.

5.2.4.4 *Chrysitrix distigmatosa* Sedge Steppe

Chrysitrix distigmatosa, a *Mesomelaena*-like sedge that is a common associate of porcupine grass on compact substrates, also forms communities in the centres of shallow basins surrounded by *Acacia jutsonii* scrub. The communities are usually small and species-poor, as at VS35, where there are four distinctive but overlapping concentric bands. At the centre is the *Chrysitrix*, which overlaps with a band of *Baeckea* sp. (ASW 14813). A band of porcupine grass separates the *Baeckea* from the *Acacia jutsonii* scrub and continues as an understorey into the scrub.

The *Chrysitrix* is much more extensive at VS69, in the southern part of the survey area, but there it occurs with porcupine grass and borders on burnt broombush scrub instead of *Acacia jutsonii* scrub. There is a large stand of desert grass trees (*Xanthorrhoea thorntonii*) north of the stand.

5.2.5 Complexes

Vegetation in the survey area generally occurs as small homogeneous stands, as larger heterogeneous intergrading communities or as complexes. Distinctive complexes needing special mention include those on sand ridges or dunes, on and around kopi or gypsum pans and the one around the clay pan at VS18.

5.2.5.1 Sand Ridge (dune) Complex

Although the crests and upper slopes of the sand ridges have species in common with the lower slopes and sand plains, they also have characteristic species, suites of species and vegetation patterns. Vegetation is more patchy, with conspicuous areas of loose, open, yellow sand. *Grevillea stenobotrya*, *Gyrostemon ramulosus*, *Callitrix preissii* ssp. *verrucosa*, *Eucalyptus incrassata*, *E. youngiana*, *Acacia*

fragilis, *Persoonia* sp. nov., *Allocasuarina corniculata*, *A. acutivalvis*, *Lomandra leucocephala*, *Micromyrtus flaviflora*, *Pityrodia loricata*, *Phebalium filifolium*, *Lepidobolus desertii*, *Glischrocaryon* ? *flavescens*, *Calothamnus gilesii*, and *Leucopogon* sp. are all represented.

On the dune at VS20, one of the most prominent dunes in the study area, *Newcastelia hexarrhena*, *Helipterum* ? *pterochaetum*, *Caustis dioica*, *Conospermum leiscanthum*, *Thryptomene* sp. (ASW 17786), *Micromyrtus flaviflora* and *Gyrostemon ramulosus* were found only on the crest. Over 75% of the crest surface consists of bare ground and drifted sand. *Eucalyptus incrassata*, *Acacia fragiles*, *Olearia lanuginosa*, *Verticordia picta* and *Comesperma scoparium* are restricted to the upper slopes, along with *Hybanthus floribundus*, *Grevillea didymobotrya* and a dominant, *Allocasuarina acutivalvis*.

Some of the eucalypts characteristic of sandplains vegetation also occur on some sand ridge crests. The most conspicuous of these species is the ubiquitous marble gum.

5.2.5.2 Kopi Complexes

Kopi complexes comprise gypsum pans which are usually with crystalline gypsum and usually bare of vegetation, together with the surrounding tree, mallee and shrub communities on gypsum-rich substrates.

The kopi complex is most extensive and diverse at VS13 and neighbouring VS19, where 4m to 5m tall *Acacia acuminata* shrubs complement kopi mallees. Other large shrubs at the sites include several that are rare in the project area: *Grevillea sarissa*, *Jasiminum didymum* and *Heterodendrum olaeifolium*.

VS10 is the only site where the saltbush *Atriplex stipitata* was found. The saltbush forms a dwarf scrub in the otherwise bare pan and extends, at reduced density, into the surrounding woodlands, shrublands, and scrubs.

5.2.5.3 Varnished Claypan Complex

The varnished clay pan at VS18 is unusual in the survey area in several respects. It was one of the few claypans with standing water, and it was the only place where the desert canegrass, *Eragrostis australasica*, was found. It has a few *Eremophila miniata* shrubs and a regenerating stand of mulga-like *Acacia duriuscula* next to it. It also has a good stand of the mallee *E. cylindriflora* next to it, as part of the complex.

5.3 Vegetation Maps

The distribution of vegetation in the survey area is shown in the 1:50,000 scale vegetation map presented with this report (Figure A-1). The vegetation symbols used on the map are the same as those presented in the table of Plant Associations and Vegetation Complexes (Appendix A, Table A-1, Column 5). They are listed in the legend on the map and are defined in greater detail in the table.

Latitudes and longitudes are given for the map, and the airstrip, the campsite and costean are shown as reference points. To provide more reference points and correlation with other features of the project area, a transparent copy of the vegetation map can be used as an overlay with other 1:50,000 base maps.

Most of the map units are mosaics or combinations of units, and most are, basically, marble gum tree steppe (HW). The most prominent vegetation is indicated first, as in HWDW, marble gum tree steppe/dune complex/woodlands.

The order of the symbols is important; HWMD is not the same as HWDM.

In general, specific mallee and shrub associations are not distinguishable, even at large scales. Nor are they discrete; shrublands and shrub steppes tend to be continuous but with dominant species replacing each other.

Vegetation sites and trapping sites are also indicated on the map, by "X"s. Trapping site numbers are italicized and are usually on the right side of the "X". The vegetation site numbers are not italicised and are usually on the left side.

Two larger scale maps, drawn at 1:10,000, are also presented with this report. They cover parts of the Shogun and Emperor orebodies (Figures A-2 and A-3) and indicate units and boundaries too small or ambiguous to be shown at the scale of 1:50,000. The vegetation symbols used are the same as the ones used on the 1:50,000 scale map.

5.4 Discussion

5.4.1 Distributions

Although relatively little is known about the vegetation of the Great Victoria Desert and its distribution, abundance and variation, this little is sufficient basis for assessing the sensitivity of most types of vegetation in the survey area.

Certainly many of the survey area's associations are common and widespread. For example, the marble gum (*Eucalyptus gongylocarpa*) and porcupine grass (*Triodia basedowii*) associations and sand dune complexes occupy very large proportions of the Great Victoria Desert, and the survey area. But one of the most poorly represented associations in the survey area, black oak (*Casuarina cristata*) low woodland, is also common in other parts of the desert, especially near Lakes Throssell and Rason (Beard 1974) and Plumridge Lakes (Burbidge et. al. 1976). Mulga (*Acacia aneura*) associations, relatively rare in the survey area, are widely distributed not only through the Great Victoria Desert but also through a large part of arid, central Australia (Beard 1981b).

Saltbush dwarf scrubs are also well-represented in the centre, but the representation of such scrubs dominated by *Atriplex stipitata* is unknown.

The distribution and abundance of associations dominated by species of *Acacia*, *Melaleuca* and mallees are particularly difficult to assess where the taxonomic status of the dominant species is questionable. Examples of such associations in the survey area include many woodlands and mallee shrublands (WR, WE, WK, M1, M2, M3, M5, M8) and a few scrubs (S1, S2).

5.4.2 Fire

Fire is an important factor in the determination of the type of vegetation to be found in most parts of the Great Victoria Desert, but its frequency and intensity vary. East and west of the survey area there are extensive belts that have been burnt recently, and the greater part of the survey area shows signs of past fires that occurred at least twice. None of them appears, however, to be more recent than ten years ago (K. Fulwood pers.comm.).

Frequent fires tend to eliminate mulga and promote the mallee habit. Both the relative paucity of mulga in the survey area and the shrubbiness of its mallees are probably due to intensity and frequency of fire in the past.

5.4.3 Rarity and Conservation Status

An association may be considered rare either because a dominant species of the association is rare or because there are few occurrences of the suite of species that constitutes the association itself. An association may also be considered rare for a combination of these reasons and because, like mulga communities, it varies widely in structure and composition from site to site. Within the boundaries of the survey area associations that qualify as rare according to their definition include the following:

- Mulga Low Woodlands/Scrub (especially VS34, 48, 56),
- Black Oak Open Low Woodland (VS72),
- Redwood Woodlands (VS57; possibly not in survey area but only north of it),
- *Eucalyptus* sp. Mallee Low Woodland (VS75),
- Acacia *sibirica* Scrub (VS8B, 31, 45A),
- Saltbush Dwarf Scrub (VS10A),
- Sand Ridges (Dunes) Complexes VS3A, 5, 20, 71, 8AA)
- Kopi Complexes (VS9, 10, 12, 13, 19, 73)
- Varnished Claypan Complex (VS18).

Until much more is known about both the vegetation and the flora of the Great Victoria Desert as a whole, and indeed all of arid central Australia, it is impossible to make an informed estimate about the rarity or conservation status of many of the rarer associations and complexes found in the survey area. A continuing series of central Australian biological surveys initiated during the last decade (Burbidge et al. 1976; Biological Surveys Committee, Western Australia 1984; McKenzie and Burbidge 1979) and privately sponsored surveys such as this one and the Lake Way and Mereenie Surveys (Blackwell and Trudgen 1980; Dames & Moore 1983) are filling in the gaps in our knowledge of the Central Australia vegetation

and flora. If surveys and studies continue at the current rate, there should be enough information about the regional flora and vegetation upon which to base management strategies in 5 to 10 years.

Until more is known about the regional vegetation the recommended approach to development within the survey area is to protect the vegetation at VS3A, 5, 8, 10, 10A, 12, 13, 18, 19, 20, 31, 34, 45A, 48, 56, 57, 72, 73 and similar locations. Most of the locations are outside the main orebody areas.

6.0 FLORA

6.1 Introduction

The survey area, like the rest of the Great Victoria Desert, is in the Helms Botanical District of the Eremaean Botanical Province (Beard 1980). The district extends well into South Australia, where it is bordered on the south by the Eucla Botanical District (Nullarbor Plain) and on the north by the Giles Botanical District (the Central Ranges, which are mainly in the Northern Territory).

Although the Great Victoria Desert is encompassed by the standard botanical reference for Central Australia, *Flora of Central Australia* (Jessop 1981), the desert's flora is still poorly known. The very inadequate knowledge of the district's flora and its distribution is inferrable from the observation that a large proportion of the species growing in the survey area cannot be identified using the *Flora*. There is no reference to them in the *Flora* simply because they had not been collected in Central Australia before; most had not previously been collected east of the Kalgoorlie area.

6.2 Flora Description

One hundred and fifty-seven species, varieties and subspecies of vascular plants are now recorded from the PNC leases in the Mulga Rocks area. The record is not complete, but it does include most of the woody shrubs and trees that are dominant, widespread, common and characteristic in the area.

The species of vascular plants observed during the survey are listed in Table B-1. Table B-1 also incorporates observations made by O'Connor (1984) and indicates A.S. Weston plant collection numbers and vegetation and trapping sites where the plants were recorded.

The plants are listed by family in the same order in which they are filed and catalogued in the Western Australian Herbarium (Green 1985).

Most of the taxa listed are determined to species, at least tentatively. Some of the entries in the table that have not been determined to species positively may be second collections of other species on the list, but this possibility exists for no more than six of the entries.

Specimens not positively determined to named species have, as part of the name, 'aff.' 'cf.'. '?', 'sp.' or 'ASW'.

Common names have been dispensed with in the table because most of the species listed do not have common names, because some common names apply to more than one species, and because some species have more than one common name.

6.3 Rarity and Conservation Status

No species of plant found in the survey area is officially listed or gazetted as rare or otherwise in need of special protection, and no species listed as rare or otherwise in need of special attention is likely to be present in the area.

Because there has been so little plant collecting done in the Great Victoria Desert, it is impossible to accurately assess the rarity and conservation status of any species that does occur there. Surveys in the Western Australian Herbarium of poorly collected species which have been recorded from the Desert do, however, give some indication of species that may be rare or geographically restricted. Three of the species listed in Table B-1 and their collection sites are in this category. These species are:

Thryptomene sp. inedit (ASW 14786)
Myrtaceae (273)
VS5

Persoonia sp. (ASW 14789)
Proteaceae (90)
VS5, VS9

Dicrastylis nicholasii F.Muell.
Chloanthaceae (311A)
VS31

The first two species are both undescribed and may be not so much rare as poorly collected. Being undescribed, neither species is eligible for inclusion in any list of rare and geographically restricted species.

The third species, *Dicrastylis nicholasii*, was one of only two species listed by Leigh and Boden (1979) as rare in the Great Victoria Desert. (The other species is *Newcastelia chrysotricha*, also in the family Chloanthaceae). There are still only two collections of the *Dicrastylis* in the Western Australian Herbarium, one from 35km west of Plumridge Lakes, the other from 127km south-west of Warburton Mission. Other collections have been recorded from two nature reserves near the project area, Plumridge Lakes and Queen Victoria Spring (Laczo pers. comm.).

The *Dicrastylis* was found in the survey area on sandy soil at Site 31 with *Banksia elderiana*, *Triodia basedowii*, *Allocasuarina acutivalvis* and *Eucalyptus youngiana*.

Another species found in the survey area, *Pityrodia loricata*, is not currently on any publication of rare or threatened species, but it is being added to the Australian Rare or Threatened Plants Lists for the Northern Territory (Briggs and Leigh 1984). It was collected at Site 8AA, next to the main north-south track east of the main camp and airstrip, 4.18km north of the northern access track to the airstrip. It was an occasional low shrub on a low dune crest.

Three other species in the survey area that are neither rare nor geolographically restricted but are of particular interest are the desert poplar (*Codonocarpus cotinifolius* - Fam. 108), desert grass tree (*Xanthorrhoea thorntonii* - Fam. 54D) and Ooldea mallee (*Eucalyptus youngiana* - Fam. 273). Although desert poplar is currently rare in the project area localised populations can be expected to germinate and develop rapidly after fires into distinctive, short-lived shrubs or trees up to 7m tall. Ooldea mallees have exceptionally large flower that may be crimson, pink, cream or golden-yellow, with each colour being on

separate plants. The desert grass tree was once thought to be rare and to comprise several varieties or species. It is now treated as a single species and considered to have the widest range of any Western Australian Species of *Xanthorrhoea* (cf., e.g., Gould League *Nature Study Guide* 24(3), 1974). Stands are, however, generally small and made up of widely-spaced individuals.

7.0 FAUNA

7.1 Introduction

The fauna survey was carried out to assess:

- The species of vertebrates present (invertebrates are so poorly known that no useful study can be made).
- The distribution of the species in relation to the different habitats.
- The conservation status of the fauna locally and in a regional context.
- The practicality of catching the different species for radionuclide and heavy metal analyses.

7.2 Results

7.2.1 Trapping Site Locations and Descriptions

Locations and full descriptions of the 14 trapping sites are given in Appendix C. For the purposes of discussing the results of the fauna survey, descriptions of the sites are summarised in Table C-2.

Trapping and observations were carried out from 18 June to 2 July 1985 and the various traplines were run from 6 to 13 days (Table C-2). The trapping programme coincided with very cold mornings (unofficial daily minimums were -3° to 8° C) and mild days (unofficial daily maximums were 15° to 29°C).

7.2.2 Amphibians and Reptiles

No amphibians were encountered during the survey, and potential habitat was very limited. Due to the cold nights and mild days, the reptiles were comparatively inactive and few species were collected. Dr D. King of the Agriculture Protection Board caught lizards around the Ambassador orebody in October 1985, and his results have been added to produce a more useful species list (Table D-2).

7.2.3 Birds

A total of 28 species were recorded, with 21 species being recorded during the standardised transects and a further 7 by opportunistic sightings (Table D-3).

The birds recorded during the standardised transects are given in Table D-4. All identifiable birds were recorded in the transects and no corrections have been made for differences in visibility between species. Two species were identified solely from calls - the Crested Bellbird and the Striated Pardalote.

7.2.4 Mammals

7.2.4.1 Small Mammals

A total of 113 specimens of 11 species of small mammals were collected. The 11 species comprised the introduced House Mouse, two native rodents and eight small dasyurids. The captures at the various trapping sites are given in Table D-6.

7.2.4.2 Bats

The only sites where bats appeared to congregate were about the lights of the camp-site and above some brackish water tanks 10km to the south of the campsite. Mist netting at the tanks for five nights and at the camp for four nights produced only one bat, *Chalinolobus gouldii* (Little Chocolate Bat), from above the water tanks. Bats were common in the area but did not appear to congregate sufficiently for effective mist netting. One specimen of *Nyctophilus major* (Greater Long-eared Bat) was caught in a pit trap, where it was presumably feeding on the ground.

7.2.4.3 Larger Mammals

The Grey Kangaroo (*Macropus fuliginosus*) was found to be common throughout the area in all habitats. Ten animals were collected for radionuclide and heavy metal analysis (Table D-1). The Red Kangaroo (*Megaleia rufa*) was observed well to the west of the survey area in an area with more grasses, and probably occurs in the survey area as an occasional visitor.

The only other large animals identified were wild dogs or dingos, rabbits and feral cats. The tracks of dogs were common throughout the area. The only live rabbit observed was approximately 2km west of TS8, but signs of rabbits were also seen at TS4 and TS10 and the animals are probably widespread.

One feral cat was present around the campsite, and the species is also probably widespread.

7.3 Discussion

7.3.1 Amphibians

Several species of frogs, including *Neobatrachus centralis*, *N. sutor* and *Pseudophryne occidentalis*, may occur in the survey area but potential habitat is very limited. These frogs are all opportunistic breeders which will only be visible around rocks or in clay pans after heavy rain. These species are all widespread, but sparsely scattered, over a large area of arid Western Australia.

7.3.2 Reptiles

Twenty-one species of lizards were collected, which represents a good proportion of the species likely to be present in the survey area. All of the species have wide ranges over large areas of arid Western Australia. None are officially listed as rare or otherwise in need of special protection (Davies 1985) and no species listed as rare or otherwise in need of special protection is likely to be present in the project area.

No snakes were caught, and although several rare species may be present in the area all are widespread and none would be endangered by the loss of a small area of habitat.

7.3.3 Birds

The 28 species identified in the survey area are unlikely to represent the total number of species present. Birds are typically very mobile and some species are uncommon, so that many species, possibly 60 to 100, could be observed over a very long time. However, a realistic estimate of the number of species which could be regarded as resident or reasonably regular visitors would be 40 to 50. Seasonal differences in the species would also be expected. In the present study the Red Wattlebird and Regent Parrot would be only winter and spring visitors, and other species will be observed with heavy flowering of particular plant species.

The 28 species observed represent most of the common species likely to be resident in the survey area and a proportion of the less common species. None of the species observed is rare or has a restricted range.

The avifauna is dominated by two species, the Weebill (39% of all individuals) and the Yellow-throated Miner (26.5% of all individuals). Only four other species are represented by 3% or more of the individuals (White-fronted Honeyeater 7.5%, Regent Parrot 3.5%, Jacky Winter 3.2% and Pied Butcherbird 3%). The remaining 15 species collectively represent only 17.3% of all individuals. Because the standardised transects are replicated five times there is a tendency for some individuals to be counted repeatedly. For example, half the White-fronted Honeyeaters were recorded at TS1, and these were almost certainly the same three individuals. The results are also confused by recording all identifiable birds. Some, such as the Little Falcon, are highly mobile and are not resident in a particular area.

Only 21 of the 28 species were recorded in the transects. The other seven species are mostly larger and more mobile birds which are present at lower densities.

The numbers of birds of each species observed at each trapping site are shown in Table D-4. The trapping sites are grouped into habitat types - woodland (including tree steppe), mallee and seven others - in Table D-7, with numbers of birds shown for each type. It is clear that the Weebill prefers the mallee (41.5% of the recordings of Weebills, rather than woodland (7.5%). Conversely, the Yellow-throated Miner prefers the woodland (with 35%) rather than mallee (5.5%). The diversity of species in the woodland sites is very low. Apart from the Weebill and Yellow-throated Miner, the other species are nearly all large birds (Ringneck Parrot, Regent Parrot, Ground Cuckoo-shrike and Crested Bellbird) and there is a conspicuous absence of small species. These small birds represent a much larger proportion in the mallee sites.

The difference between woodland and mallee trapping sites is probably due to a difference in plant density. The woodland has trees over spinifex with relatively few shrubs or mallees. The mallee areas tend to have a few trees with a greater density of shrubs and mallees, over spinifex. The smaller birds are largely insectivorous and feed in the shrub/mallee layer.

The remaining trapping sites are heterogeneous. They are mostly small areas of particular vegetation types surrounded by woodland or mallee. Trapping Sites 1, 4, 11 and 13 are surrounded by mallee and

Sites 8 and 10 by woodland. Trapping Site 3 is indeterminate. The distribution of species in these sites generally follows that of the surrounding vegetation (Table D-7).

7.3.4 Mammals

The small mammal trapping was very successful, with all but one of the anticipated species being caught. In addition, one species not previously recorded in Western Australia was caught. *Antechinomys laniger* shown in the adjacent photo, has a recorded distribution range which includes the survey area. It has a wide distribution but is not often collected and is rare or at best very local in distribution. It may be present in the survey area, but it was not found during the survey. The species not previously recorded in Western Australia is the Sandhill Dunnart, *Sminthopsis psammophila*.

All of the species collected, except *Sminthopsis psammophila*, have wide distributions over various parts of arid Australia, although some are not common within their ranges. *Dasycercus cristicauda* is rare throughout its range. It is a central Australian species, and the study site is probably close to the edge of its range. Both it and the Sandhill Dunnart are officially listed as rare or otherwise in need of special protection (Davies 1985). The *Dasycercus* is not threatened by the loss of small areas of its range.

The conservation status of *Sminthopsis psammophila* (Sandhill Dunnart) and its relative *Sminthopsis hirtipes* (Hairy-footed Dunnart) is uncertain (Frith 1979). The former is known only from three locations, roughly 1000km from each other, but from the same habitat in each case. The habitat is sandy country, with hummocks of porcupine grass and shrubs and wide swales between low, parallel sand ridges. This habitat is apparently widespread and the animal may also be widespread though rare. So little is known of its distribution that it is not possible to describe its conservation status with confidence. The Sandhill Dunnart is the only species recorded during the survey that is listed among 28 species of Australian marsupials that are at risk or probably extinct (Ride and Wilson 1982). At this stage it must be regarded as a very rare animal.

Sminthopsis psammophila was collected from Trapping Sites 5, 6, 7 and 11 and would appear to have been not uncommon at the time of the field survey. The five animals collected during the survey are the only ones ever caught in traps; the few Sandhill Dunnarts caught in 1984 and 1969 were all caught while they were running (Strahan 1983).

No useful comparison can be made of the distribution of any of the species between sites, except that no species appears to be site specific on the basis of the present results.

It is not known whether the great diversity of small mammals is a typical feature of the study area or whether it is due to a chance factor such as favourable weather. There are published records of only two previous organised mammal collecting expeditions in. the Great Victorian Desert. Burbidge and others (Burbidge et al. 1976; McKenzie and Burbidge 1979) carried out rapid but wide-ranging surveys in the

Great Victoria Desert after two exceptionally good seasons and found large numbers of small mammals although not the full range of expected species. Morris and Rice (1981) trapped at Queen Victoria Spring, approximately 60km south of the survey area, after bad seasons and caught only three individuals in total.

The survey carried out for the present study is the most intensive study carried out to date in the general region. There are no detailed weather records available, but from unofficial records in the Bureau of Meteorology it appears that there has been at least one good summer rainfall in each of the last three years. It is likely that while conditions have not been ideal they have also not been unfavourable. Under these conditions the native animals may have built up to relatively high numbers, which led to the relatively successful trapping of mammals during this survey. Wide fluctuations in numbers are typical of arid areas, with weather being the dominant factor. Fire is also likely to be important but its role is not well understood. No detailed discussion of the study area is possible), but it is clear that the area has not been burnt for at least ten years (K. Fulwood pers. comm.).

Eight of the eleven small mammal species are illustrated in Appendix D. The common house mouse is not illustrated. *Ningaui yvonnea* is indistinguishable from *Ningaui ridei* and is not illustrated. *Sminthopsis dolichura* is not illustrated because its taxonomy has been changed recently and most photographs cannot be identified.

8.0 RADIONUCLIDES AND HEAVY METALS

8.1 Introduction

Radionuclides and heavy metals in biological systems are poorly understood, but it must always be assumed that they enter biological systems and can then disperse or accumulate in ways which are not immediately obvious. Although biological systems in the survey area are relatively simple, it is not feasible to carry out a complete inventory survey. It is also difficult to predict the behaviour of radionuclides or heavy metals until a detailed mining and processing proposal is made.

The survey carried out was designed to give baseline data on radionuclides and heavy metals present in biological systems by examining selected plants and animals. The samples were to be collected and prepared for long term storage on the assumption that analyses would not be carried out until the mining proposal was more advanced.

8.2 Potential Pathways in Food Chains

The Mulga Rock survey area is an area of desert where there is a well developed flora and fauna but effectively no aquatic ecosystem. Aquatic ecosystems provide the greatest potential for biological movement of radionuclides and heavy metals. For instance, at the Ranger mine in Arnhem Land aquatic systems dominate the monitoring programme and include most of the "problem" situations.

Dust is the next greatest problem. Direct exposure to radiation is likely to be a relatively small problem.

These generalisations must be tempered by the nature of the local environment. At the Ranger mine there is a local population of Aborigines who do reside in the area and consume food and water locally. Under these conditions a great deal of attention must be given to human food chains rather than just animal and plant food chains. Conversely, in a dry environment with no local human population (other than workers) animal and plant food chains would be studied in their own right. The health of workers is a separate problem although the study of dust, for example, would be relevant to both.

Figures E-1a and E-1b give schematic outlines of major potential pathways for radionuclides and heavy metals. In practice, monitoring of the pathways is only feasible by measuring levels at each step. The major levels are soil, its flora and fauna, and above-ground invertebrates, plants, reptiles, birds and mammals.

The soil flora and fauna and the invertebrates are very large parts of any ecosystem, but they are generally not suitable for monitoring because they cannot be readily identified, are individually small and are difficult to collect.

Plants are typically good monitors because they are identifiable, sedentary, long-lived and easy to collect. The vertebrate groups are contradictory. They are useful in that they are identifiable and, being higher in food chains than plants, have a great capacity to concentrate radionuclides and heavy metals. Conversely, they are often not easy to collect and many are too mobile.

8.3 Survey Design

Only plants and vertebrate animals were considered for collection. Invertebrate animals and lower plants were not considered for several reasons: they are too small and too few to be collected in large enough sample sizes, they are too difficult to find, they are too ephemeral and they are too low on the food chain, as well as short lived, to concentrate radionuclides and heavy metals. The plants and animals collected were from sites close to the orebodies and between the orebodies. Two trapping sites (TS4 and TS10) were selected also because they are low-lying.

Collection of plant samples was based upon two criteria:

- long lived species which were common or widespread, and
- species which showed obvious browsing by vertebrates and would therefore be sources for them of radionuclides and heavy metals, if any.

The vertebrates presented some difficulties. Reptiles are very seasonal in their activity and are therefore unobtainable at times, but it may be possible to use some species for long-term monitoring. The bird species are mostly too mobile and are, therefore, unsuitable; the proportion of time any one bird spends in a particular area is variable and unpredictable. Of the few relatively sedentary species, only the Yellow-throated Miner is common, trappable and sufficiently large to be a possible monitor. However, at this stage the mammals appear to be more convenient. The mammals comprise three distinct groups – the Grey Kangaroo, the medium-sized animals (dog/dingo, cat and rabbit) and the small mammals.

The Grey Kangaroo is reasonably sedentary, but it is likely to have a home range of some kilometres. It is also large and relatively easily collected and is therefore a preferred animal for monitoring. Furthermore, study of the kangaroo would also be critical if it should be necessary to consider Aboriginal food chains.

The medium sized animals are either very difficult to catch (dog/dingo and cat) or very scattered and irregular in distribution (rabbit) and are therefore not suitable monitors. The small mammals are heterogeneous. They include seed-eaters (the House Mouse and native mice) and insectivores (all others), vary greatly in abundance between species, vary greatly in abundance between years and are individually small although potentially available in large numbers.

The survey was set up to sample vascular plants, Grey Kangaroos and small mammals for the reasons given above.

8.4 Results

The plants sampled are listed in Tables E-1 and E-2.

The small mammals prepared for radionuclide and heavy metal analyses are listed in Table E-3, and the wet and ash weights of the samples are given in Table E-4. Ten Grey Kangaroos were also collected

(Table D-1) and samples of heart, kidney, liver and meat were prepared for analysis. The wet and ash weights of these are also given in Table E-4.

8.5 Discussion

The catch of the different small mammal species varied greatly (Table D-6). Two of the species, *Dasycercus cristicauda* and *Sminthopsis psammophila*, are gazetted as rare or otherwise in need of special protection and should not be used as monitors (Davies 1985).

The remaining species of small mammals caught include three seed eaters and six insectivores. The insect eaters are preferable as monitors because they are higher up the food chains, but any of these species could be a suitable monitor. The final choice will depend on the abundance of the species and the particular circumstances at the time when mining proposals are more definite.

The construction of a mine and processing facility will alter the distribution of animals. The major effects will be an increase in human-tolerant scavengers, such as crows, and possibly the establishment of an aquatic ecosystem as part of the processing cycle.

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Pressing, drying and fumigating facilities of the Western Australian Herbarium, and its reference collections, were made available by the Curator, J.W. Green, and a set of labelled, identified herbarium specimens from the project area is being donated to the Western Australian Herbarium.

The animal experts include D. King of the Agriculture Protection Board and staff members of the Western Australian Museum, particularly D. Kitchener, L. Carlton and J. White.

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APPENDICES

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APPENDIX A

VEGETATION FIGURES (MAPS), TABLES AND PLATES

TABLE A-I PLANT ASSOCIATIONS AND VEGETATION COMPLEXES OF THE MULGA ROCK PROJECT AREA, GREAT VICTORIA DESERT

SECTION	ASSOCIATION	SUBSTRATE	PLATES	SYMBOL	TRAPPING SITES		
					AREA		VEGETATION SITES
5.2.1	**Low Woodlands (1-)10-30(-70)%; 4->10m[1]**			W			
5.2.1.1	Mulga (*Acacia aneura*) Low Woodlands/Scrub	Various; outcrops, loamy soils	1A, B, C, D	WA	3%	-	34, 47A, 48, 49, 53, 55, 56, 57
5.2.1.2	Black Oak (*Casuarina cristata*) Open Low Woodland	Calcareous, pans	IE	WO	+	-	72
5.2.1.3	Cypress Pine (*Callitris* spp.) Low Woodland to Open Scrub	Sandy & loamy soils & sand ridges	1F, G	WP	3%	5, 9, 12	7, 22, 26, 32, 51
5.2.1.4	Marble Gum (*E. gongylocarpa*) Open Low Woodland	Sands & loamy sands, plains	1H	WB	+	-	3, 28
5.2.1.5	Redwood (*E.* aff. *transcontinentalis*) Woodlands	Red earths on northern plateau	2A	WR	+	-	57
5.2.1.6	*Eucalyptus* sp.(ASW 14938) Mallee Low Woodland	Calcareous red earths	2B	WE	+	-	75
5.2.1.7	Kopi Mallee (*E. leptophylla* var. *leptophylla*) Low Open Woodland	Gypsum soils	2C	WK	+	4, 10	9, 10, 12, 13, 43?, 73
5.2.2	**Mallee (*Eucalyptus*) Shrublands (1-)10-30(-70)%; 2-4(-8)m[1]**			M			
5.2.2.1	Narrow-leaved Mallee (*E. leptophylla* sens. lat.) Shrubland	Sands & loamy sands	2D	MI	30%	7, 14	4
5.2.2.2	Flowery Mallee (*E. leptophylla* var. *floribunda*) Shrubland	Sand & loam over gypsum	2E	M2	5%	3, 6	9A, 11, 14?, 16
5.2.2.3	Stiff-leaved Mallee (*E. rigidula*) - Narrow-leaved Mallee (*E. leptophylla*) Shrubland	Sandy calcrete soils, mainly rises	2F	M3	5%	12	2, 6, I5B, 40, 41, 44, 65A, 66
5.2.2.4	Woodline Mallee (*E. cylindrocarpa*) Shrubland	Dark loamy soils	-	M4	1%	-	17, 18
5.2.2.5	*E. mannensis* Mallee Shrubland	Red-brown loamy sands	2G, 1H	M5	1%	8	7, 28
5.2.2.6	Tammin Mallee (*E. leptopoda*) Shrubland	Sandy soils over laterite	2H	M6	3%	-	8C, 3I, A, 47B, 52
5.2.2.7	Oldfield's Mallee (*E. oldfieldii*) Shrubland	Pale sand with laterite gravel	3A	M7	+	-	46, 50, 52
5.2.2.8	*Eucalyptus* sp.(ASWI4854) Mallee Shrubland	Sandy loam on calcrete & gypsum	-	M8	+	-	15C
5.2.2.9	Boorabbin Mallee (*E. platycorys*) Shrubland	Sandy loams	3B	M9	+	12	41
5.2.3	**Scrubs (1-)10-30(->70)%; <2m[1]**			S			
5.2.3.1	*Acacia sibirica* Scrub	Low-lying red-brown compact soils	-	SI	+	-	8B, 31, 45A
5.2.3.2	*Acacia jutsonii* Scrub/Open Scrub	Various sands and loams	3C, D	S2	30%	1, 7	1, 35, 39, 45, 47, 47A, 50, 52, 67, 68, 69, 70
5.2.3.3	Bastard Mulga (*A. stowardii*) Scrub	Loams on laterite or sandstone	-	S3	+	-	34, 53
5.2.3.4	*Acacia acuminata* Scrub	Compact earths, often with kopi	3E	S4	3%	-	18, 19, 44, 53, 54
5.2.3.5	*Acacia helmsiana* Mixed Scrub	Sandy soils	3F, 2G	S5	1%	-	7A, 22, 37
5.2.3.6	Broombush (*Melaleuca uncinata*) Thicket/Scrub	Compact red-earths & sandy loams	3G	S6	2%	11	38, 50, 59, 61, 67, 70
5.2.3.7	Saltbush (*Atriplex stipitata*) Dwarf Scrub	Crystalline and kopi soils	3H	S7	+	10	10A
5.2.3.8	*Allocasuarina acutivalvis* Scrub	Various; mainly sandy	2H	S8	2%	-	30
5.2.4	**Steppes**			-			
5.2.4.1	Marble Gum (*E. gongylocarpa*) Tree Steppes	Sand plains and slopes	4A-G	HW	>60%	2, 5, 9	3, 7, 21, 23, 25, 28, 29, 33, 34, 36, 40, 42, 47A, 51-54, 58, 60, 62
5.2.4.2	Shrub Steppes	Sand plains and slopes	-	HY	20%	-	-
5.2.4.3	Grass Steppe	Sand plains	-	H	+	-	-
5.2.4.4	*Chrysitrix distigmatosa* Sedge Steppe	Low-lying heavy soils	4H, 3D	C	+	-	27, 35, 63, 63A, 69
5.2.5	**Complexes**						
5.2.5.1	Sand Ridge (Dune) Complexes	Sand ridge crests & upper slopes	-	D	10%	8, 13	3A, 5, 20, 71
5.2.5.2	Kopi Complexes	Gypsum-rich soils	-	K	1%	4, 10	9, 10, 12, 13, 19, 73
5.2.5.3	Varnished Claypan Complex	Claypans	-	V	+	-	18

I. Percentage canopy cover and height in metres of the dominant or tallest species.

CAPTIONS – PLATE 1 – VEGETATION (WOODLANDS)

A Mulga Low Woodland/Forest (WA; VS34; ASW2-21)
Unburnt, on sandstone knoll. *Eremophila* spp. and *Olearia* sp. in understorey.

B Mulga Low Woodland/Forest (WA; VS34; ASW2-24)
On slopes of sandstone knoll as seen from bare area near summit. *Eremophila*? *decipiens* in foreground. Mallees in background.

C Mulga Low Woodland (WA; VS49; ASW4-3)
Unburnt mulga on sandy soil with porcupine grass and *Eremophila* spp.

D Mulga Scrub (WA; VS48; ASW4-0)
Several year old stand, regenerating after fire. With small myrtaceous shrubs and *Phebalium canaliculatum*.

E Black Oak Open Low Woodland (WO; VS72; ASW4-29)
Small, open stand of trees with sparse shrub layer and no porcupine grass, on calcareous hard pan with bits of calcrete. Southern part of SW quadrant.

F Cypress Pine Low Woodland (WP; VS26; ASW2-8)
Copse on sand ridge that escaped burning. With mallee, *Allocasuarina acutivalvis*, *A. Corniculata* (short), *Lepidobolus desertii* and porcupine grass.

G Cypress Pine Low Woodland (WP; VS51; ASW4-7)
Unburnt cypress pine with *Allocasuarina acutivalvis*, *Acacia ligulata*, *A. tetragonophylla*, *Scaevola spinescens*, mallee, marble gum and porcupine grass. At edge of marble gum steppe.

H Marble Gum Open Low Woodland (WB; VS28; ASW2-18)
Atypically dense stand of straight-stemmed marble gums with *E. mannensis* on sand and laterite gravel in foreground.

PLATE 1

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CAPTIONS - PLATE 2 - VEGETATION (WOODLANDS & MALLEES)

A Redwood Low Woodland (WR; VS57; ASW4-15)
An apparently undescribed eucalypt to over 12m tall, with mulga and porcupine grass. Mainly north of the project area on heavier soils.

B *Eucalyptus* spp. (ASW 14938) Low Woodland (WE; VS75; ASW4-30)
Apparently two species of eucalyptus, E. *comitae-valis* and *E*. sp. nov., with an open understorey, on calcareous red earth.

C Kopi Mallee Low Open Woodland (WK; VS9:ASW1-23)
Eucalyptus leptophylla var. *leptophylla*, with an open understorey of *Lachnostachys bracteosa*, *Grevillea acuaria* and porcupine grass on flocculated soil with crystelline gypsum.

D Narrow-leaved Mallee Shrubland (M1; VS4, TS7; ASW1-6)
Typical stand of narrow-leaved mallee shrub land or steppe, with *Eucalyptus leptophylla* sens. lat. about 2m tall and porcupine grass, on red sandplains.

E Flowery Mallee Shrubland (M2; VS16; ASW1-33)
Mallee shrubland similar to M1 but with *Eucalyptus leptophylla* var. *floribunda* and gypsum-rich red earth soils.

F Stiff-leaved Mallee - Narrow-leaved Mallee Shrubland (M3; VS2; ASW1-2)
Eucalyptus rigidula and *E. mannensis* mallees about 3m tall on calcrete knoll, with dead, burnt stems, *Allocasuarina helmsii*, *Acacia ligulata* and, in foreground, porcupine grass and *Chrysitrix distigmatosa*.

G *E. mannensis* Mallee Shrubland (M5; VS7; ASW1-12)
Enclave of mixed *E. mannensis* shrubland in marble gum steppe, with Cypress pine, *Hakea minyma* and *Acacia rigens*. *Phebalium canaliculatum* shrubs on sandier soil in foreground.

H Tammin Mallee Shrubland (M6; VS47B; ASW4-5)
A moderately dense mixed stand of *E .leptopoda* and *Allocasuarina acutivalvis*.

PLATE 2

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CAPTIONS - PLATE 3 - VEGETATION (MALLEES & SCRUBS)

A Oldfield's Mallee Shrubland (M7; VS46; ASW3-8)
E. Oldfieldii mallee with *Allocasuarina acutivalvis*, *Banksia elderiana*, *Acacia* spp. and porcupine grass, on pale, fine-grained sand with scattered lateritic gravel.

B Boorabbin Mallee Shrubland (M9; VS41A: ASW2-17)
E. platycorys and *E.* ? *rigidula* with, primarily, *Bertya dimerostigma*, Species ASW 14874 and porcupine grass.

C *Acacia jutsonii* Scrub (S2; VS47A; ASW4-6)
Extensive stand of *A. jutsonii* on sandy soil with Oldfield's mallee and marble gum in mid-ground, marble gum steppe in background, and mulga on horizon.

D *A. jutsonii* Scrub/*Chrysitrix distigmatosa* Sedge Steppe (S2/C; VS35; ASW2-12)
Chrysitrix and *Baeckea* sp. (ASW 14813) at bottom of depression (foreground), then a band of porcupine grass and, beyond it, *A. jutsonii* behind, with *Bertya dimerostigma* and *Eucalyptus trivalvis*.

E *A. acuminata* Scrub (S4; VS44; ASW3-6)
Bowgada-like *A. acuminata* on clay pan with kopi mallee in distance; at late afternoon.

F *A. helmsiana* Mixed Scrub (S5; VS22; ASW2-1)
Scrub mostly under 1m tall: *A. helmsiana*, *A. rigens*, *Beyeria brevifolia*, *Phebalium tuberculosum*, ASW 14874.

G Broombush Thicket (S6; VS38; ASW2-15)
Melaleuca uncinata shrubs to 2m tall; *E. concinna*, *E.* ? *platycorys* and other mallees in background.

H Saltbush Dwarf Scrub (S7; VS10; ASW1-29)
Crystalline gypsum and *Atriplex stipitata*, extending into kopi mallee in background.

PLATE 3

CAPTIONS - PLATE 4 - VEGETATION (STEPPES)

A Marble Gum Tree Steppe (HW; VS8C; ASW1-19)
Widely scattered marble gums with porcupine grass (*Triodia basedowii*) and various mallee and shrub communities, at sunset.

B Marble Gum Tree Steppe (HW; VS21; ASW2-0)
Tree steppe and low shrubs between sand ridges, PNP1936.

C Marble Gum Tree Steppe (HW; VS23A; ASW2-2)
Tree steppe with little porcupine grass and many shrubs. Species ASW 14874, *Bertya dimerostigma*, *Callitris columellaris*.

D Marble Gum Tree Steppe (HW; VS23B; ASW2-3)
Typical simple tree steppe across the track from 4C, with marble gums to more than 14m tall and porcupine grass and virtually nothing else. *Santalum acuminatum*, *Alyxia buxifolia*, *Acacia* sp. and 4C species in background.

E Marble Gum Tree Steppe (HW; VS42; ASW3-0)
Tree steppe just east of PNP1948 with *E*. ? *leptophylla*, *Eremophila platythamnos* and *Xanthorrhoea thorntonii*.

F Marble Gum Tree Steppe (HW; -; ASW1-15)
Acacia jutsonii as the principal understorey in tree steppe, with narrow-leaved mallee.

G Marble Gum Tree Steppe (HW; VS36; ASW2-14)
Marble gum congregations often have communities of particular small shrubs instead of porcupine grass, including *Eremophila platythamnos* and *Olearia exiguafolia*.

H *Chrysitrix distigmatosa* Sedge Steppe (C; VS69; ASW4-20)
Extensive stand of *Chrysitrix* with porcupine grass, *Baeckea* sp. (ASW 14813) and other species.

PLATE 4

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APPENDIX B

FLORA TABLE AND PLATES

SYSTEMATIC LIST OF CHARACTERISTIC AND CONSPICUOUS VASCULAR IN PNC MULGA ROCKS LEASE AREA OFFICER BASIN , GREAT VICTORIA DESERT

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
	7 ADIANTACEAE		
Cheilanthes austrotenuifolia H.Quirk & T.C.Chambers			34
	18 CUPRESSACEAE		
Callitris columellaris F.Muell.		SOC	3, 26, 32, 33
Callitrix pressii Miq.ssp.verrucosa (A.Cunn.ex Endl.) J. Garden			5, 51
	13 POACEAE		
Eragrostis australasica (Steudel) C.E.Hubb.		14857	18
Triodia ? basedowii E.Pritzel		14771	Most
	32 CYPERACEAE		
Caustis dioica R.Br.		14792	5
Chrysitrix distigmatosa C.B.Clarke		14773	1, 2, 4, 7A, (1)
Lepidosperma viscidum R.Br.		14877	28
Schoenus brevisetis (R.BR.) Benth.		14815	(1)
	39 RESTIONACEAE		
Lepidobolus deserti Gilg		14783, 14791	3, 5
	54C DASYPOGONACEAE		
Lomandra leucocephala (R.Br.) Ewart ssp. robusta A.T. Lee		14781, 14844	3, 5, 9A
	54D XANTHORRHOEACEAE		
Xanthorrhoea thorntonii Tate			
	54E PHORMIACEAE		
Dianella revoluta R.Br.			
	70 CASUARINACEAE		
Allocasuarina acutivalvis (F.Muell.) L. Johnson		SOC, 14827, 14870	20, 26, 27, 30, 31, 33
Allocasuarina corniculata (F.Muell.) L. Johnson		14788	5, 26

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
Allocasuarina helmsii (Ewart & M. Gordon) L. Johnson		SOC, 14776, 14803	2, 6
Casuarina cristata Miq.		14936	72
	90 PROTEACEAE		
Banksia elderiana F.Muell.& Tate		14775	1, (1)
Conospermum leianthum E.Pritzel		14864	20
Grevillea acuaria F.Muell.ex Benth.		14852, 14897	15C, 40
Grevillea ? armigera Meissner		14912	46
Grevillea didymobotrya Meissner		14871	(8)
Grevillea sarissa S.Moore		14860, 14903	19, 44
Grevillea sp.		14796	5
Grevillea sp.		14839	9
Grevillea sp. inedit.(aff.hakeoides; ASW 14875, PER)		14875, 14924	25-26, 53 + 54
Hakea francisiana F.Muell.		14774	1, 3, 7
Hakea minyma Maconochie		14833	
Persoonia sp.nov.(ASW 14789, PER)		14842, 14789	5, 9
	92 SANTALACEAE		
Choretrum ? glomeratum R.Br.		14820	
Exocarpos sparteus R.Br.		14824, 14909	46
Santalum acuminatum (R.Br.)A.DC.		SOC	2, 3, 6, 8, 8A
Santalum ? murrayanum (Mitch.) C.Gardner			5
	97 LORANTHACEAE		
Amyema miquelii (Lehm.ex Miq.)Tieghem		14821	
	105 CHENOPODIACEAE		
Atriplex stipitata Benth.		14846	10
Maireana suaedifolia (Paul G.Wilson) Paul G.Wilson		14906	
Rhagodia drummondii Moq.		14848	10

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
	106 AMARANTHACEAE		
Ptilotus ? obovatus (Gaudich.)F.Muell.			(1)
	108 GYROSTEMONACEAE		
Codonocarpos cotinifolius (Desf.)F.Muell.			
Gyrostemon ? ramulosus Desf.		14863	20
	111 PORTULACACEAE		
Calandrinia sp.			(10)
	152 PITTOSPORACEAE		
Billardiera bicolor (Putterl.)E.M. Bennett var. bicolor		14824	
	163 MIMOSACEAE		
Acacia acanthoclada F.Muell.		14911	46
Acacia acuminata Benth.		SOC, 14861A, 14922	19, 53, 54
Acacia aneura F.Muell.ex Benth.		14913	48
Acacia colletioides Benth.		14817, 14849A	8, 10
Acacia? duriuscula W.Fitzg.		14858	18
Acacia fragilis Maiden & Blakely		SOC, 14785	5
Acacia grasbyi Maiden		14921, 14926	53 + 54, 55
Acacia helmsiana Maiden		14780	3
Acacia hemiteles Benth.		14805	6
Acacia jutsonii Maiden sens.lat.		14770B, 14835, 14880	1, 35, (1)
Acacia kempeana F.Muell.		(?)14923	53, 54
Acacia ligulata Cunn.ex Benth.		14804, 14779, 14886, 14917	2, 6, 34, 51
Acacia rigens Cunn.ex Don		14770C, 14810, 148470(?), 14874A	1, 7, 9(?), 22
Acacia sibirica S.Moore		14770A, 14832	1, (1)
Acacia stowardii Maiden		SOC, 14884, (?)14913, (?)14921	34, 48, 53, 54

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
Acacia tetragonophylla F.Muell.		14919	51
	264 CAESALPINIACEAE		
Cassia nemophila Cunn.ex Vogel		14937	3, 8A, 72
	165 PAPILIONACEAE		
Daviesia benthamii Meissner		SOC	
?Daviesia sp.		14798, 14851	5, 11
Gastrolobium sp.		SOC, 14834(?)	(6)
	167 GERANIACEAE		
Erodium sp.			(10)
	173 ZYGOPHYLLACEAE		
Zygophyllum sp.			(10)
	175 RUTACEAE		
Microcybe multiflora Turcz. var. baccharoides		SOC	
Phebalium canaliculatum (F.Muell. & Tate)J.H. Willis		14819	7A
Phebalium filifolium Turcz.		14831	
Phebalium tuberculosum (F.Muell.)Benth.		SOC, 14873	22
	183 POLYGALACEAE		
Comesperma scoparium Steetz		14868	20
	185 EUPHORBIACEAE		
Adriana hookeri (F.Muell.)Muell.Arg.		14843	9
Bertya dimerostigma F.Muell.		14822	7, 7A
Beyeria brevifolia (Muell.Arg.)Benth. var. robustior		14872	22
Monotaxis luteiflora F.Muell.		14896	38
sp.		14811	7
	207 SAPINDACEAE		
Dodonaea lobulata F.Muell.		14883	34

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
Dodonaea stenozyga F.Muell.		14808	6
Heterodendrum oleaefolium Desf.		14905	44
	215 RHAMNACEAE		
Cryptandra ? nutans Steudel		14793	5
	223 STERCULIACEAE		
Rulingia sp.		SOC	
	243 VIOLACEAE		
Hybanthus floribundus (Lindley) F.Muell.		14865	20
	273 MYRTACEAE		
Baeckea aff. clavifolia S.Moore		SOC	
Baeckea (1) cryptandroides F.Muell.		14772, 14814, 14836	1, (1)
Calothamnus gilesii F.Muell.		14790, 14799	5
Calothamnus sp.nov.		SOC	
cf.Calytrix sp.		SOC	
Eucalyptus comitae-vallis Maiden		14938	75
Eucalyptus concinna Maiden & Blakely		14894	38
Eucalyptus cf. conglobata (R.Br. ex Benth.) Maiden		SOC	
Eucalyptus cylindriflora Maiden & Blakely		SOC, 14855A, 14902	17, 18?
Eucalyptus cylindrocarpa Blakely		SOC, 14855	17
Eucalyptus gongylocarpa Blakely			3, 7
Eucalyptus gracilis F.Muell.		14801	6
Eucalyptus incrassata Labill.		14782, 14935	3, (5), 5
Eucalyptus leptopoda Benth.		14834	
Eucalyptus leptophylla F.Muell.ex Miq ssp.floribunda Blakely ex Miq.		14802, 14818, 14895	6, 8, 38, (2), (3), 6A
Eucalyptus leptophylla F.Muell.ex Miq. ssp.leptophylla		14930, 14931 14841	9

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
Eucalyptus leptophylla F.Muell.ex Miq .sens. lat.		14932	(7), 4
Eucalyptus mannensis Boomsma		14778, 14809, 14823, 14876	2, 7, 28
Eucalyptus oldfieldii F.Muell.		14908	46
Eucalyptus platycorys Maiden & Blakely		14899	41
Eucalyptus rigidula Maiden		14777, 14831A, 14898	2, 40
Eucalyptus aff. transcontinentalis Maiden		14927	57
Eucalyptus trivalvis Blakely·		14879A	35
Eucalyptus yilgarnensis Diels.		14900	(10)
Eucalyptus youngiana F.Muell.		SOC	5
Eucalyptus sp.		14854	15C
Eucalyptus sp.		14938A	75
Leptospermum fastigiatum S.Moore		14816	(1, 7A)
Leptospermum roei Benth.		SOC	
Melaleuca eleuterostachya F.Muell.		14850	11
Melaleuca uncinata R.Br. sens.lat.		14893, 14933	38, (6)
Micromyrtus flaviflora (F.Muell)F.Muell. ex J.Black		14826	
Thryptomene ? maisonneuvei F.Muell.		14920	54
Thryptomene sp. inedit. (ASW 14786, PER)		14786	5
Verticordia picta Endl.		14867	20
Wehlia thryptomenoides F.Muell.		14812	1, (1)
	276 HALORAGACEAE		
Glischrocaryon flavescens (J.Drumm. ex Hook.) Orch.		14794	5
	281 APIACEAE		
Platysace effusa (Turcz.)Norman		14910	46

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
	288 EPACRIDACEAE		
Leucopogon sp. (L.imbricata group)		14829	
Styphelia sp.		14797	5
	301 OLEACEAE		
Jasminum didymum G.Forster		14885	4
	304 APOCYNACEAE		
Alyxia buxifolia R.Br.			23
	311A CHLOANTHACEAE		
Dicrastylis nicholasii F.Muell.		14878	31
Lachnostachys ? bracteosa C.Gardner		14878	91
Newcastelia hexarrhena F.Muell.		14861	20
Newcastelia viscida E.Pritzel		SOC	
Pityrodia lepidota (F.Muell.)E.Pritzel		SOC, 14784	4
Pityrodia loricata (F.Muell.)E.Pritzel		14828	8AA
	313 LAMIACEAE		
Prostanthera sp.		14890A	35
Westringia dampieri R.Br.		SOC	
	326 MYOPORACEAE		
Eremophila clarkei A.F.Oldfield & F.Muell.		14881	34
Eremophila decipiens Ostenf.		14847, 14859, 14904	10, 18, 44
Eremophila forrestii F.Muell. (=E.leucophylla)		14914	49
Eremophila latrobei F.Muell.ssp.ined.		14879, 14915	34, 49
Eremophila latrobei F.Muell.ssp.latrobei			
Eremophila latrobei F.Muell.		SOC	
Eremophila longifolia (R.Br.) F.Muell.		SOC	
Eremophila miniata C.Gardner		14856	18
Eremophila paisleyi F.Muell.		14845	10

Species	Family	Collectors/ Numbers	Vegetation/ (Trapping) sites
Eremophila platythamnos Diels		14899, 14892, 14901, 14928	34, 36, 42, (2)
	331 RUBIACEAE		
Canthium lineare E.Pritzel		14888, 14916	34, 49
	341 GOODENIACEAE		
Dampiera oligophylla Benth.		SOC	
?Goodenia sp.		14830	
Scaevola spinescens R.Br.		14853, 14887, 14918	2, 11, 34, 51, 8A
	345 ASTERACEAE		
Helipterum ? pterochaetum (F.Muell.)Benth.		14862	20
Olearia cf. cassiniae Benth.		14849	10
Olearia exiguifolia (F.Muell.)F.Muell.ex Benth.		14891	36
Olearia lanuginosa (J.H.Willis)Wakef.		14866, 14787	5, 20
Olearia muelleri (Sonder)Benth.		14806	6
Olearia cf. revoluta F.Muell.ex Benth.		14807	6
Olearia sp.		14882, 14929 (?)	34, (2)
?Olearia sp.		14890	34
?Olearia sp.		14907	44
Senecio magnificus F.Muell.		14838	9
	FAMILY INDET.		
ASW 14800			
ASW 14869			20
ASW 14874			22

KEY

Species	Species names and authors follow Green (1985), except some species of *Eucalyptus* which follow Brooker (pers. comm.).
Family	The family numbers and names also follow Green (1985).
Collectors/Numbers	'SOC' is for Sue O'Connor, who made a few collections during archaeological field work in November and December 1983. Her specimens were identified by M.E. Trudgen. The five digit numbers in the 14000 Series refer to collections made by Arthur Weston in June 1985.
Vegetation/Trapping Sites	The numbers refer to detailed observation and trapping sites at which the species were collected or observed or both, in June 1985. Trapping site (or trapline) numbers are in brackets. Vegetation site numbers are not. The listing of sites is representative, not comprehensive.

Note: This list of about 150 species is not complete, although it is comprehensive for widespread, common, characteristics distinctive and conspicuous shrubs and trees occurring in the area.

CAPTIONS - PLATE 5 - FLORA

A Buds and flowers of Ooldea Mallee (*Eucalyptus youngiana*). Stamens red and anthers yellow. Common, large-flowered, large-fruited mallee in marble gum tree steppe. (ASW).

B Ooldea Mallee flower with yellow stamens and anthers. Also common. (ASW).

C *Eremophila latrobei* F. Muell. ssp. *glabra* (L.S. Smith) (ASW 14915) at Vegetation Site 49, in small stand of mulga (ASW 4-7).

D *Eremophila latrobei* F. Muell. ssp. *latrobei* (ASW 14925) at Vegetation Site 49. (ASW 4-13).

E *Eremophila forrestii* F. Muell. (ASW 14914) at Vegetation Site 49 in small stand of mulga (ASW 4-3).

F Raised lignotuber and lower stems of *Eucalyptus*? *leptophylla* F. Muell. ex Miq. ssp. *floribunda* Blakely, west of VS10.

G *Acacia grasbyi* at Vegetation Site 56, with prominent minni - ritchi bark. (ASW 4-14).

PLATE 5

A

B

C

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G

CAPTIONS - PLATE 5a – RARE FLORA

A *Dicrastylis nicholasii* F.Muell. herbarium specimen.

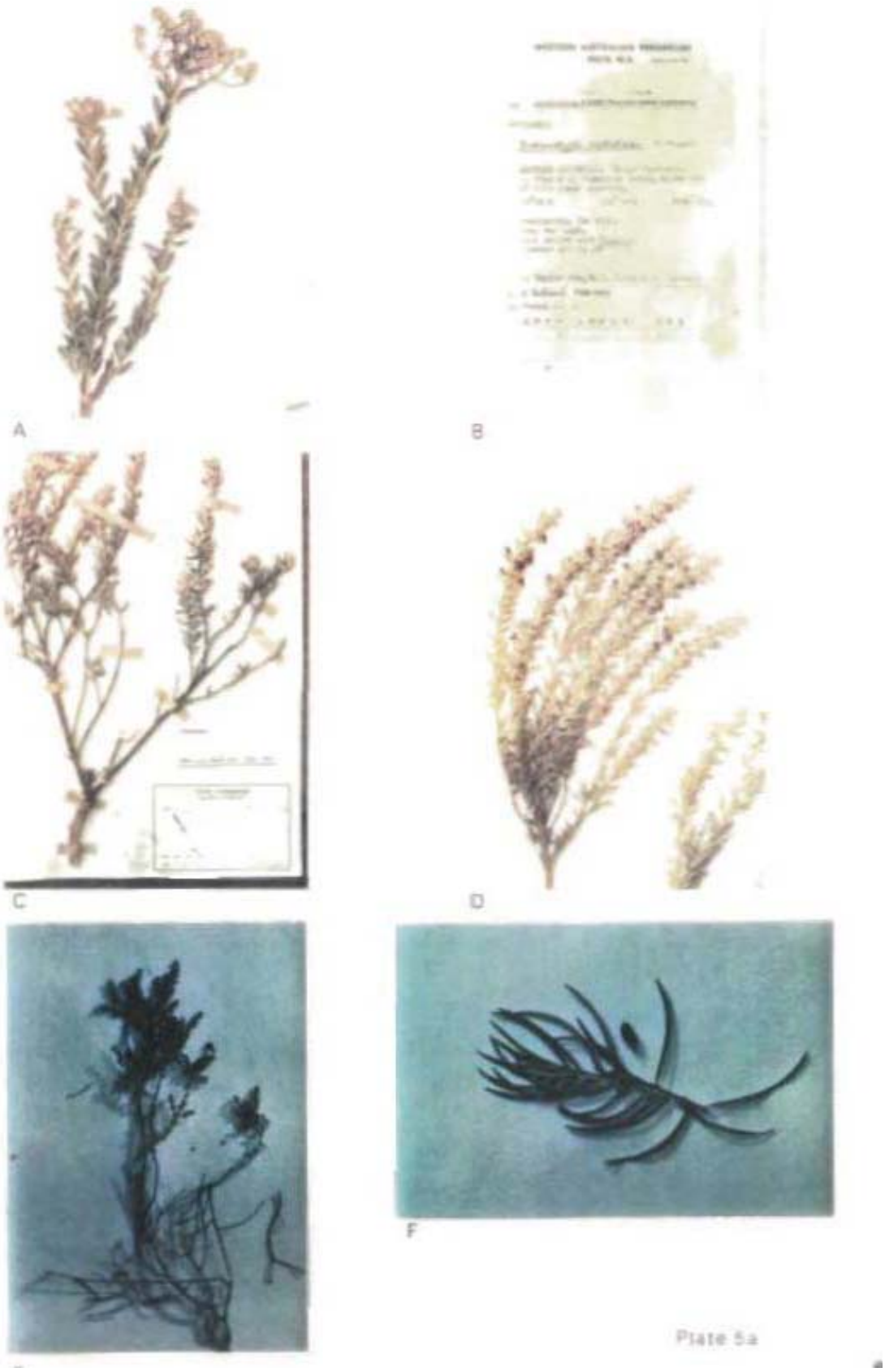
B *Dicrastylis nicholasii* herbarium specimen label, "c.35km w. of Plumridge Lakes".

C, D *Pityrodia loricata* (F.Muell.) E. Pritzel herbarium specimen.

E *Thryptomene* sp. inedit. (ASW 14786) herbarium specimen with fruit.

F *Persoonia* sp. nov. (ASW 14789) herbarium specimen with fruit.

PLATE 5a



APPENDIX C

TRAPPING SITES AND TRAPLINES

TABLES, DESCRIPTIONS AND PLATES

TABLE C-1

Trapping Site Locations

Trapping Site	Location
1	Opposite “PNC 10”. (Near NE corner of Airstrip).
2	Opposite "PNP 2383". (CD-1256)
3	150m N.W. from "PNP 2325". (1-1156).
4	Opposite "PNP 393". (1-211)
5	900m N.W. from the corner near "PNP 495". (1-191)
6	50m N.W. from "PNP 502". (1-158)
7	S.W. side of the water bore number 2, PNP 359. (1-471B).
8	100m N.E. from "PNP 2119". (CD-1073)
9	Opposite "PNP 1668". (CD-765)
10	At "PNP 1584". (Midway between 1-21 and CD823)
11	50m S.E. along a track, from main road near "PNP 1652". (1-619)
12	At "PNP 748". (1-457)
13	On top of a sand ridge, on the south side of the track, approximately 200m from Trapping Site 14.
14	50m S.E. from "PNP 2357". (1-1231)

Note: The numbers on tags at the locations indicated above were, respectively: TS1-PNC10, TS2-CD1256, TS3-1156, TS4-211, TS5-191, TS6-PNP502, TS7-PNP1835 and PNP1834, TS8-PNP2119, TS9-705, TS10-PNP1584, TS11-1652, TS12-PNC457, TS14-1231. The non-PNP numbers have, where possible, been translated into PNP numbers from the 21.06.85 Survey Data Report.

TABLE C-2

Summary of the trapping sites. The orebodies are Emperor (A), Shogun (B) and Ambassador (C)

Trapping Site	Vegetation	Soil	Nearest Orebody	No. of Days Trapped
1	*Acacia jutsonii* open scrub	Deep yellow sand	C	13
2	Marble Gum tree steppe	Deep yellow sand	C	13
3	Flowery Mallee shrubland	Red earth over calcrete at 40cm	C	12
4	Kopi Mallee low woodland	Red sand over kopi	A/B	12
5	Marble Gum tree steppe	Deep yellow sand	B	12
6	Flowery Mallee shrubland	Deep yellow sand	B	12
7	Narrow-leaved Mallee shrubland/*Acacia jutsonii* open scrub	Deep yellow sand	C	11
8	Sand ridge complex and mallee on mid-slope	Deep yellow sand	A	11
9	Cypress Pine low woodland in Marble Gum tree steppe	Deep yellow to red sand with hard brown earth	A	11
10	Kopi Mallee low woodland/ Saltbush dwarf scrub	Red earth over kopi	A	11
11	Broombush thicket	Deep yellow-red sand	B	10
12	Boorabbin Mallee shrubland	Deep red sand	A	10
13	Sand ridge complex	Deep yellow sand	C	8
14	Narrow-leaved Mallee steppe	Deep red sand	C	6

VEGETATION OF THE TRAPLINES

The following tables detail and illustrate the vegetation sampled by the pit traps and fences in Traplines 1 to 14. Each outline lists the species, by status (see Muir 1977), that are next to the drift fence or over it, their heights and the percentage of the 50cm wide fence strip they or their canopies cover. In many cases the total cover exceeds 100% because the cover of each stratum or layer is considered separately; the tree canopy often overlaps a shrub layer canopy, both of which overlap the porcupine grass or herbaceous plant layer canopy.

TRAPLINE 1

***Acacia jutsonii* Open Scrub**

	Height	Cover
Stratum 1	1.0 – 1.5m	10%
Acacia jutsonii	1.3m	5-10%
Acacia sibirica	1.3m	<1%
Banksia elderiana	1. 5m	<1%
Leptospermum fastigiatum	1m	<1%
Stratum 2	<0.2-0.5	ca30%
Triodia basedowii	0.2m	10-30%
Wehlia thryptomenioides	<0.5m	1%
Baeckea cryptandroides	<0.5m	<10%
Schoenus brevisetus	<0.2m	1%
Chrysitrix distigmatosa	0.5m	1-5%
Bare ground		ca30%

TRAPLINE 2

Marble Gum (*Eucalyptus googylocarpa*) Tree Steppe

	Height	Cover
Stratum 1	8-14m	1-10%
Eucalyptus gongylocarpa		

	Height	Cover
Stratum 2	3-4m	ca1%
Eucalyptus leptophylla var. *floribunda*		
Callitris glumellaris		
Stratum 3	0.4-0.8m	1-2%
Olearia sp.		
Bertya dimerostigma		
Species ASW 14874		
Eremophila platythamnos		
Stratum 4	0.2m	ca30%
Triodia basedowii		
Bare ground		>30%

TRAPLINE 3

Flowery Mallee (*E. leptophylla* var. *floribunda*) Shrubland

	Height	Cover
Stratum 1	to 8m	ca30%
Eucalyptus leptophylla		>60% at S end
Stratum 2	1.0-2.5m	?
? Santalum sp. (at S end)		<10%
Acacia colletioides (at N end)		ca30%
Stratum 3	0.2m	
Triodia basedowii (at N end)		>30%
Bare ground		ca50%

TRAPLINE 4

Kopi Mallee (*E. leptophylla* var. *leptophylla*) Low Woodland

	Height	Cover
Stratum 1	6m	ca50%
Kopi Mallee		>60% at S end
Stratum 2	1.5-2.0m	>20%
Acacia colletioides		
Triodia basedowii	0.2m	<20%
Bare ground		>60%

TRAPLINE 5

Marble Gum (*Eucalyptus gongylocarpa*) Tree Steppe/Shrub Steppe

	Height	Cover
Stratum 1	3-6m	30%
Callitris columellaris		
Eucalyptus incrassata		
Eucalyptus leptophylla		
Eucalyptus gongylocarpa		
Stratum 2	0.5-1.5m	<30%
Acacia ? jutsonii		
Callitris columellaris (young)		
Bertya dimerostigma		
Santalum acuminatum		
Eremophila platythamnos		
Stratum 3		
Triodia basedowii	0.2m	<30%
Bare ground		>50%

TRAPLINE 6

Flowery Mallee (*E. leptophylla* var. *floribunda*) Shrubland

	Height	Cover
Stratum 1	2-4m	1-10%
Eucalyptus leptophylla var. *floribunda*		
Eucalyptus concinna		
Stratum 2	0.8-1.5m	10%
Melaleuca uncinata		
Grevillea sp.		
Acacia ? *jutsonii*		
Acacia acuminata		
? Gastrolobium sp.		
Santalum acuminatum		
Bertya dimerostigma		
Stratum 3	0.2m	20%
Triodia basedowii		
Chrysitrix distigmatosa		
Bare ground		>50%

TRAPLINE 7

Narrow-leaved Mallee (*E. leptophylla* sens.lat.) Shrubland/*Acacia jutsonii* Open Scrub

	Height	Cover
Stratum 1	2.5-3m	1%
E. leptophylla sens.lat.		1%
Stratum 2	0.8-1m	10-30%
Acacia jutsonii		10-30%
Leptospermum fastigiatum		<1%

	Height	Cover
Stratum 3	0.3-0.5m	<10%
Grevillea sp. aff. *hakeoides*		1%
Allocasuarina corniculata		1%
Cryptandra sp.		1-10%
Bertya dimerostigma		1-10%
Stratum 4	0.2m	30%
Triodia basedowii		
Bare ground		ca50%

TRAPLINE 8

Sand Ridge (dune) Complex and Mallee on midslope

	Height	Cover
Stratum 1	2.5-3.0m	20-30%
Eucalyptus ? *incrassata*		
Callitris preissii ssp. *verrucosa*		
Stratum 2	1.0-1.5m	30%
Grevillea didymobotrya	1.5m	
Acacia fragiles	>1.0m	
Grevillea stenobotrya	1.0m	
Olearia lanuginose	1.0m	
Persoonia sp. nov	1.0m	
Allocasuarina Corniculata	1.0m	
Thryptomene sp. (ASW 14786)	1.0m	
Stratum 3	<1.0m	<10%
Cryptandra sp.		

	Height	Cover
Stratum 4 (ground layer)	<50cm	40%
Triodia basedowii		
Lepidobulus deserti		
Lomandra leucocephala		
Pityrodia loricata		
Newcastelia hexarrhena		
Bare ground		ca30%

TRAPLINE 9

Cypress Pine Low Woodland in Marble Gum Tree Steppe

	Height	Cover
Stratum 1		
Callitris columellaris	>2m	30-50%
Stratum 2		
Bertya dimerostigma	1m	10-30%
Species ASW14874	0.5m	<10%
Stratum 3		
Triodia basedowii	<0.5m	10-30%
Bare ground		ca50%

TRAPLINE 10

Kopi Mallee (*E. leptophylla* var. *leptophylla*) Low Woodland/Saltbush (*Atriplex stipitata*) Dwarf Scrub

	Height	Cover
Stratum 1	4-6m	<10m
Eucalyptus leptophylla ssp. *leptyphylla*		
Eucalyptus yilgarnensis		
Stratum 2	1-2m	<10%
*Eremophila decipiens**		
Acacia colletioides		
Stratum 3	0.5m	30%
*Rhagoida drummondii**		20-30%
Atriplex stipitata		<10%
Stratum 4	<0.2m	<1%
Calandrinia sp.		
Erodium sp.		
Zygophyllum sp.		
Bare ground		>60%

* browsed heavily

TRAPLINE 11

Broombush (*Melaleuca uncinata*) Thicket

	Height	Cover
Stratum 1	5->6m	<1%
Eucalyptus concinna (off trapline)		
Stratum 2	1-2m	>30%
Melaleuca uncinata		>30%
Acacia colletioides		1%
Olearia sp.		1%
Stratum 3	0.2m	1%
Triodia basedowii		
Bare ground		ca50%

TRAPLINE 12

Boorabbin Mallee (*E. platycorys*) Shrubland (formerly Cypress Pine Low Woodland/Low Forest)

	Height	Cover
Stratum 1	4m	<10%
Eucalyptus ? *yilgarnensis*		
Stratum 2	1.5-3m	30%
Hakea ? francisiana		
Acacia rigens		
? *Santalum acuminatum*		
Stratum 3	0.3-0.5m	ca30%
Callitris columellaris (young)		
Species ASW 14874		
Grevillea acuaria		
Stratum 4	0.2m	ca20%
Triodia basedowii		
Bare ground		>40%

TRAPLINE 13

Sand Ridge (dune) Complex, Mallee and Desert Grass Tree

	Height	Cover
Stratum 1	2.5-3.5m	20%
Eucalyptus youngiana		
Eucalyptus gongylocarpa		
Eucalyptus spp.		
Xanthorrhoea thorntonii		
Stratum 2	1.0-1.5m	30%

	Height	Cover
Acacia spp.		
Other spp.		
Stratum 3	<1.0m	?
Triodia basedowii		
Bare ground		>40%

TRAPLINE 14

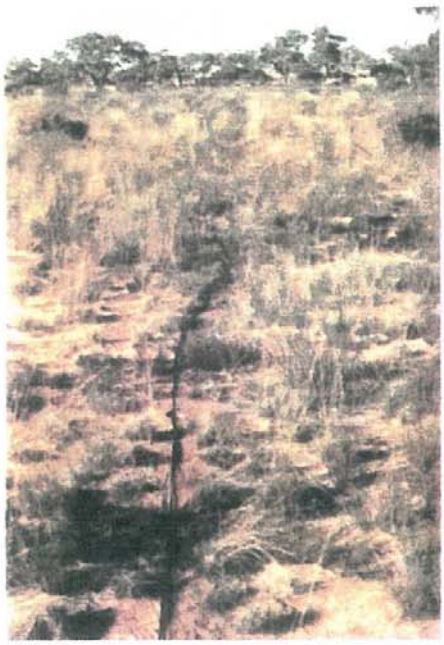
Narrow-leaved Mallee Shrub Steppe/Shrubland

	Height	Cover
Stratum 1	1.5-2.0m	<10%
Eucalyptus leptophylla sens. lat.		
Stratum 2		
Acacia jutsonii	0.5-1.0m	ca10%
Stratum 3	<0.5m	<10%
Stratum 4		
Triodia basedowii	0.2m	20%
Bare ground		>30%

CAPTIONS - PLATE 6 - TRAPLINES AT TRAPPING SITES 1-5

A	Trapline 1	*Acacia jutsonii* open scrub
B	Trapline 2	Marble gum tree steppe
C	Trapline 3	Flowery mallee shrubland
D	Trapline 4	Kopi Mallee low woodland
E	Trapline 5	Marble gum tree steppe/shrub steppe

PLATE 6



A

B

C

D

E

CAPTIONS - PLATE 7 - TRAPLINES AT TRAPPING SITES 6-10

A	Trapline 6	Flowery mallee shrubland
B	Trapline 7	Narrow-leaved mallee shrubland/*Acacia jutsonii* open scrub
C	Trapline 8	Sand ridge complex and mallee on midslope
D	Trapline 9	Cypress pine low woodland in marble gum tree steppe
E	Trapline 10	Kopi mallee low woodland/saltbush dwarf scrub
F	Trapline 10	*Atriplex stipitata* saltbush dwarf scrub

PLATE 7

A

B

C

D

F

CAPTIONS - PLATE 8 - TRAPLINES AT TRAPPING SITES 11-14

A	Trapline 11	Broombush thicket
B	Trapline 12	Boorabbin mallee shrubland
C	Trapline 12	Boorabbin mallee shrubland
D	Trapline 13	Sand ridge complex and heterogeneous, with desert grass tree
E	Trapline 14	Narrow-leaved mallee shrub steppe/shrubland

PLATE 8

A

B

C

D

E

APPENDIX D

FAUNA TABLES AND PLATES

TABLE D-1

Location, weight, sex and date of capture of Grey Kangaroos sampled

No.	Location	Weight	Sex	Date
1	Halfway between Trapping Site 7 and Shogun costean	17kg	Male	24/6/85
2	4km west of campsite	20kg	Male	25/6/85
3	27km west of campsite	17kg	Male	25/6/85
4	18km west of campsite	35kg	Male	28/6/85
5	15km west of campsite	30kg	Male	25/6/85
6	9km east of campsite	18kg	Male	26/6/85
7	2km east of campsite	16kg	Female	27/6/85
8	8km east of campsite	17kg	Female	27/6/85
9	2km east of campsite	16kg	Male	28/6/85
10	0.5km north west of Trapping Site 11	20kg	Male	1/7/85

TABLE D-2

Species and numbers of reptiles collected in or near the survey area

	Individuals
Geckoes	
Diplodactylus elderi	
Gehyra purpurescens	3
Gehyra variegata	1
Nephrurus laevissimus	14
Skinks	
Ctenotus atlas	13
Ctenotus brooksi brooksi	8
Ctenotus leae	3
Ctenotus quattuordecimlineatus	6
Ctenotus schomburgkii	16
Egernia inornata	5
Lerista bipes	1
Lerista muelleri	4
Menetia greyii	1
Morethia butleri	2
Omolepida branchialis	2
Legless Lizards	
Delma fraseri	1
Dragons	
Ctenophorus isolepis gularis	8
Ctenophorus inermis	1
Moloch horridus	2
Monitors	
Varanus eremius	1
Varanus gouldii	1
Total	93

TABLE D-2A

Species and numbers of reptiles collected at trapping sites

Site	Species	Individuals
1	*Ctenotus schomburgkii*	1
2	*Ctenotus atlas*	2
3	*Ctenotus atlas*	1
4	-------	-
5	*Menetia greyii*	1
6	-------	-
7	-------	-
8	*Lerista bipes*	1
	Lerista muelleri	1
9	*Ctenotus schomburgkii*	1
10	*Gehyra variegated*	1
11	*Ctenotus schomburgkii*	2
12	-------	-
13	*Ctenotus brooksi brooksi*	4
14	*Varanus eremius*	1
	Ctenotus schomburgkii	1

TABLE D-3

Bird species recorded. Species marked with an asterisk were recorded only by opportunistic sightings

Whistling Kite*	*Haliastur sphenurus*
Little Falcon	*Falco longipennis*
Brown Falcon*	*Falco berigora*
Australian Bustard*	*Ardeotis australis*
Crested Pigeon	*Ocyphaps lophotes*
Regent Parrot	*Polytelis anthopeplus*
Ringneck Parrot	*Barnardius zonarius*
Tawny Frogmouth	*Podargus strigoides*
Black-faced Cuckoo-shrike*	*Coracina novaehollandiae*
Ground Cuckoo-shrike	*Coracina maxima*
Red-capped Robin	*Petroica goodenovii*
Hooded Robin	*Melanodryas cucullata*
Jacky Winter	*Microeca leucophaea*
Crested Bellbird	*Oreoica gutturalis*
Willie Wagtail	*Rhipidura leucophrys*
Weebill	*Smicrornis brevirostris*
Inland Thornbill	*Acanthiza apicalis*
Chestnut-rumped Thornbill	*Acanthiza uropygialis*
Rufous Treecreeper*	*Climacteris rufa*
Red Wattlebird	*Anthocaera carunculata*
Yellow-throated Miner	*Manorhina flavigula*
Yellow-fronted Honeyeater	*Lichenostromus plumulus*
White-fronted Honeyeater	*Phylidonyris albifrons*
Striated Pardalote	*Pardalotus striatus*
Black-faced Woodswallow	*Artamus cinereus*
Grey Butcherbird	*Cracticus torquatus*
Pied Butcherbird	*Cracticus nigrogularis*
Torresian Crow	*Corvus orru*

TABLE D-4

Numbers and species of birds observed in standardised transects at trapping sites

	Site														
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
Weebill	6			20	9	7	20		1	11	19	16	13	13	135
Yellow-throated Miner	3	8	13	3	5	2	3		19	17	6		9	3	91
Grey Butcherbird	1		1				1	1				2	1		7
Pied Butcherbird			2				2	3				1	2		10
Red Wattlebird	2		2										2		6
Jacky Winter	3			4		1	1					1		1	11
White-fronted Honeyeater	13					2	9					1	1		26
Yellow-fronted Honeyeater	2									2					4
Hooded Robin	1										1				2
Red-capped Robin				1								1			2
Ringneck Parrot	2	2	4							1					9
Regent Parrot									1		2		4	5	12
Ground Cuckoo-shrike		2													2
Crested Bellbird		1					1								2
Torresian Crow			1							4			1		6
Inland Thornbill							2				1				3
Chestnut-rumped Thornbill											2				2
Little Falcon							2								2
Striated Pardalote							1			1	2	3			7
Black-faced Woodswallow					2		1				2				5
Willie Wagtail											1				1

TABLE D-5

Species of small mammals trapped

House Mouse	*Mus domesticus*
Sandy Inland Mouse	*Pseudomys hermannsburgensis*
Spinifex Hopping-mouse	*Notomys alexis*
Mulgara	*Dasycercus cristicauda*
Wongai Ningaui	*Ningaui ridei*
-	*Ningaui yvonneae*
Fat-tailed Dunnart	*Sminthopsis crassicaudata*
-	*Sminthopsis dolichura*
Hairy-footed Dunnart	*Sminthopsis hirtipes*
Ooldea Dunnart	*Sminthopsis ooldea*
Sandhill Dunnart	*Sminthopsis psammophila*

TABLE D-6

The small mammals captured at each trapping site

	Trapping Site														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
Mus domesticus		1	2	2						2					7
Pseudomys hermannsburgensis	9		1	2	1	2	1	6	2	1	1		5	1	32
Notomys alexis							1	2	2			1	2	3	11
Dasycercus cristicauda	1														1
Ningaui ridei	2		2	1	2	2		2	1		1	2			15
Ningaui yvonneae		1	1		1	4	1	1	1		2	1		1	14
Sminthopsis crassicaudata										2					2
Sminthopsis dolichura				1						4			1		6
Sminthopsis hirtipes	3				2	1	2	2			1	2		2	15
Sminthopsis ooldea		1						1				3			5
Sminthopsis psammophila					1	1	1				2				5

TABLE D-7

The distribution of bird species and numbers in trapping sites of different vegetation

Species	Site									Total
	Woodland (sites 2, 5 & 9)	Mallee (sites 6, 7, 12 & 14)	8	13	1	3	4	10	11	
Weebill	10 7.5%	56 41.5%		13 10%	6 4%		20 15%	11 8%	19 14%	135 100%
Yellow-throated Miner	32 35%	5 5.5%	3 3%	9 10%	3 3%	13 14%	3 3%	17 19%	6 7%	91 100%
Grey Butcher bird		3	1	1	1	1				7
Pied Butcher bird		3	3	2		2				10
Red Wattlebird			2	2	2					6
Jacky Winter		4			3		4			11
White-fronted Honeyeater		11		1	13				1	26
Yellow-fronted Honeyeater					2				2	4
Hooded Robin					1				1	2
Red-capped Robin		1					1			2
Ringneck Parrot	2				2	4		1		9
Regent Parrot	1	5		4					2	12
Ground Cuckoo-shrike	2									2
Crested Bellbird	1	1								2
Torresian Crow				1		1		4		6
Inland Thornbill		2							1	3
Chestnut-rumped Thornbill									2	2
Little Falcon		2								2
Striated Pardalote		4						1	2	7
Black-faced Woodswallow	2	1							2	5
Willie Wagtail									1	1

CAPTIONS - PLATE 9 – SMALL MAMMALS

A Mulgara (*Dasycercus cristicauda*)
Photo: A. G & B. A. Wells (from Strahan 1983, p. 26)

B Ooldea Dunnart (*Sminthopsis ooldea*)
Photo: R. Whitford (from Strahan 1983, p. 54)

PLATE 9

A

B

CAPTIONS - PLATE 10 – SMALL MAMMALS

A Sandhill Dunnart (*Sminthopsis psammophila*)
Photo: R. Ruehle (from Strahan 1893, p.60)

B Fat-tailed Dunnart (*Sminthopsis crassicaudata*)
Photo: R. Whitford (from Strahan 1983, p. 62)

PLATE 10

A

B

CAPTIONS - PLATE 11 – SMALL MAMMALS

A Hairy-tailed Dunnart (*Sminthopsis hirtipes*)
Photo: A. G & B. A. Wells (from Strahan 1983, p. 67)

B Wongai Ningaui (*Ningaui ridei*)
Photo: H. J. Aslin (from Strahan 1983, p. 70)

PLATE 11

A.

B

CAPTIONS – PLATE 12 – SMALL MAMMALS

A Sandy Inland Mouse (*Pseudomys hermannsbergensis*)
Photo: B. G. Thomson (from Strahan 1983, p. 407)

B Spinifex Hopping-mouse (*Notomys alexis*)
Photo: H. & J. Beste (from Strahan 1983, p. 428)

PLATE 12

A

B

APPENDIX E

RADIONUCLIDE AND HEAVY METALS FIGURES AND TABLES

TABLE E-1

Sample numbers of plants sampled In June 1985 from plants common to most of the trapping sites

(NP = not present)

Species Sampled	Trapping Sites													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Acacia jutsonii	1D	2E	3G	4E	5F	6D	NP	8E	9F	10J	11E	12D	NP	14C
Grevillea ? acuaria	1F	2F	3H	4F	5E	6C	7C	8D	9E	10I	11F	12F	13C	14D
Hakea francisciana	1E	2D	3F	4D	5A	6B	7B	8C	9A	10G	11C	12A	13B	14B
Eucalyptus leptophylla	1B	2A	3A	4C	5C	6A	7A	8A	9C	10C	11B	12B	13A	14A
Eucalyptus gongylocarpa	1C	2B	3D	NP	5D	NP	NP	8B	9B	10H	11D	12E	13D	14E
Santalum acuminatum	1A	2C	3E	NP	5B	6E	NP	8F	9D	10D	11G	12G	13E	NP

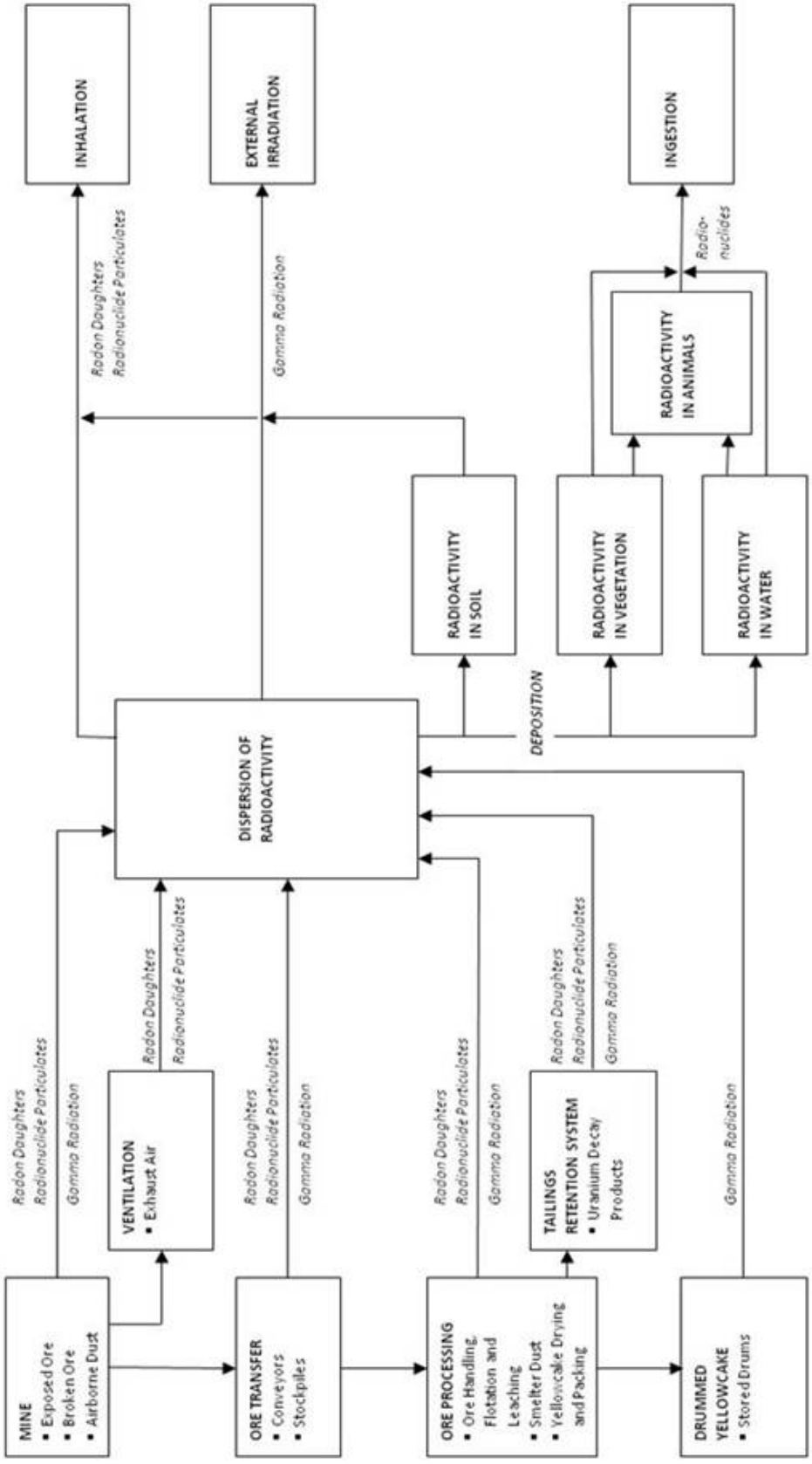


FIGURE E-1 Schematic diagram of major potential pathways for the movement of radionuclides and heavy metals in biological systems.
(from Kinhill-Stearns Roger Joint Venture 1982)

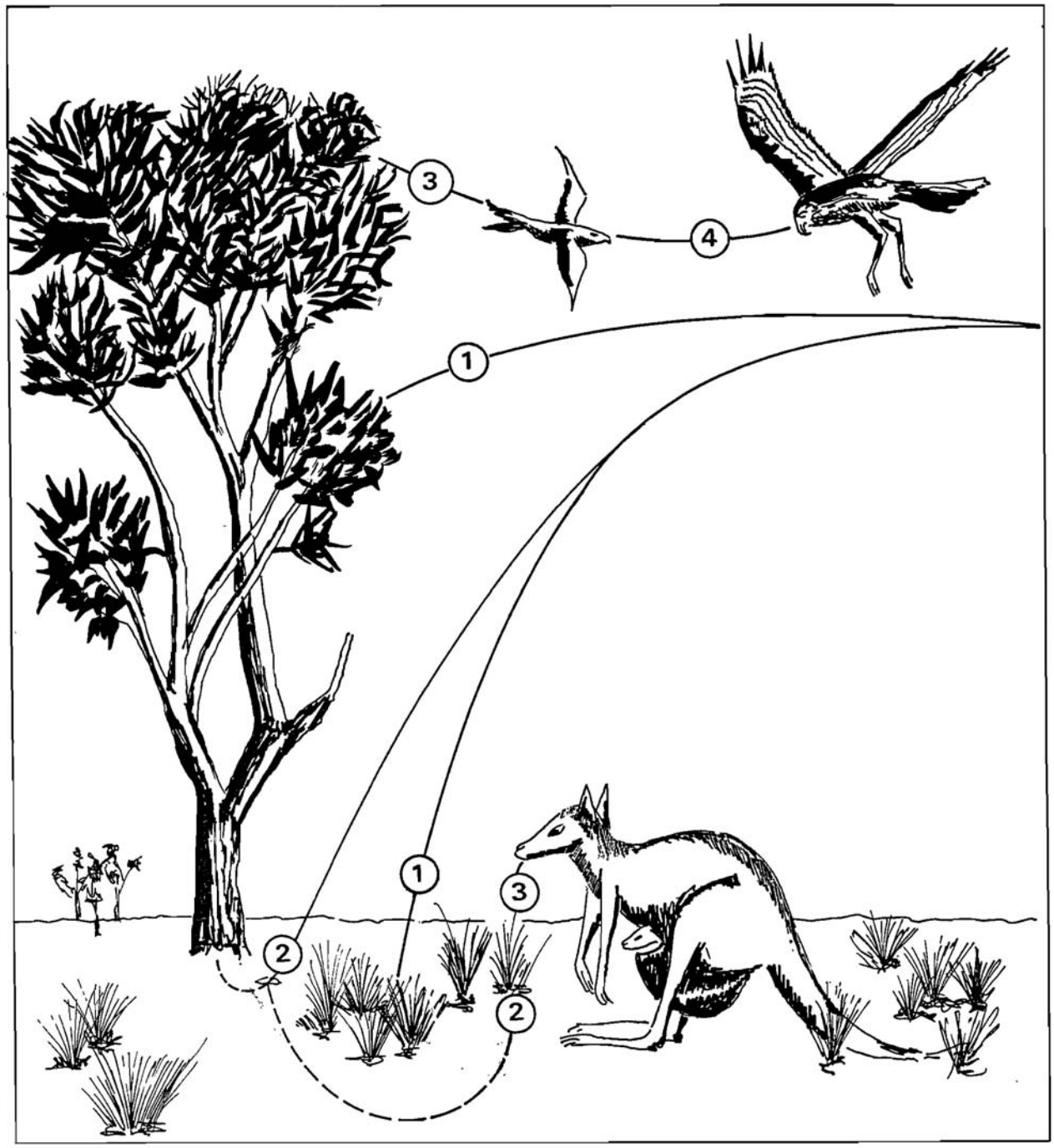


FIGURE E-2 Stylised illustration of major potential pathways for the movement of wind-blown dust bearing radionuclides and heavy metals into the predominant Mulga Rock ecosystem:

1) Radionuclides and heavy metals incorporated into leaves.

2) Radionuclides and heavy metals incorporated into soil and taken up by leaves through roots.

3) Radionuclides and heavy metals in leaves eaten by herbivorous animals, both invertebrates and vertebrates.

4) Radionuclides and heavy metals in herbivores eaten by carnivores.

TABLE E-2

Sample numbers of leaves sampled from plants which showed signs of having been browsed (B) or were particularly common (C) at a few sites

Species	Traplines				
	3	4	10	11	12
Atriplex stipitata (B)	NS	NS	10A	NS	NS
Eremophila decipiens (B)	3B	NS	10F	NS	NS
Melaleuca uncinata (C)	NS	NS	NS	11A	NS
Lachnostachys bracteosa (C)	NS	4B	10E	NS	NS
Rhagodia drummondii (B)	NS	NS	10B	NS	NS
Scaevola spinescens (B)	3C	NS	NS	NS	NS
Senecio magnificus (C)	NS	4A	NS	NS	NS
Species ASW 14874 (C)	NS	NS	NS	NS	12C

TABLE E-3

Small mammal and reptile samples collected. The samples were prepared for radionuclide and heavy metal analyses except where marked by one asterisk (reptiles, all donated to the W.A. Museum) or two asterisks (small mammals or bats donated to the W.A. Museum)

No.	Species	Site
1	*Ningaui yvonneae*	2
2 *	*Ctenotus atlas*	2
3	*Pseudomys hermannsburgensis*	1
4	*Pseudomys hermannsburgensis*	1
5	*Pseudomys hermannsburgensis*	1
6	*Pseudomys hermannsburgensis*	4
7	*Ningaui yvonneae*	6
8 *	*Lerista muelleri*	8
9 *	*Lerista bipes*	8
10 *	*Ctenotus schomburgkii*	9
11 *	*Ctenotus schomburgkii*	1
12	*Sminthopsis ooldea*	2
13	*Ningaui yvonneae*	6
14	*Pseudomys hermannsburgensis*	6
15	*Ningaui yvonneae*	6
16	*Sminthopsis hirtipes*	5
17	*Ningaui ridei*	4
18	*Mus domesticus*	4
19	*Sminthopsis crassicaudata*	10
20	*Mus domesticus*	10
21	*Ningaui yvonneae*	8
22	*Notomys alexis*	8
23	*Notomys alexis*	8
24	*Sminthopsis hirtipes*	8
25	*Sminthopsis hirtipes*	6
26	*Pseudomys hermannsburgensis*	1
27	*Pseudomys hermannsburgensis*	1
28	*Mus domesticus*	2
29	*Ningaui ridei*	3

No.	Species	Site
30	*Ningaui yvonneae*	3
31	*Notomys alexis*	7
32	*Sminthopsis hirtipes*	6
33	*Pseudomys hermannsburgensis*	6
34	*Sminthopsis crassicaudata*	10
35	*Sminthopsis hirtipes*	12
36	*Pseudomys hermannsburgensis*	9
37	*Notomys alexis*	9
38	*Pseudomys hermannsburgensis*	9
39	*Pseudomys hermannsburgensis*	8
40	*Pseudomys hermannsburgensis*	8
41	*Pseudomys hermannsburgensis*	3
42	*Ningaui yvonneae*	11
43	*Pseudomys hermannsburgensis*	8
44	*Ningaui ridei*	8
45	*Pseudomys hermannsburgensis*	8
46	*Notomys alexis*	12
47	*Sminthopsis hirtipes*	12
48	*Sminthopsis dolichura*	10
49 **	*Pseudomys hermannsburgensis*	10
50	*Sminthopsis dolichura*	10
51	*Sminthopsis dolichura*	4
52 **	*Sminthopsis psammophila*	5
53	*Ningaui yvonneae*	6
54 **	*Sminthopsis psammophila*	6
55	*Sminthopsis hirtipes*	7
56 **	*Sminthopsis psammophila*	11
57	*Sminthopsis dolichura*	10
58	*Sminthopsis ooldea*	12
59	*Ningaui ridei*	9
60 **	*Sminthopsis ooldea*	9
61	*Ningaui ridei*	8
62 **	*Ningaui ridei*	5
63	*Ningaui ridei*	6
64	*Ningaui ridei*	1

No.	Species	Site
65 **	*Dasycercus cristicauda*	1
66	*Pseudomys hermannsburgensis*	13
67	*Pseudomys hermannsburgensis*	13
68	*Pseudomys hermannsburgensis*	13
69	*Pseudomys hermannsburgensis*	13
70	*Notomys alexis*	13
71	*Pseudomys hermannsburgensis*	13
72	*Notomys alexis*	13
73	*Mus domesticus*	3
74	*Pseudomys hermannsburgensis*	1
75 **	*Sminthopsis hirtipes*	1
76 **	*Sminthopsis psammophila*	7
77	*Sminthopsis hirtipes*	7
78	*Pseudomys hermannsburgensis*	7
79	*Pseudomys hermannsburgensis*	5
80	*Pseudomys hermannsburgensis*	4
81	*Sminthopsis dolichura*	10
82	*Sminthopsis ooldea*	12
83	*Pseudomys hermannsburgensis*	8
84 *	*Ctenotus schomburgkii*	11
85 **	*Sminthopsis psammophila*	11
86 *	*Ctenotus brooksi brooksi*	13
87	*Sminthopsis dolichura*	13
88	*Pseudomys hermannsburgensis*	1
89	*Pseudomys hermannsburgensis*	1
90	*Sminthopsis hirtipes*	14
91	*Notomys alexis*	13
92	*Ningaui ridei*	3
93	*Mus domesticus*	3
94	*Sminthopsis hirtipes*	5
95	*Mus domesticus*	10
96 **	*Sminthopsis ooldea*	12
97	*Ningaui yvonneae*	12
98	*Pseudomys hermannsburgensis*	8
99 **	*Chalinolobus gouldii*	8

No.	Species	Site
100 *	*Varanus eremius*	14
101	*Notomys alexis*	14
102	*Ningaui yvonneae*	14
103	*Sminthopsis hirtipes*	14
104	*Sminthopsis hirtipes*	11
105 *	*Menetia greyii*	5
106 *	*Gehyra variegate*	10
107	*Ningaui yvonneae*	9
108	*Mus domesticus*	4
109	*Ctenotus atlas*	3
110	*Pseudomys hermannsburgensis*	1
111	*Sminthopsis hirtipes*	1
112 *	*Ctenotus atlas*	2
113 *	*Ctenotus brooksi brooksi*	13
114	*Pseudomys hermannsburgensis*	11
115 **	*Ningaui yvonneae*	5
116 **	*Ningaui ridei*	6
117	*Ningaui yvonneae*	7
118	*Notomys alexis*	9
119	*Sminthopsis hirtipes*	1
120 *	*Ctenotus brooksi brooksi*	13
121 *	*Ctenotus brooksi brooksi*	13
122 *	*Ctenotus schomburgkii*	14
123 **	*Ningaui ridei*	12
124	*Ningaui yvonneae*	11
125 **	*Ningaui ridei*	11
126 **	*Ningaui ridei*	1
127	*Notomys alexis*	14
128	*Pseudomys hermannsburgensis*	1
129	*Ningaui ridei*	12
130	*Ningaui ridei*	5
131	*Nyctophilus major*	5
132 *	*Ctenotus schomburgkii*	11

TABLE E-4

LETTER FROM ANALABS

A list of the samples ashed and stored for future radionuclide and heavy metal analyses. The sample numbers are the same as in Table E-3. Sample 18 has been mislabelled as 81 (i.e. sample 18 and not 81 was ashed). Specimens 129-132 of Table E-3 were not supplied to Analabs and are therefore not listed in Table E-4.

ANALABS
A division of Macdonald Hamilton Pty. Ltd.
Perth Head Office.
52 Murray Road Welshpool, Western Australia 6106.
Tel: (09) 458 7999, 458 7154. Telex: Analab AA92560.
P.O. Box 210 Bentley, W.A. 6102.

GDM:sc

11 November 1985

W.G. Martinick & Assoc.
19 Mount Street
PERTH WA 6000

OUR REF : 1000.0.01.40830
YOUR REF: O/N 7978

Dear Sir

Herewith are the results of the ashing of the animal tissue samples, which we received at this office on 10 October 1985.

SAMPLE	WET WT.	ASH WT.
1	2.3072	0.0791
2	sample not supplied	
3	5.1674	0.1715
4	4.2041	0.1529
5	3.3240	0.1172
6	3.7447	0.1254
7	2.2363	0.0798
8	sample not supplied	
9	sample not supplied	
10	sample not supplied	
11	sample not supplied	
12	2.8106	0.1094
13	2.6553	0.1133
14	5.7256	0.1930
15	2.1139	0.1153
16	4.5634	0.1787
17	2.1895	0.0755
18	sample not supplied	
19	2.9477	0.0094
20	5.4664	0.1527
21	1.8936	0.0837
22	11.2472	0.4060
23	12.8720	0.4513
24	3.4670	0.1381
25	5.0028	0.1479
26	5.7355	0.2334
27	4.6330	0.1633
28	3.7223	0.1106
29	2.3154	0.0739
30	2.0820	0.0778
31	9.7251	0.3525
32	4.9356	0.1862

cont'd ../2

- 2 -

SAMPLE	WET WT.	ASH WT.
33	3.6163	0.1290
34	3.1802	0.1430
35	4.5585	0.1726
36	5.8634	0.1732
37	8.0819	0.2395
38	6.4059	0.2086
39	4.9594	0.1478
40	2.9916	0.0954
41	5.2076	0.1619
42	1.8287	0.0224
43	6.5682	0.2296
44	1.7637	0.0675
45	4.1215	0.1391
46	10.6307	0.4118
47	4.7999	0.1736
48	4.0165	0.2735
49	sample not supplied	
50	3.2997	0.1307
51	3.0526	0.1420
52	sample not supplied	
53	2.1109	0.0712
54	sample not supplied	
55	4.4067	0.1567
56	sample not supplied	
57	4.3442	0.1771
58	2.7020	0.1046
59	1.7821	0.0724
60	sample not supplied	
61	2.0012	0.0691
62	sample not supplied	
63	1.8494	0.0709
64	1.9959	0.0767
65	sample not supplied	
66	6.0826	0.2098
67	5.7560	0.2153
68	5.7045	0.1848
69	5.5603	0.2064
70	12.1472	0.4416
71	5.5063	0.1782
72	12.9049	0.4487
73	3.1913	0.0829
74	4.8912	0.1671
75	sample not supplied	
76	sample not supplied	
77	5.7600	0.1852
78	5.5555	0.1697
79	4.9790	0.1814
80	5.4106	0.1899
81	4.0593	0.1769
82	2.4292	0.0859
83	4.3548	0.1554
84	sample not supplied	
85	sample not supplied	
86	sample not supplied	

cont'd../3

SAMPLE	WET WT.	ASH WT.
87	3.5146	0.1352
88	5.2888	0.1865
89	6.4148	0.2302
90	3.7418	0.1238
91	10.2724	0.3345
92	1.7002	0.0666
93	3.2696	0.0823
94	5.6000	0.2270
95	6.0847	0.2144
96	sample not supplied	
97	2.1333	0.0982
98	4.4337	0.1511
99	sample not supplied	
100	sample not supplied	
101	13.3324	0.4630
102	2.5936	0.0926
103	6.1011	0.2129
104	4.3433	0.1627
105	sample not supplied	
106	sample not supplied	
107	2.3862	0.0925
108	2.9869	0.1261
109	sample not supplied	
110	4.6066	0.1622
111	6.2551	0.2339
112	sample not supplied	
113	sample not supplied	
114	1.8053	0.0494
115	sample not supplied	
116	sample not supplied	
117	3.3738	0.1529
118	16.0435	0.4922
119	4.3246	0.1624
120	sample not supplied	
121	sample not supplied	
122	sample not supplied	
123	sample not supplied	
124	2.1918	0.0832
125	sample not supplied	
126	sample not supplied	
127	11.7475	0.3491
128	4.5833	0.1532

cont'd ../4

SAMPLE		WET WT.	ASH WT.
Kangaroo 1	Kidney	56	0.6739
	Liver	238	1.7957
	Meat	443	3.9991
Kangaroo 2	Heart	159	0.9151
	Kidney	68	0.8763
	Liver	319	1.6318
	Meat	333	3.1287
Kangaroo 3	Heart	141	1.7778
	Kidney	56	0.6499
	Liver	258	2.1918
	Meat	519	5.1923
Kangaroo 4	Heart	238	2.0127
	Kidney	95	1.2023
	Liver	404	3.7033
	Meat	438	3.8972
Kangaroo 5	Heart	235	1.5210
	Kidney	135	1.3663
	Liver	575	4.2199
	Meat	467	4.6690
Kangaroo 6	Heart	137	0.8374
	Kidney	56	0.7572
	Liver	253	2.0712
	Meat	586	5.3614
Kangaroo 7	Heart	161	0.6955
	Kidney	52	0.7190
	Liver	269	3.9697
	Meat	539	5.7122
Kangaroo 8	Heart	127	0.7323
	Kidney	58	0.6588
	Liver	255	0.3450
	Meat	550	5.6903
Kangaroo 9	Heart	147	1.0567
	Kidney	59	0.9443
	Liver	286	4.3327
	Meat	571	5.313
Kangaroo10	Heart	144	0.7770
	Kidney	47	0.5883
	Liver	246	1.9340
	Muscle	300	2.6598

PLEASE NOTE: All results expressed as grammes.

Yours faithfully
ANALABS - A Division of
Macdonald Hamilton and Co Pty Ltd

G.D. MOORE
Operations Manager