Chapter 13

POSSIBLE IMPACT OF COAL MINE AND POWER STATION

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Abstract

This chapter identifies potential impacts of the proposed coal mine and power station on the proposed Lesueur National Park. It is not a full environmental impact statement.

Consultants to the mining Companies have identified a minimum impact area (the coal mines and batters alone) and a maximum impact area (an area within a line surrounding all possible mines, batters, the power station and infrastructure). They state that the actual area of impact lies somewhere between these figures. The minimum impact area within the proposed national park is about 934 ha and the maximum impact area is about 4 258 ha. An additional 3 406 ha outside the proposed national park boundaries is within the maximum impact zone, some of it bushland of high nature conservation value.

The four eastern landforms of the proposed national park will be affected to varying degrees, with Banovich Uplands (40% - 94%) and Bitter Pool Rises (8% - 100%) being most affected, and Gairdner Dissected Uplands (4% - 28%) and Lesueur Dissected Uplands (0% - 3%) being less affected. The upper portions of the four major catchments in the proposed national park will sustain high impact.

Some vegetation types are greatly affected, particularly lateritic heath dominated by an undescribed species of Dryandra, two other lateritic upland types of heath, the best stands of a particular type of wandoo woodland, and Calothamnus quadrifidus heath.

All seven species of Declared Rare Flora that occur in the proposed national park will be affected. Figures for total plants destroyed, both inside and outside the park, vary from 0% to 57% (minimum and maximum impact) of individuals for Acacia forrestiana to 6% to 79% for Hakea megalosperma, 11% to 22% for the sun orchid Thelymitra stellata and 12 to 49% for Banksia tricuspis. Figures for those plants inside the proposed park are higher, with 91% of Asterolasia drummondii and 100% of Thelymitra stellata being affected under maximum impact. Of the 111 regional endemics in the proposed national park, two thirds (65%) would be affected should mining affect all the maximum impact area. Twenty-six very geographically restricted plant taxa occur in the maximum impact zone.

Impact on animal species is difficult to quantify because of the lack of data. Particular concern is expressed for species that depend on the wandoo woodlands for nesting, especially Carnaby's Black Cockatoo and the Regent Parrot.

Dieback disease caused by Phytophthora species would have a major impact if introduced because of the suitable climate, the abundance of susceptible plant species and vegetation types and the type of soils present. The probability of introduction of Phytophthora is high when extensive use of earth-moving equipment and vehicles takes place in a highly susceptible area, even if high standards of hygiene are maintained. If introduced, the impact of Phytophthora could be extensive, because the development affects all catchments in the proposed national park, and because of the high proportion of susceptible vegetation types and plant species.

The most scenic parts of the proposed national park would not be mined. However, there will be a significant degree of impact on visual resource values if the mine goes ahead because the area that will be mined is a supporting landscape and important foreground to the eastern flank of the Gairdner Range. The viewsheds east and northeast from the eastern edge of the Gairdner Range would also be affected and the coal-fired power station, with its reported 200 metre high stack, would also be visible from a considerable distance, both from within and outside the reserve. The natural character and scenic beauty of what are some of the most attractive landscapes within the northern kwongan will be severely degraded should the project proceed.

Experience with attempted rehabilitation of somewhat similar kwongan vegetation at Eneabba suggests that rehabilitation at Lesueur would be extremely difficult, if not impossible. The Lesueur mining operation will have problems additional to those met by the sand mining Companies at Eneabba. The substrate is quite different and soils are much more complex, and the overburden is likely to be toxic to plant growth. Moreover, successful germination and establishment, either in cultivation or rehabilitation areas, of many species of Restionaceae, Cyperaceae, Orchidaceae and Epacridaceae has not been achieved, due to as yet unknown horticultural difficulties.

13.1 INTRODUCTION

It is not the purpose of this report to be a full Environmental Review and Management Program. Nevertheless, it is important to identify potential impacts and problems. While this chapter confines itself to a discussion of potential impacts on the proposed Lesueur National Park, a much larger area than this is likely to be affected.

13.2 TOTAL AREA OF IMPACT ON THE PROPOSED NATIONAL PARK

The Notice of Intent (NOI) (Canning Resources Pty Ltd and Hill River Power Development Company Pty Ltd 1989) shows only the area of projected open cut pits. No batters are shown, nor are the areas where overburden will be stored. It also shows a conceptual location of the power station, sedimentation ponds and some associated infra-structure.

Martinick and Associates (1989c) show the impact areas from open cut mining, including batters. They also show additional impact areas from underground mining and overburden disposal, which cover a greater area, including part of Reserve 24275 at Mount Lesueur, and the maximum limit of impact from total resource utilization (Figure 13.1). Martinick and Associates state:

"2.1 Areas of impact from open cut mining

"The area directly overlying the coal deposits for the proposed project has been identified. This development would take place over some 30 years. The impact areas are shown in Figure 2, and include provision for batters. This underestimates the true area of impact because there will be initial overburden dumps outside the pits, and infrastructure, such as haul roads and dams, has not been included. The power station site has not been included because its location is not final.

"2.2 Area of impact from total resource utilization

"This area defines all land containing coal at any depth, with all possible pits battered out fully and all possible underground mining included (Figure 2). This overestimates the actual area of impact because the coal is not continuous, not all the land would be dug up or covered, and land over deep coal would be disturbed only by ventilation shafts for underground mining. Figure 2 shows some areas where it is known that the surface disturbance from underground mining would be very small.

"The coal resource included in this area is considerably greater than that required for the proposed power station, and the time scale for total resource utilization would be much longer than the 30 years for the present project."

There is no mention of underground mining in the NOI, nor does it provide information on the likely total impact of the project on the proposed Lesueur National Park, making it difficult for us to make an accurate assessment of potential impact.

In addition, there are discrepancies between the two documents regarding the amount of disturbance. The NOI states "Vegetation clearing will have no impact on the Mt Lesueur Reserve, and only about 70 ha (or 1.0 %) of the Horse Breeding Reserve will be disturbed. Clearing will mainly be restricted to VCL (i.e. vacant Crown land) and farm land" (p. 11). The NOI has not made it clear that the "Mt Lesueur Reserve", the Horse Breeding Reserve and the VCL are all within the proposed National Park. Martinick and Associates list a total of 96 ha as the minimum and 700 ha as the maximum impact on the Horse Breeding Reserve. They also list a maximum impact area of 244 ha for the "Mt Lesueur" Reserve (their Table 2).

We have, therefore, used the areas defined by Martinick and Associates for assessment of minimum and maximum impact.

Table 13.1

Minimum and maximum impact on landforms of the proposed Lesueur National Park

Landform	Total Area In Park (ha)	Minimum Impact		Maximum Impact	
		Area	Per Cent	Area	Per Cent
Lesueur Dissected Uplands	2 325	0	0.0	69	3.0
Gairdner Dissected Uplands	3 470	148	4.3	968	27.9
Banovich Uplands	1 615	51	40.3	1 522	94.2
Bitter Pool Rises	1 699	135	7.9	1 699	100.0
TOTAL		**934**		**4 258**	

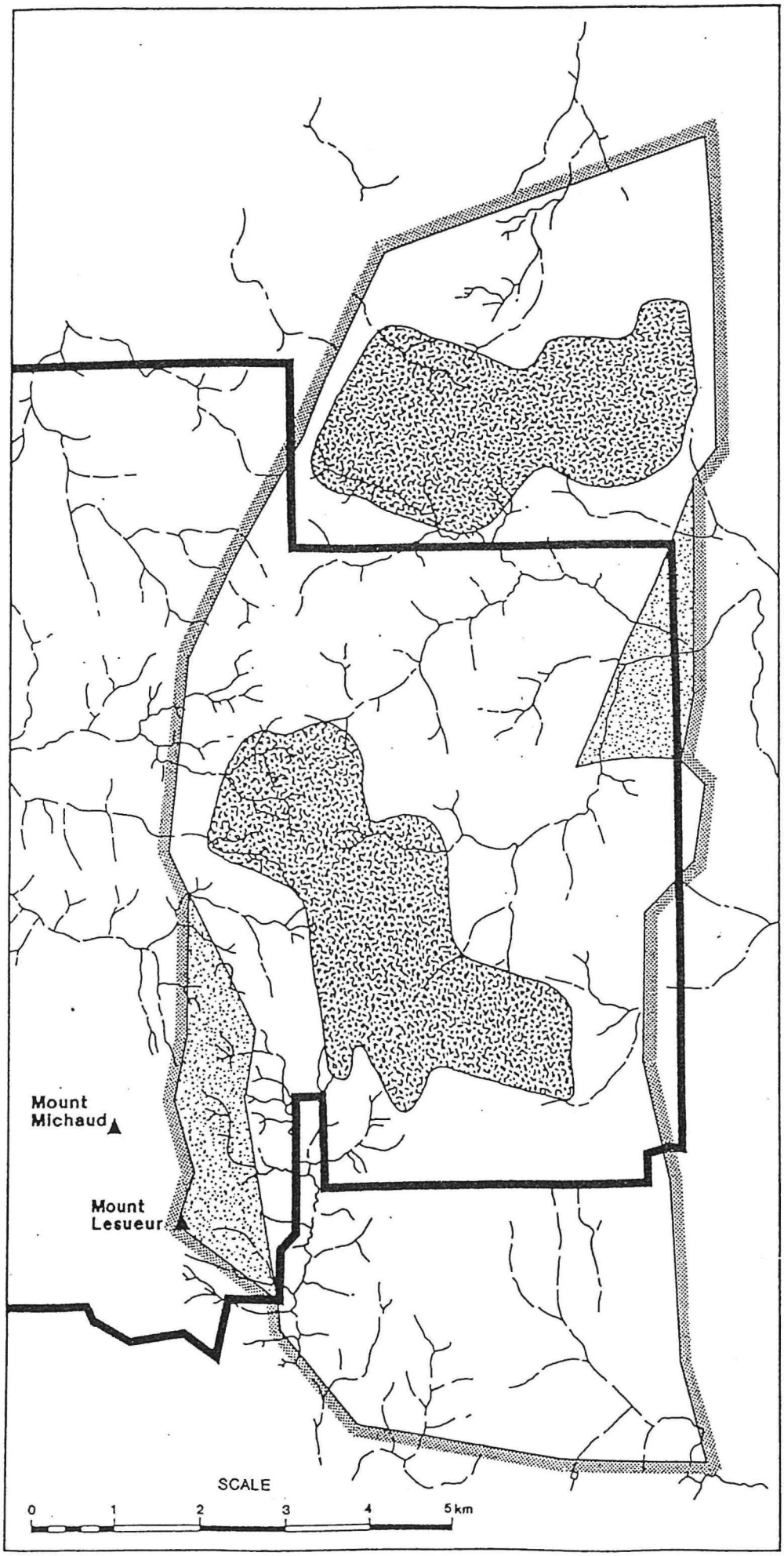
Table 13.2

Summary of landform vegetation categories affected (calculated from Martinick and Associates 1989c).

Vegetation-landform Category	Total Area Mapped (ha)	Minimum Impact		Maximum Impact	
		area	per cent	area	per cent
Heath and woodland on sandy slopes and valleys	2 799	374	13	977	35
Heath and scrub on lateritic upland	1 365	280	21	667	49
Heath and scrub on dissected sandstone slopes	626	77	12	279	45
Heath and woodlands on gravelly hills and slopes	1 065	65	6	549	52
Heath on duplex soils, benched slopes and broad valleys	2 384	165	7	1 334	56
E. wandoo woodland on clay slopes	644	9	1	304	47
Drainage line vegetation	276	35	13	135	49

Figure 13.1

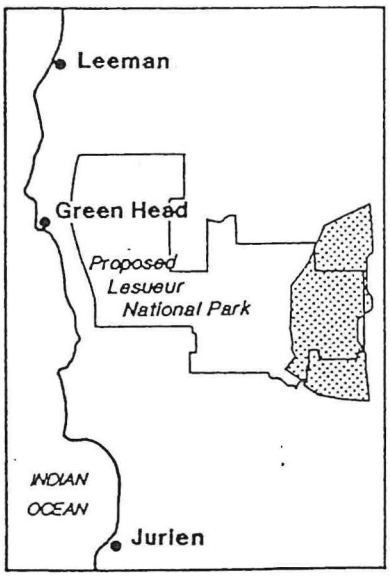
MINING IMPACT AREAS

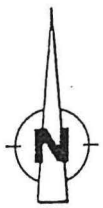


LEGEND

- Minimum Impact Area From Open Cut Mining
- Minimal Impact Area From Potential Underground Mining
- Proposed Park Boundary
- Maximum Impact Area

LOCALITY MAP





Calculations from digital maps prepared by CALM's Land Information Branch using data in Martinick and Associates (1989c) show that the minimum impact area within the proposed national park is 934 ha, and the maximum area is 4 258 ha. The figures given by Martinick and Associates (1989c) are 1 005 ha and 4 293 ha respectively. A further 3 406 ha of land outside the proposed park boundaries is within the maximum impact zone, and some of this is bushland of high nature conservation value. This does not include areas that might be affected by dust or pollution from the power station and its stacks, nor areas where dieback would spread if introduced, nor areas where the visual landscape would be affected.

13.3 IMPACT ON LANDFORMS

Table 13.1 provides data on the minimum and maximum areas of impact on the four eastern landforms that may be affected by mining and power station construction. These figures are calculated from digital maps prepared by CALM's Land Information Branch using data in Martinick and Associates (1989c).

Table 13.1 shows that the main direct impact will be on the Banovich Uplands (40% of area of the proposed national park under minimum impact; 94% under maximum impact) and Bitter Pool Rises (8%, 100%) landforms, with a lesser direct effect on Gairdner Dissected Uplands (4%, 28%). Lesueur Dissected Uplands will only be affected if underground mining gets under way (0%, 3%).

The currently protected upper portions of the catchments of Cockleshell Gully, Munbinia Creek and Coomallo Creek would all be affected by the mine and would cease to be of value in "bench mark" studies to provide information for catchment management in the region.

The very high impact of the proposed development on the Bitter Pool Rises landform and its associated vegetation types is of particular concern. This unit is comprised mainly of heavy clayey soils and has a very sluggish (mature) drainage system feeding into Coomallo Creek to the east. The particular combination of low relief, heavy soils and poor drainage is unique in the region.

13.4 IMPACT ON VEGETATION TYPES

Because of the complexity of vegetation in the proposed Lesueur National Park it is difficult to calculate the effect of the proposed development on it. Martinick and Associates (1989c) provide calculations for the minimum and maximum impact of the project on 54 vegetation mapping units. They also give the total area mapped of these units in the study area - the eastern part of the proposed national park and "CRA Farm", private land owned by CRA to the south. They state "It is difficult to interpret the results ... because of the large areas occupied by mosaics of vegetation units." They then attempted to reduce complexity by lumping the vegetation into seven "landform-vegetation categories".

Table 13.2, which is calculated from data in Martinick and Associates (1989c), shows the minimum impact and maximum impact area of each lumped vegetation type in the proposed national park. Data given show that the minimum impact varies from 1% for "wandoo woodland on clay slopes" to 21% for "heath and scrub on lateritic upland", while the maximum impact varies from 35% for "heath and woodland on sandy slopes and valleys" to 56% for "Heath on duplex soils, benched slopes and broad valleys". Under this worst case scenario, all these landform-vegetation types and complexes will be reduced by more than one third, and most will be reduced by half.

This is considered not to be a satisfactory way of assessing impact because it does not take account of either the complexity of the vegetation nor the considerable differences in species composition that can occur within one vegetation type.

A more detailed analysis of impacts of the proposed development on the proposed national park is somewhat confounded by the fact that the north-eastern area of the proposed national park has not been sampled as intensively as other parts for reasons given earlier. Assessment based on information provided in the vegetation map (Martinick and Associates 1988) and results of the study of lateritic uplands (Griffin and Hopkins unpublished) reveals seven vegetation units that will be adversely affected by the coal mine-power station development:

Lateritic heath dominated by *Dryandra* aff. *patens* (E.A. Griffin 1507) (lateritic uplands study, Group XI, Figure 4.3) which occurs in Martinick and Associates (1988) vegetation type B (rarely in D) in the northern part of the eastern block. This will be completely destroyed by the proposed development if it goes ahead. The dominant species, *Dryandra* aff. *patens* (E.A. Griffin 1507) is undescribed and occurs patchily throughout its limited range in the region. It is poorly represented in existing conservation reserves.

Two other lateritic upland groups, III and IV (Figure 4.3), which are sub-types of vegetation unit B, will be substantially depleted as a consequence of the proposed development.

The best stands of *Eucalyptus wandoo* woodlands occurring on steep V-shaped valleys with *Trymalium floribundum* as an understorey dominant the whole way up the slope are associated with the outcrop of coal NNE of Mount Lesueur. A smaller area of this vegetation type to the east of Mount Lesueur is still within the boundary of the maximum impact area. Woodland is very patchily distributed in the northern kwongan and is essential to hole-nesting birds; it is a limiting resource and any loss of woodland could have serious consequences (see section 13.6).

The *Calothamnus quadrifidus* heath (type J) in the Bitter Pool Rises landform differs from that occurring elsewhere, although this has not been documented in detail. This heath is associated with the poorly-drained heavy soils that are a feature of this landform unit.

Heath dominated by *Ecdeiocolea monostachya* (type E) occurs in both the northern and eastern blocks of vacant Crown land proposed for inclusion into the Lesueur National Park. However, the substrates on which the heath occurs differs between the two blocks: the northern areas are conspicuously more sandy.

The maximum impact area contains a high proportion of drainage line vegetation (types L and M) in the proposed national park (Figure 13.1). Sandy substrates there support particularly fine stands of *Melaleuca preissiana*, while the broad, clayey flats have *Melaleuca hamulosa* and some associated open sedgelands.

13.5 IMPACT ON PLANT SPECIES

Data are limited to address the question of the potential impact of the proposed coal mine and power station on individual plant species. As discussed in Section 5.2, there are many poorly known taxa among the 111 regional endemics recorded in the proposed Lesueur National Park. Most require field survey to accurately map populations and determine abundance. Such data are the bare minimum required to document what proportions of the total numbers of extant populations and of individual plants would be destroyed in the mine and power station operation. Only in the case of the seven species of Declared Rare Flora are such inventory data available. Except for *Banksia tricuspis* and to a lesser extent, *Eucalyptus suberea* and *E. lateritica*, no data are available on population genetic structure, reproductive biology or recruitment. Hence, on current information, the impact of reducing population numbers through the mining operation on the risk of extinction for almost all rare, poorly known and regionally endemic taxa is unknown. Data on cryptogams in the proposed national park have not been collected, so no statement on potential impact can be made.

13.51 Impact on Declared Rare Flora

Available CALM survey data (Table 13.3) enable a quantitative assessment of the impact of the proposed mining on the numbers of the seven species of Declared Rare Flora affected in the proposed national park. It would appear that similar data were used by Martinick and Associates (1989c) for their impact assessment, as their figures on impact correspond fairly closely to ours.

Within the minimum impact area (Table 13.1, Figure 13.1) all species except *Acacia forrestiana* would be affected. *Eucalyptus lateritica, Banksia tricuspis, Thelymitra stellata* and *Eucalyptus suberea* would sustain the greatest loss of individual plants (15.5%, 11.9%, 11.2% and 9.1% of the total known respectively), while *Hakea megalosperma* (6.3%) and *Asterolasia drummondii* (0.2%) would sustain smaller losses. Of the individuals currently occurring within the proposed Lesueur National Park, 54.5% of *Thelymitra stellata* would be destroyed in the minimum impact area, 25% for *Eucalyptus lateritica*, 13.3% for *E. suberea* and 12.1% for *Banksia tricuspis*.

Impact on these species is much greater within the maximum impact area (Table 13.1, Figure 13.1)). All seven species would be affected, with between 21.6% (*Thelymitra stellata*) and 78.5% (*Hakea megalosperma*) of all known individuals likely to be destroyed. Of the individuals within the proposed national park, the maximum impact area affects 100% for *Thelymitra stellata*, 90.7% for *Asterolasia drummondii*, 86.9% for *Hakea megalosperma*, 63.4% for *Acacia forrestiana* and 49.1% for *Banksia tricuspis*.

Whether or not the remaining plants in the proposed national park would constitute viable populations is a matter requiring careful research. Enzyme analysis of the mating systems of *Banksia tricuspis* (van Leeuwen and Coates unpublished) and of *Eucalyptus rhodantha* (Sampson 1988) have shown that normal levels of outbreeding of 60% or more may drop to around 30% or less when populations become small and isolated. An enhanced probability of population extinction is likely as a consequence unless active genetic management is practised (Soule 1987; Hopper and Coates 1989). This approach, combined with studies on critical factors limiting recruitment would be essential to develop an adequate understanding of the impact of the proposed mine and power station

development on rare plants in the proposed national park.

13.52 Regional endemics

A preliminary analysis of the numbers of known populations of regional endemics affected by the proposed mine and power station is possible, although we caution that many of these plants are poorly known and require further survey to establish their precise distribution and abundance in the Lesueur National Park and elsewhere. All known populations of the 111 regional endemics recorded in the proposed national park were plotted onto a 1:1 000 000 base map showing boundaries of all existing and proposed conservation reserves in the northern kwongan. The total number of known separately mapped populations was counted, and the occurrence was determined in all conservation reserves, in the proposed Lesueur National Park and in the eastern section of the proposed national park overlying the proposed coal mine and power station sites.

A useful check on the accuracy of this approach in estimating maximum impact is available in the case of the seven species of Declared Rare Flora discussed above. The following list compares estimates of impact on known populations using the 1:1 000 000 mapping approach compared with accurate mapping at 1:50 000 using detailed field survey data.

Per cent mappable populations affected by the proposed mine and power station

	Mapping Scale	
	1:1 000 000	1:50 000
Acacia forrestiana	33% (6)*	40% (5)
Asterolasia drummondii	33% (5)	36% (11)
Banksia tricuspis	67% (12)	64% (72)
Eucalyptus lateritica	11% (9)	23% (13)
Eucalyptus suberea	18% (11)	27% (11)
Hakea megalosperma	33% (9)	36% (11)
Thelymitra stellata	20% (5)	36% (11)

* Total number of mappable populations known for the species

The average per cent difference between the two approaches is 8%. Thus, the following impact statistics should be interpreted as being accurate within about ±10%.

Of the 111 regional endemics in the proposed national park, two thirds (72, 65%) would have populations destroyed should mining affect the maximum impact area (Appendix 2). Taxa most affected would include *Banksia tricuspis* (67%), *Hypocalymma* aff. *ericifolium* (E.A. Griffin 1972) (50%), *Eucalyptus* aff. *haematoxylon* (43%), *Acacia forrestiana* (33%), *Thysanotus sparteus* (33%), *Tetratheca remota* (33%), *Persoonia rudis* (33%), *Patersonia argyrea* (33%), *Hakea megalosperma* (33%), *H. auriculata* var. *spathulata* (33%), *Gompholobium* aff. *polymorphum* (33%), *Asterolasia drummondii* (33%) and *Acacia plicata* (29%).

If substantiated by further survey of poorly known taxa among the regional endemics, these statistics indicate that the proposed mine would have an impact on a large number of the species of special conservation significance in the park.

Within the context of populations of regional endemics within the proposed national park itself, eight taxa have been found only in the eastern section and would therefore not be in the park should the mine proceed and the eastern area be excluded. These taxa, their total number of known populations and the per cent on existing conservation reserves are:

Banksia chamaephyton - 31, 19%
Beaufortia bicolor - 14, 28%
Dryandra aff. *falcata* (E.A. Griffin 3459) - 50, 20%
Dryandra aff. *patens* (E.A. Griffin 1507)- 22, 18%
Dryandra carlinoides - 89, 10%
Dryandra tortifolia - 7, 14%
Phlebocarya pilosissima ssp. *pilosissima* - 13, 15%
Stylidium maitlandianum - 15, 20%

All are represented elsewhere on conservation reserves, although *Dryandra* aff. *patens* (E.A. Griffin 1507) only sparingly.

Perhaps of greater concern are those nine taxa endemic to the proposed Lesueur National Park itself (Table 5.6). *Hypocalymma* aff. *ericifolium* (E.A. Griffin 1972) has two known populations, one of which would be affected by the mine. Comparable figures for *Eucalyptus* aff. *haematoxylon* (E.A. Griffin 2451) are 7 with 3 affected, *Persoonia rudis*, *Grevillea thelemanniana* spp. *delta* and *Gompholobium* aff. *polymorphum* (E.A. Griffin 2304) each have 3 with 1 affected and *Leucopogon plumuliflorus* has 6 with 1 affected. None of the two known populations of *Andersonia longifolia*, 5 of *Phebocarya pilosissima* ssp. *teretifolia* nor the one of *Restio* sp. (Briggs 7473 and Johnson) are known to occur in the area proposed for mining. Urgent further survey of all these endemics is a high priority to adequately assess the impact of the proposed mine.

There are 26 very geographically restricted taxa (maximum range 50 km) that occur in the proposed mining impact zone. Twenty of these 26 taxa are not known on current conservation resrves. These taxa, their total number of known mappable populations (at

1:1 000 000 scale) and the percentage of these populations on current conservation reserves are:

Species	Total number mappable pop.	% on cons. res.
Acacia retrorsa	8	12
Banksia tricuspis	12	0
Darwinia helichrysoides	9	0
Daviesia sp. (M.D. Crisp 6213)	5	20
Daviesia epiphyllum	4	0
Daviesia sp. (M.D. Crisp 5429)	8	0
Dryandra sclerophylla	35	22
Eucalyptus aff. *haematoxylon*	7	0
Eucalyptus lateritica	13	7
Eucalyptus suberea	11	0
Genus nova aff. *Ecdeiocolea* E.A. Griffin 2157	7	28
Gompholobium aff. *polymorphum* (E.A. Griffin 2304)	3	0
Grevillea acrobotrya ssp. *uniforma*	6	0
Grevillea thelemanniana ssp. *delta*	2	0
Hakea erinacea var. *longiflora*	8	12
Hakea neurophylla	10	0
Hypocalymma aff. *ericifolium*	2	0
Leucopogon plumuliflorus	6	0
Patersonia argyrea	3	0
Persoonia rudis	3	0
Phlebocarys pilosissima ssp. *teretifolia*	5	0
Stylidium aeonioides	6	16
Tetratheca remota	2	0
Thysanotus aff. *sparteus*	3	0
Thysanotus vernalis	4	0
Xanthosia tomentosa	15	0

13.53 Taxa at their northern or southern limit

There are 81 species at the northern and southern limit of their distribution within the proposed national park. Of these, 45 would be affected within the area of maximum impact of the proposed mine. Ten are not found elsewhere in the proposed park. Six of these, including species such as *Acacia drummondii*, *Thelymitra crinita* and *Baumea preissii*, are at the northern limit of a continuous distribution. The remaining four, *Eucalyptus exilis*, *Goodenia fasciculata*, *Polypompholyx multifida* and *Utricularia menziesii* are disjunct northern outliers of otherwise more southern distributions.

13.54 Widespread species

Populations of many widespread species will be destroyed should the proposed mine proceed. Depletion of such plants need not necessarily be of concern. However, studies such as that of Coates and James (1979; Coates 1980) on *Stylidium crossocephalum* indicate that major genetic variation may lie hidden within a common species. A project like the proposed mine has the potential to destroy local genetic races in such species, but the actual potential impact is unknown because no more than a handful of Lesueur's *ca* 700 widespread species have been studied throughout their range by geneticists.

13.6 IMPACT ON ANIMAL SPECIES

It is difficult to assess impact on fauna using existing data.

Site specific quantitative data on vertebrate animals are limited to 32 sites in the region of the proposed mines and power station, on both the proposed national park and on adjacent freehold land owned by CRA. The draft report on this study (Martinick and Associates 1989b) does not analyse or interpret these data. Comparative data on areas of the proposed national park to the west of the proposed mining area are not available, making interpretation difficult.

While available data indicate that most vertebrates have been recorded in more than one landform this is not particularly helpful in assessing impact. Some species are restricted to particular micro-habitats, which may be of limited extent, even over a large area of land. Data on the minimum area of habitat needed by many species to survive in habitat fragments are not available.

Available data do highlight some vertebrate species that may be affected by the proposal.

Carnaby's Black Cockatoo depends on a combination of habitats (see sections 6.22 and 7.1), requiring woodlands with suitable nesting hollows, kwongan for feeding, and drinking places. The eastern section of the proposed national park is one of the few remaining areas where all these requirements are available. A reduction in the extent or quality of one of the habitats may be sufficient to critically reduce the viability of the resident population.

Many other species are dependent on the wandoo woodlands in the eastern parts of the Lesueur area. Minimum and maximum impact figures for wandoo woodland in the proposed national park are 9 ha and 304 ha; the total area in the eastern part of the proposed national park is 644 ha (Table 13.2). Another

206 ha exists on CRA Farm, immediately to the south, of which 26 ha are in the minimum impact area and 126 ha are in the maximum impact area (Martinick and Associates 1989c). The best quality wandoo woodlands will be affected (see above).

The Regent Parrot is a species that has declined as a result of land clearing. The Lesueur - Coomallo Creek area is a stronghold for it. It uses a tree hollow that is considerably larger than the bird itself - more the size that a galah would use. As galahs increase in the Lesueur area, as they will as more land is cleared for agriculture, they will compete with Regent Parrots and Carnaby's Cockatoos for nest sites. Any loss of woodland will decrease available nest sites and increase competition for this resource - to the detriment of the rarer species.

The fossorial skink *Lerista christinae* has been recorded only from the freehold land to the south of the proposed national park. It was recorded in *Banksia attenuata - B. menziesii* heath (vegetation type A2), an association restricted to the eastern section of the proposed national park and adjacent private land.

No assessment can be made of possible effects on invertebrates, because of lack of data from the area of the proposed mine. Data on terrestrial invertebrates are lacking and data on aquatic invertebrates are insufficient, because the only sampling was carried out too late in the season.

13.7 POSSIBLE IMPACT OF *PHYTOPHTHORA*

The establishment of a coal mine and power station has the potential to threaten many susceptible plant species and communities throughout the proposed national park if their operation led to the introduction of *Phytophthora* spp.

13.71 Hazard and risk ratings of plant communities in the proposed Lesueur National Park

The susceptibility of each vegetation type to *Phytophthora* spp. can be tentatively predicted by assessing a variety of factors that influence the relationship between pathogens and hosts. Keighery and Tippett (1986) rated the disease risk/hazard of south coast vegetation types by giving each a disease risk/hazard score, based on the following queries:

1. Climate. Warm, moist conditions for part of the year?
2. High concentration of susceptible species present?
3. Are susceptible species the dominants in the community?
4. Is the risk of infection high? (amount of human use, and position in the landscape)
5. Do conditions favour the spread of the fungi?
6. Do soil characteristics suggest that conditions are favourable for the fungi?

The risk rating of a vegetation type predicts the ease with which it could become infected, and is determined mainly by its position in the landscape, its soil type and its proximity to roads and drainage lines. Risk rating is covered in point four of the above list. The other five questions address the hazard rating of the community, which reflects the likely impact of disease on the vegetation.

In a high priority area, such as the proposed Lesueur National Park, the risk rating of a plant community becomes somewhat meaningless, as the only acceptable risk, for long term management of the park, is no risk at all. For this reason, the risk and hazard ratings have been separated. Hazard ratings will be scored out of five; the higher the score, the more acute the likely impact. Risk will be given a subjective rating of low, medium or high.

Some comments on the hazard rating categories are given below:

Climate. The Lesueur area receives virtually the same amount of annual rainfall, around 600 mm, as the severely diseased Stirling Range National Park, though it has drier summers (Figure 13.2). Most rain falls between May and September, a time when temperatures are comparable with late spring and early autumn at Stirling Range. In the jarrah forest, Shearer and Shea (1987) recorded the highest recoveries of *P. cinnamomi* from surface soil in mid- and late-winter, from both upland and lowland sites.

Another strong indicator of suitable climatic conditions for the fungi in the proposed park is the presence of "outlying populations of species from mesic environments to the south" which "may reflect an amelioration of the general climate" (Hopkins and Griffin 1984). Overall, the relatively warm conditions in the area during winter provide a five month window for establishment and activity of *Phytophthora* spp.

The harsh summer conditions in the area will, however, not preclude survival of the fungi in the soil. At Gnangara, *P. cinnamomi* survived in 63% and 14% of colonised pine plugs buried for one and two years respectively. Plugs were buried at a depth of 0.3 m in banksia woodland growing on Bassendean sand.

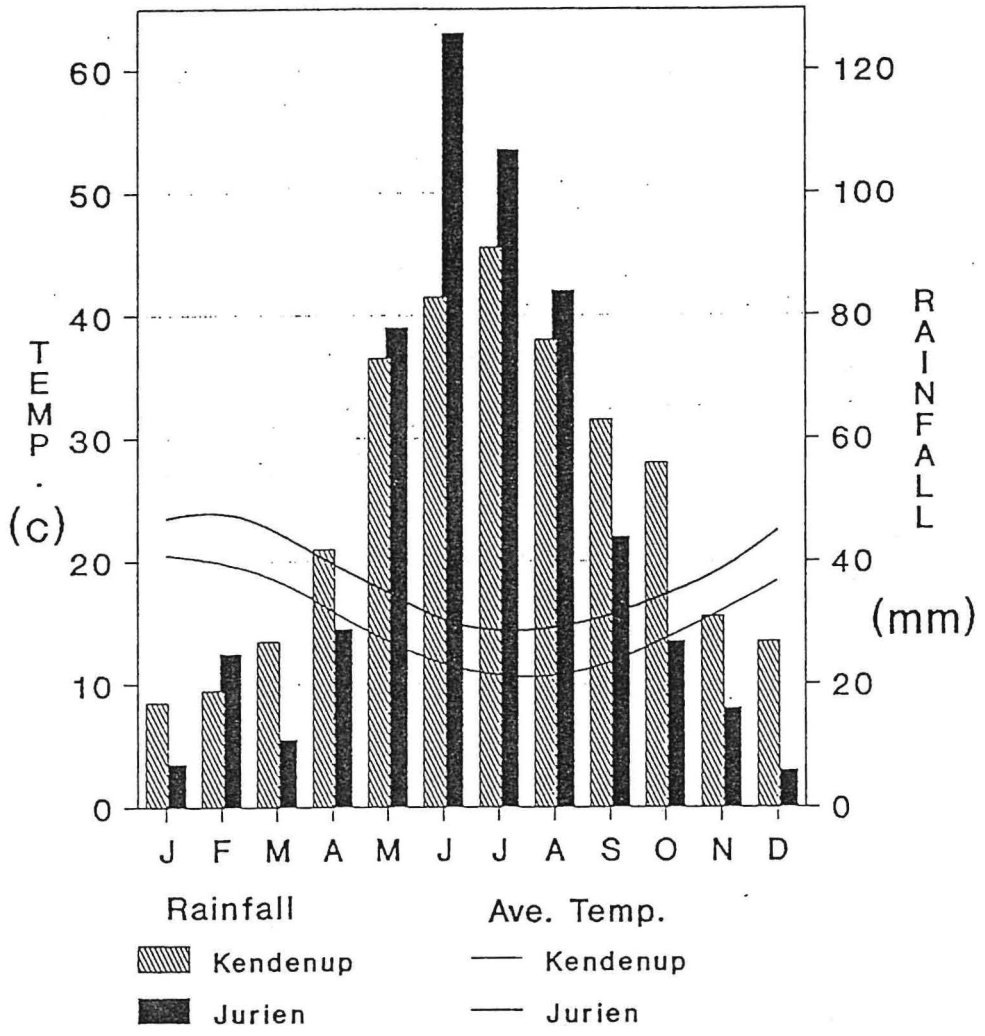


Figure 13.2 Comparative Rainfall and average temperature data for Jurien and Kendenup (south-west of the Stirling Range)

Survival rate of the fungus was even greater in plugs buried at 1.3 m, easing from 100% to 88% over the same period. Soil moisture in summer dropped to 0.6% of dry soil weight at 0.3 m (T.C.J. Hill, unpublished data).

The region also occasionally receives heavy rain in summer. In February of 1986, for example, Jurien received 164 mm; in 1976, 93 mm; and in 1970, 90 mm. If Greenhouse Effect predictions are correct, cyclonic influences and summer rainfall will increase in both frequency and intensity, thereby increasing the potential dieback hazard.

Abundance of susceptible species. The abundance of susceptible species in a plant community is, possibly, the most important factor in determining its hazard rating. Jarrah forest, banksia woodlands, banksia shrublands, proteaceous thickets, scrub heath and heath, all of which contain an abundance of susceptible species, are the most severely affected communities in south-western Australia. When the community is dominated by susceptible species, conditions for the fungus can become so favourable that it can virtually uncouple itself from the edaphic environment, and spread by growing within roots of susceptible plants; infecting new hosts at points of root to root contact. The Bell Track infection in the Fitzgerald River National Park appears to be operating in this manner, devastating *Banksia baxteri/Lambertia inermis* shrubland growing in deep sand, at a site that receives only 390 mm of annual rainfall.

Soil and Topography. Soil profile and topography are closely related. In the uplands of the proposed Lesueur National Park, soils on steep slopes are usually skeletal and impeding, the impeded drainage assisting the rapid, lateral spread of zoospores, but this characteristic would, however, also hinder the establishment of the fungus because the soil would dry quickly. Colluvial accumulation on lower slopes builds either poorly-drained loams and clay soils or deep, well-drained, siliceous sands. The latter, because of their low fertility, are often dominated by highly susceptible proteaceous species. Soils on uplands tend to be moderately impeding due to the presence of duricrust near the surface, but their small gradients do not promote lateral sub-surface flow.

Susceptible Vegetation Types. Table 13.4 gives the hazard and risk ratings of major plant communities in the proposed Lesueur National Park. The eastern sector of the proposed national park contains many vegetation types with high hazard ratings. By contrast, the western (coastal plain) sector contains only one potentially threatened community: banksia low woodland on Bassendean Dunes. This vegetation type occurs only as a small intrusion between the Peron Slopes and Spearwood Dunes landforms.

The hazard ratings of five eastern sector vegetation types (of Martinick and Associates 1988) were scored as very high (4-5 to 5). They are:

C - *Hakea neurophylla/Banksia tricuspis* heath
D - *Petrophile chrysantha* heath
H - *Petrophile seminuda* heath
M1 - *Verticordia densiflora* heath
X - *Allocasuarina campestris* Thicket

These communities are characteristically dominated (often with 50-100% foliage cover) by susceptible species, as well as containing a high concentration of associated susceptible elements. *P. cinnamomi* would probably completely destroy the present structure and significantly reduce the diversity of these communities. Complete or localised extinction of some plant species is also likely. Importantly, these vegetation types occur on a wide range of positions in the landscape, including uplands, slopes, low rises, middle to lower slopes, lower slopes, drainage lines and depressions. As in the Stirling Range, position in the landscape does not confer immunity to the disease. If *P. cinnamomi*, or any other *Phytophthora* species, is introduced, its impact would not simply be confined to low-lying, water-gaining sites.

Six other heath associations (types A,B,E,F,G and J) were rated between 3 and 4. Types A and B, the sand and lateritic heaths, contain a wide variety of sub-types; some significantly more vulnerable than others by virtue of the presence of one or more susceptible dominants. The likely impact of disease in these moderate to high hazard types is not possible to predict, though the low-lying, medium to high risk E,F,G and J associations would inevitably harbour the disease and consequently incur some level of damage.

13.72 Will mining lead to the introduction of *Phytophthora*?

The only known *Phytophthora* occurrence within the proposed park lies beside Cockleshell Gully Rd, 1 km north of the southern park boundary (Figure 8.1). *Phytophthora citricola* was isolated from the collar of a single, dying *Banksia prionotes* in 1988. Most surrounding vegetation appeared healthy at that time.

No systematic dieback surveys have been carried out in the proposed park. A brief visual survey conducted in June 1989 found no indication of disease on Banovich Road and other major tracks in the area, nor on minor tracks near Mounts Lesueur and Michaud.

Table 13.3

Minimum and maximum impacts on Declared Rare Flora of the proposed mine and power station.

	Total		In proposed national park		Impact area			
					Minimum		Maximum	
	No. Pop	No. Plants	Pop	Plants	Pop	Plants	Pop	Plants
Acacia forrestiana								
number	5	920	4	820	0	0	2	520
% total populations	-	-	80.0	89.1	0	0	40.0	56.5
% park populations	-	-	-	-	0	0	50.0	63.4
Asterolasia drummondii								
number	11	3213	9	17131	5	4	1555	
% total populations	-	-	81.5	53.3	9.1	0.2	36.4	48.4
% park populations	-	-	-	-	11.1	0.3	44.4	90.7
Banksia tricuspis								
number	72	19031	65	18940	15	2268	46	9220
% total populations	-	-	90.3	97.2	20.8	11.9	63.8	48.5
% park populations	-	-	-	-	23.0	12.1	70.7	49.1
Eucalyptus lateritica								
number	13	260	8	160	2	40	3	60
% total populations	-	-	61.5	61.5	15.4	15.5	23.1	23.1
% park populations	-	-	-	-	25.0	25.0	37.5	37.5
Eucalyptus suberea								
number	11	220	8	150	1	20	3	60
% total populations	-	-	72.7	68.2	9.1	9.1	27.3	27.3
% park populations	-	-	-	-	12.5	13.3	37.5	40.0
Hakea megalosperma								
number	11	1274	6	1150	3	80	4	1000
% total populations	-	-	54.5	90.3	27.3	6.3	36.4	78.5
% park populations	-	-	-	-	50.0	6.9	66.7	86.9
Thelymitra stellata								
number	11	51	4	11	2	6	4	11
% total populations	-	-	36.4	21.5	18.2	11.2	36.4	21.6
% park populations	-	-	-	-	50.0	54.5	100.0	100.0
MEAN								
% TOTAL POPULATIONS	-	-	68.1	68.7	14.2	7.7	37.6	43.4
(±SE)			17.1	24.5	8.3	5.5	12.9	19.3
% PARK POPULATIONS	-	-	-	-	24.5	16.0	58.1	66.8
(± SE)					17.8	17.6	21.0	23.8

Experience in other parts of south-western Australia, as well as in parts of south-eastern Australia, suggests that there is a high probability of introduction of *Phytophthora* spp. when extensive use of earth-moving equipment or vehicles takes place in a highly susceptible area (see Chapter 8). Even if high standards of hygiene are maintained, the great intensity of disturbance associated with the coal mine and power station during the construction phase and the 30 year mine life will pose a high risk of introduction of the disease into the area.

The recent construction of numerous exploratory roads and drilling tracks by the mining companies was carried out under strict dieback hygiene controls. However, the opening up of large, previously inaccessible areas to both two-wheel drive and four-wheel drive vehicles presents an unacceptable hygiene risk to the proposed national park, and is, of course, disturbingly reminiscent of other case histories. There are no hygiene controls on the use of the area by private vehicles.

13.73 Possible impact of *Phytophthora* if introduced

The proposed coal mine and, possibly, the power station, will be sited in the eastern part of the proposed park, and will affect the Bitter Pool Rises, Banovich Uplands and Gairdner Dissected Uplands landforms (Table 13.1).

The Bitter Pool Rises unit contains the greatest abundance of high hazard vegetation types in the proposed national park, with significant expanses of types D, H and M1, as well as DEH and FGH mosaics. The Gairdner Dissected Uplands unit also contains large areas of highly susceptible heaths, particularly types D, H, DFH, DFG, FGH and AE. Banovich Uplands contain fewer of the highly susceptible vegetation units. However, amongst the widespread lateritic and sand heaths are sub-types of moderate to high susceptibility. The highly susceptible types D and M1 occur in places.

In addition to the direct impact of the minesite, the power station and overburden dumps, and ancillary activities such as access roads and sedimentation pond construction will contribute to the likely introduction, establishment and spread of *Phytophthora* spp. in the area.

Rehabilitation of the minesite and other disturbed areas will provide further opportunities for the introduction or spread of the wide range of *Phytophthora* species that are regularly associated with nursery stock in this State.

Mining activities would directly impinge on three major catchments (Coomallo Creek, Cockleshell Gully and Munbinia Creek), which together drain the bulk of the area designated elsewhere in this report as biologically most important. The fourth catchment present in the proposed national park, Stockyard Gully, will also be affected by the proposed mine site on private land to the north of the park boundary. Every opportunity would, therefore, exist for *Phytophthora* species to rapidly contaminate the heart of the proposed park if introduced, particularly if Cockleshell Gully was infected.

Of the seven Declared Rare flora species in the proposed park, at least one, *Banksia tricuspis*, would be seriously threatened if dieback was introduced. It occurs in C1 and B1.1 vegetation sub-types, both of which were scored as high to very high hazard. Localised extinction is possible. *Hakea megalosperma*, though probably susceptible to *P. cinnamomi*, occurs in less susceptible, lateritic heath communities.

Based on current Herbarium information and field studies, nine plants are entirely restricted to the proposed national park. Of these, five belong to susceptible genera (or in the case of *Eucalyptus*, informal sub-genera). A further 24 species have between 50% and 100% of known populations confined to the proposed national park. Fourteen of these belong to susceptible genera (Table 5.6).

Of the 111 geographically restricted and/or rare species listed in Appendix 2 that occur in the proposed national park, 60 belong to susceptible genera.

Outlying occurrences of several species, particularly *E. marginata*, may also be at risk.

Overall, dieback diseases have the potential to cause major degradation of the nature conservation values of the proposed Lesueur National Park if the area is not protected, properly quarantined and managed. Stirling Range National Park provides a warning of the problems that could occur (R. Wills pers. comm.).

13.8 POTENTIAL VISUAL IMPACTS

The area of the proposed Lesueur National Park of primary interest for coal mining lies east of the Lesueur Fault along the western margin of the Banovich Uplands. There are also mineable coal deposits north of the proposed park. The Notice of Intent indicates that the proposed coal-fired power station would be sited between these deposits in the Bitter Pool Rises.

These two landform units, as previously indicated, have been assessed as being of Moderate Scenic Quality. Thus it would appear that the most scenic

portions of the Gairdner Range landscape, the Lesueur and Gairdner Dissected Uplands, would be largely spared from mining. There will, however, be a significant degree of impact on visual resource values should the proposed mining operations and power station development proceed. Impacts that would need to be carefully evaluated and addressed include:

1. Loss of supporting landscape values. The Banovich Uplands and Bitter Pool Rises are a supporting landscape and important foreground to the eastern flank of the Gairdner Range. Any mining activity or development in this zone would have a major impact on the visual integrity of the adjoining landscape irrespective of its ultimate vesting and use. In addition, the possible introduction of dieback, and the devastating impact this could have on some plant species and associations and hence landscape values, also needs to be evaluated.

2. Impact on major viewsheds and vistas. The areas proposed for mining such as the coal seam situated under the ridge south of the headwaters of Cockleshell Gully would be visible from numerous vantage points within the Lesueur and Gairdner Uplands. In particular, the viewsheds east and northeast from Mount Peron and from the eastern edge of the Gairdner Range would be most significantly affected. The coal-fired power station, with its reported 200 metre high stack, would also be visible from a considerable distance, both from within and outside the reserve.

Other associated visual impacts that will need to be assessed include the visibility of overburden dumps, roads, powerlines and ancillary facilities as well as the smoke from stack emissions and dust from blasting and mining operations.

The main purpose in listing these potential impacts is simply to clarify the nature of visual resource management issues that will need to be addressed if this development should proceed. When access is available to detailed information on the precise location, layout and design of the proposed plant, the size and configuration of open cut areas and the disposal and management of overburden, it would be possible to accurately describe and assess the resulting visual impacts. Various computer generated digital terrain models such as VIEWIT and PREPLAN are available for assessing how much of a particular landscape can be seen from various observation points.

Irrespective of what these assessments reveal, it is clear that the proposed mining operations and power plant development will impact significantly upon the visual quality of the Lesueur area. The natural character and scenic beauty of what are some of the most attractive landscapes within the northern kwongan will be severely degraded should this project proceed. Landscape rehabilitation efforts, however well planned and executed, are likely to fall well short of being able to restore the integrity and visual qualities of this area. Such impacts can not be dismissed lightly.

Should the proposed mine and power station proceed, those recreational activities and human experiences that are dependent on the quality and integrity of the visual environment will suffer.

13.9 REHABILITATION

Having drawn attention to the extent to which present natural ecosystems might be destroyed, or at least seriously disturbed, by the proposed mine and power station, it is pertinent to consider the likely success of any rehabilitation program. This will be done by reviewing the results of rehabilitation work in somewhat similar kwongan vegetation after the mining of mineral sands at Eneabba in the context of what is known of coal mine rehabilitation generally.

Mining at Eneabba occurs on alluvial and colluvial deposits immediately to the west of the Gingin escarpment. The sands and clays are excavated in an open cut mining operation, the heavy minerals are removed in a wet, gravity separation process and the tailings are returned to the pits as a wet slurry that is left to dry and is then rehabilitated. Prior to mining, the native vegetation is harvested as brush. Topsoil is removed in a two-cut operation, sometimes stockpiled, and then relaid on dried tailings as the first part of the rehabilitation procedure. Areas are seeded with native plant species and sparse cereal crops for short-term stabilization and then covered with harvested brush. Small amounts of fertilizer are added and seedlings of selected species are planted out.

Results of the rehabilitation are assessed by the Mineral Sands Rehabilitation Coordinating Committee (MSRCC). The Committee has established a set of quantitative criteria to provide a framework for this assessment. Criteria relate to:

- Species richness. Numbers of species of native plants per unit area. Data on species are recorded in individual quadrats and in large rehabilitated blocks.

- Plant density. Numbers of individual plants (native species only) recorded in quadrats.

- Canopy cover. Cover of native plants, not including short-lived species.

Taken together it is believed that the criteria will provide useful insight into the long-term viability of the reconstructed plant communities.

The data used to set the values for the criteria were derived from studies of the pristine native vegetation. Values set for rehabilitation are between 40 and 50% of pristine vegetation values.

Full scale mining commenced in 1976. So far the Company mining at Eneabba has not approached the MSRCC with a view to having areas assessed as completely rehabilitated. It is believed that some of the recently treated areas approach the rehabilitation criteria values but most of the areas treated before about 1986 will require ongoing treatment. Many species, particularly in the Restionaceae, Cyperaceae, Orchidaceae and Epacridaceae fail to rehabilitate at all in mining-affected areas, both at Eneabba and Collie (K. Dixon personal communication).

A problem for rehabilitation after mineral sands mining that has not been encountered at Eneabba but that will have to be addressed at Cooljarloo is one of *Phytophthora*. Section 13.7 discusses the potential of these fungi to seriously degrade native plant communities. Effects on sites being rehabilitated can be similar to those on native vegetation.

From the rehabilitation perspective, mining for coal at Lesueur will pose much greater problems than the sand mining at Eneabba. Two aspects are important.

1. The reconstructed substrate at Lesueur will be quite different from the pre-mining substrate. There is a wide range of sedimentary formations in the area proposed to be mined at Lesueur and a variety of sedimentary rock types are at or close to the surface. This is unusual in the northern kwongan.

   Soils are highly variable, reflecting the complex geology and physiography of the proposed national park and, to great extent, the complexity of the soils controls the great variety of vegetation associations and the species richness in the flora and associated fauna. Reconstruction after mining of the complex soil profiles and relationships would be extremely difficult, if not impossible.

   If the pits are back-filled, it is likely that the geological sequence in the overburden will be significantly re-ordered and that fresh rocks will be brought to the surface. The overburden will be less compacted than the pre-mine substrate.

   In contrast, it is possible to recreate a soil profile quite similar to the pre-mine profile in the process of disposal of tailings after mineral sands mining at Eneabba. Hydraulic back-filling allows for blending of sand and clay fractions in a predetermined fashion and ensures that the sediments compact to a degree approaching that achieved in natural deposition.

2. The overburden is likely to be extremely toxic to plant growth. Oxidation of minerals, particularly pyrite, in sediments following exposure through excavation generally causes major pH changes in resultant soils. For example, pH values of 2.5 to 3 are not uncommon in overburden dumps at Collie. Release of heavy metals can also inhibit plant growth on tailings. Finally, activation of salts (NaCl and soluble Aluminium salts) in the marine sediments may cause problems of rehabilitation.

   Some of these problems may be addressed by special amendment programs such as liming. However, the most satisfactory long-term solution is deep burial to ensure that the toxic materials are maintained under anaerobic conditions.

   In contrast, tailings at Eneabba are relatively benign.

The degree to which the issues raised here influence the outcome of any rehabilitation attempts will depend on the actual physical and chemical properties of the sedimentary rocks at the site and the way in which the mining and rehabilitation program is managed. It is not possible to make any judgement on either of these: data provided in consultants' reports are inadequate for assessment and the mining program has yet to be designed.

Available information suggests that any program of rehabilitation to pre-existing native vegetation in the proposed Lesueur coal mine area is likely to be impossible. Creation of synthetic vegetation associations are possible, but given the high nature conservation values of the existing vegetation, this should not be allowed.

Rehabilitation could be further assessed by examining the record in this area at Collie.

Pg 127 is a diagram that we don't have.