

ENTERED ON GIS

Name: Gwindinup Mineral Sands Mine – Consultative Environmental Review
Date: 11/05/2006
Capture Author: Thomas Leong

Comments:

Polygon

Created to match documented study area with high level of accuracy

Accuracy Levels:

- High = Document contained visual and or described spatial references easily copied, resulting in little or no polygon boundary errors
- Acceptable = Document contained visual and or described spatial references with complex boundaries, resulting in minor boundary errors
- Low = Document contained little or no visual and or described spatial references, resulting in polygon boundary errors

Attributes

Report Info – Captured without problems

Custodial/Contact – Captured without problems

Content – Captured without problems



**GWINDINUP
MINERAL SANDS
MINE**

**CONSULTATIVE
ENVIRONMENTAL
REVIEW**

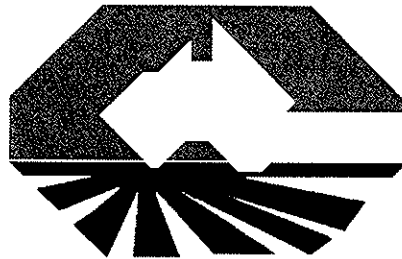


**CABLE SANDS
(WA) PTY. LTD.**

March 2000

GWINDINUP HEAVY MINERALS SAND MINE

Consultative Environmental Review



Cable Sands (WA) Pty Ltd
A.C.N. 009 137 142

March 2000

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

Cable Sands (WA) Pty Ltd proposes to develop a heavy mineral sands mine at Gwindinup, approximately 25km SSE of the city of Bunbury. In accordance with the Environmental Protection Act, a Consultative Environmental Review (CER) has been prepared which describes the proposal and its likely effects on the environment. The CER is available for a public review period of 4 weeks beginning on 6th March 2000 and closing on 3rd April 2000.

Comments from government agencies and from the public will help the EPA prepare an assessment report in which it will make recommendations to government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the CER:

- Clearly state your point of view;
- Indicate the source of your information or argument if this is applicable;
- Suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- Attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- Refer each point to the appropriate section, chapter or recommendation in the CER;
- If you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- Attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include your name, address, date and whether you want your submission to be confidential.

The closing date for submissions is 3rd April 2000.

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000
Attention: Ben von Perger

TABLE OF CONTENTS

EXECUTIVE SUMMARY	vii
1 INTRODUCTION.....	1
1.1 PURPOSE OF THIS REPORT.....	1
1.2 THE PROPONENT.....	1
1.3 RELEVANT LEGISLATION	5
1.4 DECISION-MAKING AUTHORITIES.....	6
1.5 LOCATION AND LAND TENURE.....	6
2 DESCRIPTION OF THE PROPOSAL	11
2.1 GWINDINUP MINERAL SAND DEPOSITS	11
2.2 MINE SITE LAYOUT.....	11
2.3 MINING PROCESS	15
2.3.1 <i>Vegetation clearance and topsoil removal</i>	15
2.3.2 <i>Overburden and ore removal</i>	19
2.3.3 <i>HMC production</i>	19
2.3.4 <i>By products</i>	19
2.3.5 <i>Rehabilitation</i>	20
2.4 MINING SCHEDULE.....	20
2.5 INFRASTRUCTURE	21
2.5.1 <i>Water</i>	21
2.5.2 <i>Thickener tank</i>	21
2.5.3 <i>Internal roads</i>	21
2.5.4 <i>Plant sites</i>	21
2.5.5 <i>Storage of hydrocarbons</i>	21
2.5.6 <i>Workforce</i>	22
2.6 TRANSPORTATION OF HEAVY MINERAL CONCENTRATE	22
2.6.1 <i>Haulage requirement</i>	22
2.6.2 <i>Haulage route options</i>	22
3 EXISTING ENVIRONMENT	27
3.1 REGIONAL SETTING	27
3.2 CLIMATE	27
3.3 GEOLOGY.....	28
3.4 SOILS AND LANDFORM	29
3.4.1 <i>Overview of existing information</i>	29
3.4.2 <i>Landform/soil survey of the project area</i>	30
3.5 GROUNDWATER	35
3.5.1 <i>Superficial aquifer</i>	35
3.5.2 <i>Leederville aquifer</i>	35
3.5.3 <i>Yarragadee aquifer</i>	35
3.6 SURFACE WATER.....	36
3.7 NATIVE VEGETATION AND FLORA.....	39
3.7.1 <i>Regional vegetation distribution</i>	39
3.7.2 <i>Vegetation within the project area</i>	41
3.7.3 <i>Wetland vegetation</i>	42
3.7.4 <i>Flora</i>	47
3.7.5 <i>Dieback</i>	51
3.7.6 <i>Conservation significance of the vegetation</i>	51

3.8	FAUNA	57
3.8.1	<i>Mammals</i>	57
3.8.2	<i>Birds</i>	57
3.8.3	<i>Reptiles</i>	58
3.8.4	<i>Amphibians</i>	58
3.8.5	<i>Fish</i>	58
3.8.6	<i>Significant fauna</i>	58
3.9	LAND USE	60
3.10	ABORIGINAL CULTURE AND HERITAGE	60
3.11	EUROPEAN HERITAGE	61
4	ENVIRONMENTAL MANAGEMENT	62
4.1	ENVIRONMENTAL MANAGEMENT SYSTEM	62
4.2	NATIVE VEGETATION PROTECTION STRATEGY	62
4.2.1	<i>Conservation areas</i>	62
4.2.2	<i>Minimisation of clearing requirement</i>	67
4.2.3	<i>Native vegetation rehabilitation</i>	67
4.3	ENVIRONMENTAL MANAGEMENT PROGRAMME	68
4.4	REHABILITATION PLAN	69
5	BIOPHYSICAL ENVIRONMENT: IMPACTS AND MANAGEMENT	71
5.1	BIODIVERSITY	71
5.1.1	<i>EPA objective</i>	71
5.1.2	<i>Relevant assessment standard/procedure</i>	71
5.1.3	<i>Predicted impact</i>	72
5.1.4	<i>Management</i>	72
5.1.5	<i>Predicted outcome</i>	73
5.2	LANDFORMS	73
5.2.1	<i>EPA objective</i>	73
5.2.2	<i>Relevant assessment standard/procedure</i>	73
5.2.3	<i>Predicted impact</i>	73
5.2.4	<i>Management</i>	74
5.2.5	<i>Predicted outcome</i>	74
5.3	REHABILITATION	74
5.3.1	<i>EPA objective</i>	74
5.3.2	<i>Relevant assessment standard/procedure</i>	74
5.3.3	<i>Predicted impact</i>	75
5.3.4	<i>Management</i>	75
5.3.5	<i>Predicted outcome</i>	79
5.4	VEGETATION COMMUNITIES	79
5.4.1	<i>EPA objective</i>	79
5.4.2	<i>Relevant assessment standard/procedure</i>	79
5.4.3	<i>Predicted impact</i>	80
5.4.4	<i>Management</i>	81
5.4.5	<i>Predicted outcome</i>	82
5.5	DECLARED RARE AND PRIORITY FLORA	82
5.5.1	<i>EPA objective</i>	82
5.5.2	<i>Relevant assessment standard/procedure</i>	82
5.5.3	<i>Predicted impact</i>	82
5.5.4	<i>Management</i>	83
5.5.5	<i>Predicted outcome</i>	83
5.6	WETLANDS	83
5.6.1	<i>EPA objective</i>	83
5.6.2	<i>Relevant assessment standard/procedure</i>	83
5.6.3	<i>Predicted impact</i>	84
5.6.4	<i>Management</i>	84
5.6.5	<i>Predicted outcome</i>	84

5.7	FAUNA	84
5.7.1	<i>EPA objective</i>	84
5.7.2	<i>Relevant assessment standard/procedure</i>	85
5.7.3	<i>Predicted impact</i>	85
5.7.4	<i>Management</i>	85
5.7.5	<i>Predicted outcome</i>	85
5.8	SPECIALLY PROTECTED (THREATENED) AND PRIORITY FAUNA	85
5.8.1	<i>EPA objective</i>	85
5.8.2	<i>Relevant assessment standard/procedure</i>	86
5.8.3	<i>Predicted impact</i>	86
5.8.4	<i>Management</i>	86
5.8.5	<i>Predicted Outcome</i>	86
6	POLLUTION MANAGEMENT.....	87
6.1	GROUNDWATER QUALITY.....	87
6.1.1	<i>EPA objective</i>	87
6.1.2	<i>Relevant assessment standard/procedure</i>	87
6.1.3	<i>Predicted impacts</i>	87
6.1.4	<i>Management</i>	88
6.1.5	<i>Predicted outcome</i>	89
6.2	SURFACE WATER QUALITY	89
6.2.1	<i>EPA objectives</i>	89
6.2.2	<i>Relevant assessment standard/procedure</i>	89
6.2.3	<i>Predicted impacts</i>	89
6.2.4	<i>Management</i>	90
6.2.5	<i>Predicted outcome</i>	91
6.3	DUST.....	91
6.3.1	<i>EPA objectives</i>	91
6.3.2	<i>Relevant assessment standard/procedure</i>	91
6.3.3	<i>Predicted impact</i>	91
6.3.4	<i>Management</i>	95
6.3.5	<i>Predicted outcome</i>	95
6.4	NOISE.....	95
6.4.1	<i>EPA objective</i>	95
6.4.2	<i>Relevant assessment standard/procedure</i>	95
6.4.3	<i>Noise survey</i>	95
6.4.4	<i>Predicted impacts</i>	97
6.4.5	<i>Management</i>	98
6.4.6	<i>Predicted outcome</i>	98
6.5	RADIATION.....	98
6.5.1	<i>Cable Sands objective</i>	98
6.5.2	<i>Relevant assessment standard/procedure</i>	98
6.5.3	<i>Predicted impact</i>	98
6.5.4	<i>Management</i>	99
6.5.5	<i>Predicted outcome</i>	99
6.6	GREENHOUSE GASES.....	99
6.6.1	<i>EPA objectives</i>	99
6.6.2	<i>Relevant assessment standard/procedure</i>	100
6.6.3	<i>Predicted impact</i>	100
6.6.4	<i>Management</i>	100
6.6.5	<i>Predicted outcome</i>	100

7	SOCIAL SURROUNDINGS: IMPACTS AND MANAGEMENT.....	101
7.1	VISUAL AMENITY.....	101
7.1.1	<i>EPA objective</i>	101
7.1.2	<i>Relevant assessment standard/procedure</i>	101
7.1.3	<i>Predicted impact</i>	101
7.1.4	<i>Management</i>	101
7.1.5	<i>Predicted outcome</i>	102
7.2	ROAD TRANSPORTATION/TRAFFIC.....	102
7.2.1	<i>EPA objectives</i>	102
7.2.2	<i>Relevant assessment standard/procedure</i>	102
7.2.3	<i>Evaluation of preferred haulage route</i>	102
7.2.4	<i>Predicted impact</i>	103
7.2.5	<i>Management</i>	103
7.2.6	<i>Predicted outcome</i>	104
7.3	CULTURE AND HERITAGE.....	104
7.3.1	<i>EPA objectives</i>	104
7.3.2	<i>Relevant assessment standard/procedure</i>	104
7.3.3	<i>Predicted impact</i>	104
7.3.4	<i>Management</i>	104
7.3.5	<i>Predicted outcome</i>	105
7.4	PUBLIC CONSULTATION.....	105
8	ENVIRONMENTAL COMMITMENTS.....	107
9	CONCLUSION.....	109
	REFERENCES.....	110

APPENDIX A	EPA GUIDELINES
APPENDIX B	FLORA
APPENDIX C	FAUNA
APPENDIX D	ENVIRONMENTAL POLICY

FIGURES

FIGURE 1	LOCATION OF THE GWINDINUP MINERAL SANDS MINE.....	3
FIGURE 2	LOCATIONS OF FREEHOLD AND LEASE BOUNDARIES AND MINERAL SANDS DEPOSITS	9
FIGURE 3	GWINDINUP MINE SITE LAYOUT.....	13
FIGURE 4	PROCESS FLOW CHART.....	17
FIGURE 5	HAULAGE ROUTE OPTIONS.....	25
FIGURE 6	SUMMARY CLIMATIC DATA FOR THE DONNYBROOK METEOROLOGICAL STATION.....	27
FIGURE 7	SOIL/LANDFORM MAPPING OF THE GWINDINUP PROJECT AREA	33
FIGURE 8	CAPEL RIVER CATCHMENT.....	37
FIGURE 9	DISTRIBUTION OF THE JARRAH BLACKWOOD FOREST ECOSYSTEM ON CROWN LAND.....	39
FIGURE 10	VEGETATION DISTRIBUTION WITHIN THE GWINDINUP PROJECT AREA.....	43
FIGURE 11	BASIN AND FLAT WETLANDS OCCURRING IN THE GWINDINUP AREA	45
FIGURE 12	THE DISTRIBUTION OF PRIORITY FLORA SPECIES OCCURRING WITHIN THE GWINDINUP PROJECT AREA.....	49
FIGURE 13	DIEBACK DISTRIBUTION WITHIN THE GWINDINUP PROJECT AREA.....	53
FIGURE 14	CONSERVATION SIGNIFICANCE OF VEGETATION OCCURRING WITHIN THE GWINDINUP PROJECT AREA.....	55
FIGURE 15	CONCEPTUAL POST-MINING LAND USE PLAN	63
FIGURE 16	MAP OF RESIDENCES WITHIN A 2KM ZONE OF CABLE SANDS GWINDINUP MINING LEASES.....	93

TABLES

TABLE 1	MINING LEASES AND AFFECTED LAND OWNERS	7
TABLE 2	KEY CHARACTERISTICS OF THE GWINDINUP MINERALS SANDS MINE	12
TABLE 3	CONSTRAINTS AFFECTING THE GWINDINUP MINE SITE LAYOUT	12
TABLE 4	GENERALISED SOIL PROFILE DESCRIPTIONS OF THE STUDY AREA	31
TABLE 5	GROUNDWATER RESOURCES WITHIN THE ELGIN-CAPEL RIVER GROUNDWATER SUB-AREA	35
TABLE 6	REGIONAL REPRESENTATION OF SELECTED VEGETATION COMPLEXES	40
TABLE 7	VEGETATION TYPES OCCURRING WITHIN THE PROJECT AREA.....	42
TABLE 8	CHANGE IN LAND USE AND VEGETATION AS A RESULT OF THE PROPOSAL	65
TABLE 9	DISTRIBUTION OF PRIORITY FLORA WITHIN THE PROJECT AREA.....	83
TABLE 10	TOTAL SULPHUR ANALYSIS FOR THE GWINDINUP AND HAPPY VALLEY DEPOSITS	88
TABLE 11	RESULTS OF BASELINE STUDY OF EXISTING NOISE	96
TABLE 12	ASSIGNED NOISE LEVELS AND NOISE LEVEL ESTIMATES FOR THE GWINDINUP MINE	97
TABLE 13	SUMMARY OF THE PROPONENTS ENVIRONMENTAL COMMITMENTS	107

EXECUTIVE SUMMARY

Introduction

Cable Sands (WA) Pty Ltd (Cable Sands) proposes to mine mineral sands from ore deposits near Gwindinup, approximately 25km SSE of Bunbury in Western Australia. The project area for the proposal consists of four mining leases. Two of these leases (M70/895 and M70/899) occur over freehold land while the other two (M70/900 and M70/901) occur within state forest. It is estimated that the Gwindinup deposits will produce approximately 1.4 million tonnes of Heavy Mineral Concentrate (HMC). The HMC contains heavy minerals, which are composed primarily of ilmenite, with minor amounts of zircon and some leucoxene, garnet and trace monazite also present. Mining and preliminary concentration will occur on site with the HMC being transported to Bunbury for separation.

This Consultative Environmental Review (CER) has been prepared as a requirement of Part IV of the *Environmental Protection Act 1986*. The report has been prepared for the consideration of the Environmental Protection Authority (EPA), who will provide advice on the proposal to the Minister for the Environment. The CER is intended to provide the EPA, the public and Government agencies with an understanding of the proposal and the environmental strategies and commitments applied to address environmental factors. The CER is subject to a four week public review period. At the end of this period, issues raised in written submissions from the public and Government agencies are collated and transmitted to the proponent by the Department of Environmental Protection.

The Proposal

The deposit was formed when heavy minerals were concentrated by current, wave and wind action to form two distinct strandlines, the Yoganup and Happy Valley Strands. Previous fluvial action has eroded these strandlines such that four separate deposits may be defined within the project area. These deposits are: Gwindinup South and Gwindinup North (from the Yoganup Strand); and Happy Valley South and Happy Valley North (from the Happy Valley Stand). Key characteristics of the proposal that are associated with these deposits are indicated in the table below.

There will be no net increase in mining by Cable Sands. The Gwindinup mine will replace production from other existing mine sites on the Swan Coastal Plain. A description of the current schedule for mining at Gwindinup follows, however market forces and progress at other mine sites may alter this. Consequently, a total mining period of 10 years for the project is stipulated. Given favourable conditions mining may be completed in an earlier timeframe.

Two parallel mining sequences will be in operation, with mining and primary separation operations being undertaken on a 24 hours per day and 7 days per week basis. Variation in production rates and ore throughput may alter the indicated timing. Mining of the Gwindinup South deposit is planned to commence in late 2002 or early 2003 and will take nearly 4 years, completing in 2006. Happy Valley South is then expected to take approximately 27 months to mine, finishing in 2009. Mining of the Gwindinup North deposit is planned to commence in mid-2003 and would take less than three years, completing in late 2005. Happy Valley North is then expected to take approximately 16 months to mine, finishing in mid-2007.

The deposits will be dry mined using earthmoving equipment (loaders, scrapers and bulldozers) similar to that currently in use at the Yarloop and Bengier mines. A single plant site will be established for each of the mineral deposits except Gwindinup North, which will utilise two locations for its plant. Facilities will initially be transported from other Cable Sands' operations.

KEY CHARACTERISTICS OF THE GWINDINUP MINERAL SANDS MINE

Element	Deposit ¹				Total Project
	Gwindinup South	Gwindinup North	Happy Valley South	Happy Valley North	
PROJECT CHARACTERISTICS					
Minesite production					
Mining period (months)	47	30	27	17	10 yrs
Ore body size (tonnes)	6,300,000	4,000,000	3,800,000	2,200,000	16,300,000
Depth of mine pit (m)	28	28	24	20	-
Overburden (bcm)	9,100,000	6,900,000	1,500,000	700,000	18,200,000
HMC produced (tonnes)	565,000	376,000	309,000	183,000	1,433,000
Disturbance areas (ha)					
Mine pits	85	68	41	30	224
Overburden	94	52	16	8	170
Fines dams	27	38	24	16	105
Topsoil/subsoil	18	17	11	12	58
Tailings dams	16	17	0	2	35
Infrastructure	23	11	18	17	69
		Mining Lease ²			Total Project
		M70/899	M70/895	M70/900	M70/901
Native vegetation clearance		165.0	26.3	22.3	37.0
Native vegetation rehabilitation		116.2	26.1	22.3	37.0
MINESITE OPERATION (per plantsite)³					
Operating hours	24hr 7day/week commencing in late 2002 or early 2003				
Approximate ore extraction rate (tonnes/hour)	220				
Max. HMC production (tonnes/year)	240,000				
Water Supply: source	Yarragadee aquifer				
Max. hourly use (L)	180,000				
Max. annual use (ML)	1,460				
Fuel: Maximum storage (kL)	100				
Maximum use (kL/year)	1,700				

¹ Mining characteristics such as overburden, tailings, fines and HMC production relate to the source orebodies rather than mining lease boundaries

² Areas of native vegetation clearance and rehabilitation were determined by analysis of a Geographical Information System (GIS) developed as part of the baseline vegetation survey performed by ESM (1999).

³ Either one or two plants may be in operation at any time

Prior to extraction of the ore, it will be necessary to clear covering vegetation and remove topsoil and overburden material. These materials will be stockpiled for later use in the land rehabilitation process. Clearing of native vegetation will be kept to a practical minimum and appropriate use made of any timber harvested. Non-commercial timber and tall shrubs will be stockpiled for use as mulch and fauna habitat during the rehabilitation phase.

Overburden, which is of sufficient depth to be handled independently of the ore, will be removed by earthmoving equipment (e.g. front-end loaders, bulldozers, scrapers and dump trucks). When the orebody is exposed, the ore will be removed using similar equipment. Ore is fed to a trommel, which removes oversize material. The finer fraction of the orebody will then be pumped as a slurry to the wet separation plant where heavy minerals will be separated by conventional wet gravity methods to produce a heavy mineral concentrate (HMC). Process water, used in the separation process will be abstracted from the Yarragadee aquifer. Cable Sands' maximum projected annual abstraction of groundwater will be 2,920 ML when two plants are in operation.

Plant production of HMC will tend to vary between 130,000 and 170,000 tonnes/year, depending upon the nature of the deposit. Periodically, in zones of high-grade ore, it is possible that plant production could rise to a maximum level of 240,000 tonnes/year of HMC. The HMC produced by these plants will be stockpiled at the mine site prior to being trucked to Cable Sand's dry separation plant at North Shore, Bunbury.

Tailings and fines will be produced as by-products of the mining process. Tailings are the coarse grained sandy material which will be returned to the mine pit as soon as sufficient room is available. Fines are the silt and clay fractions, which are produced in a slurry during the mining process. Fines will be dried in dams prior to being re-incorporated into the landform along with the tailings and overburden.

A conceptual post-mining land use plan developed for the area proposes to rehabilitate disturbed areas to a combination of farmland and native vegetation. The plan proposes restoring original farmland, bluegum plantations and land covered by fines dams to pasture. Some areas of private land will be rehabilitated to native vegetation. This will include the development of riparian vegetation through farmland, which will provide benefits to surface water quality and provide corridors for the movement of native fauna. All disturbed areas of state forest (M70/900 and M70/901) will be rehabilitated to native vegetation.

Environmental Factors

The EPA guidelines required the assessment of 15 environmental factors for the proposal. The EPA objective, existing environment, potential impact, proposed management and predicted outcomes for these factors are given in the following summary table. The most significant environmental issue associated with the proposal is the clearing of native vegetation. This issue directly relates to seven of the EPA's environmental factors, as discussed below:

BIODIVERSITY - The area is located in an ecotonal position between the Whicher Scarp and the Swan Coastal Plain. Several vegetation communities characteristic of the scarp are present within the project area. The proposal would result in the short to medium term loss of some native flora and fauna species and a long term reduction in the distribution of some native vegetation communities. The primary mechanism for managing these impacts is the development of a Native Vegetation Protection Strategy, which is discussed below.

VEGETATION COMMUNITIES - Whicher Valleys vegetation communities that are poorly represented within conservation reserves occur within the project area. Other vegetation communities affected by the proposal are adequately protected within existing reserves. Clearing of 250.6 ha of native vegetation will be required, however 201.6 ha will be rehabilitated to native vegetation and 92.0 ha of native vegetation on private land will be protected by inclusion in conservation covenants.

DECLARED RARE FLORA AND PRIORITY FLORA - No Declared Rare Flora have been identified within the project area, however six Priority Flora species have been identified that will be affected by the proposal. Less than 40 % of the local populations of these species will be affected. Affected species will be targeted for inclusion in the rehabilitation programme.

FAUNA - Fauna populations within the project area are typical of Jarrah Forest and the Swan Coastal Plain. The impact on these fauna will be negligible as they are adequately represented by suitable areas of habitat elsewhere. Fauna habitat will be re-established as part of the rehabilitation programme.

THREATENED FAUNA - Four Schedule 1 (the Chuditch, the Western Ringtail Possum, the Long-billed Black Cockatoo and the Short-billed Black Cockatoo), two Schedule 4, and six Priority listed fauna species may utilise the area. Due to the mobility of these species, no deaths as a direct result of mining are anticipated, however clearance of native vegetation will result in some individuals having to relocate into nearby areas of native vegetation. Cable Sands' contribution to the "Western Shield" fox control programme has helped increase the local prevalence of species

such as the Chuditch, the Brush-tailed Phascogale and the Southern Brown Bandicoot.

LANDFORM - The project area is located on gentle slopes at the boundary between the Whicher Scarp and the Swan Coastal Plain. The proposal will result in temporary disruption to landforms. Erosion control measures will be implemented during mining and appropriate post-mining landforms will be re-developed during the rehabilitation phase.

REHABILITATION - Disturbed areas will be rehabilitated consistent with long term land uses and conservation values. Rehabilitation procedures will be indicated in a Rehabilitation Plan that will be developed in consultation with the DEP and CALM prior to the development of project infrastructure. This plan will provide a significant level of information, including the provision of pre and post mining contour plans and mining and tailings return schedules.

OTHER ENVIRONMENTAL FACTORS - The company's Environmental Management System (EMS) will routinely facilitate the management of other environmental factors such as pollution control and social factors. At other Cable Sands mine sites, these factors have historically been managed satisfactorily, using the Company's existing practices.

Native Vegetation Protection Strategy

The Native Vegetation Protection Strategy is a key feature of the proposal that addresses the issue of native vegetation conservation and other related factors discussed above. The strategy has included the requirement for mine planning to minimise clearing of native vegetation. Native vegetation occurring within state forest (M70/900 and M70/901) was seen as a priority and consequently, infrastructure and by-products associated with orebodies in state forest were located on private land within M70/899. Native vegetation on private property that was of medium to high conservation value was also targeted for avoidance. The outcome of this strategy was the avoidance of areas now defined as Conservation Areas A and B.

The benefits of the initiatives discussed above are evident, with large areas of native vegetation within the project area being excluded from the impact of mining and left for conservation purposes. This is achieved by locating infrastructure and mining by-products elsewhere within mining lease M70/899. Consequently, it has been necessary to fully utilise the remaining parts of the lease. This has included the necessity to clear some areas of native vegetation on private property.

In summary, the strategy compensates for unavoidable clearing of 59.3 ha of native vegetation in state forest and 191.3 ha of native vegetation on private land by:

- (1) protecting 92.0 ha of native vegetation within conservation covenants. These covenants would result in a 23.4 ha net increase in the protection of Whicher Valleys vegetation, thus increasing the regional representation of this vegetation in protected areas from 10 % to 15 %.
- (2) rehabilitating 59.3 ha of native vegetation in state forest and 142.3 ha of native vegetation on private land. Approximately 62% of this rehabilitation will occur on areas which have only been subject to surface disturbance (eg. topsoil and overburden stockpiles), thus the underlying substrates required for redevelopment of the pre-mining vegetation will remain unchanged.

Approximately 38% of the native vegetation rehabilitation will occur over mined land. In these areas the underlying substrates will be altered, however landform reconstruction will endeavour to create a substrate that is not restrictive to plant growth.

Rehabilitation of native vegetation will restore the environmental values of the land by: providing habitat for Declared Rare and Priority Flora, and native fauna (including Threatened Fauna); stabilising the landform; protecting surface and ground water quality; and restoring biodiversity and visual amenity.

Conclusion

The proposed Gwindinup Mineral Sands Mine will allow Cable Sands to continue to provide benefits to the regional economy, which are currently provided by the Yarloop and Bengier mine sites. As the proposal relies on utilising capital and labour resources from the Yarloop and Bengier mine sites, there will be no net increase in mineral sands mining in the south-west of Western Australia as a result of the proposal.

Conservation of native vegetation has been identified as an important environmental issue that requires careful planning and management. The Native Vegetation Protection Strategy is a key feature of the proposal that addresses this issue. In addition to initially minimising the requirement to clear native vegetation, the strategy compensates for unavoidable clearance of vegetation by protecting 92.0 ha of native vegetation within conservation covenants and rehabilitating 201.6 ha of land to native vegetation.

Other environmental issues such as pollution control and social factors can be managed satisfactorily using practices currently implemented at Cable Sands' other mine sites and enforced via the companies' EMS.

1 Introduction

Cable Sands (WA) Pty Ltd (Cable Sands) proposes to mine mineral sands from mining leases M70/895, M70/899, M70/900 and M70/901 near Gwindinup, approximately 25km SSE of Bunbury in Western Australia (Figure 1). The Gwindinup deposit has been estimated to contain approximately 1.4 million tonnes of Heavy Mineral Concentrate (HMC). The HMC contains heavy minerals, which are composed primarily of ilmenite with minor amounts of leucoxene, zircon and garnet, and a trace of monazite also present. Mining and preliminary concentration will occur on site with the HMC being transported to Bunbury for separation.

The life of the project is currently estimated to be less than 10 years with development commencing in 2001 and production in the second half of 2002.

1.1 PURPOSE OF THIS REPORT

This Consultative Environmental Review (CER) has been prepared as a requirement of Part IV of the *Environmental Protection Act 1986*. The report has been prepared for the consideration of the Environmental Protection Authority (EPA), who will provide advice on the proposal to the Minister for the Environment.

The CER is intended to provide the EPA, the public and government agencies with an understanding of the proposal and the environmental strategies and commitments applied to address environmental factors. The content of the CER addresses specific guidelines developed by the EPA (Appendix A) and includes a description of the proposed mining operation, the existing environment, evaluation of potential environmental impacts associated with the proposal, and mechanisms for managing their impacts.

The CER is subject to a four week public review period. At the end of this period, issues raised in written submissions from the public and Government agencies are collated and transmitted to the proponent by the Department of Environmental Protection. An opportunity is provided for the proponent to respond to the points raised and to provide a response to the EPA for its consideration. This response and points raised in submissions are considered by the EPA in the preparation of the EPA Bulletin, which provides advice to the Minister for the Environment.

1.2 THE PROPONENT

The proponent is Cable Sands (WA) Pty Ltd, the oldest mineral sands mining company in Western Australia. Cable Sands commenced mining in 1956 at Koombana Bay, Bunbury and has continued through a series of mineral deposits at Busselton, Capel, Waroona, Wonnerup and Minninup. Currently operating minesites are located at Benger, Yarloop and Jangardup. The Gwindinup Mineral Sands Mine is intended to provide continuity of operations on the Swan Coastal Plain.

Cable Sands has considerable experience in the mining of mineral sands in south-western WA and has demonstrated a commitment to sound environmental management over a long period. Cable Sands was the first mineral sands company in the world to develop an Environmental Management System (EMS) certified to ISO 14001 (see Section 4.1). Cable Sands has experience managing issues relating to vegetation, dust, noise, radiation, groundwater and transport.

ENVIRONMENTAL FACTORS AND MANAGEMENT

ENVIRONMENTAL FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
INTEGRATING PROCESS					
BIODIVERSITY	Maintain biological diversity where that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity	The area is located in an ecotonal position between the Whicher Scarp and the Swan Coastal Plain Several vegetation communities characteristic of the scarp are present within state forest and on private land	Short to medium term loss of some native flora and fauna species A long term reduction in the distribution of some native vegetation communities	Development of a Native Vegetation Protection Strategy which includes the rehabilitation of disturbed native vegetation and protection of undisturbed areas of high conservation value native vegetation	EPA objective achieved No reduction in the diversity of native flora and fauna species occurring in the area Negligible reduction in the regional representation of native vegetation communities An increase in protection for native vegetation communities of high conservation value
BIOPHYSICAL					
LANDFORM	Establish stable and sustainable landforms consistent with surroundings	The area is located on gentle slopes at the boundary between the Whicher Scarp and the Swan Coastal Plain	Temporary disruption to landforms during mining	Implement erosion control measures during mining Ensure appropriate landforms are re-developed during the rehabilitation phase	EPA objective achieved Reinstatement of landforms which are compatible with the surrounding environment
REHABILITATION	Ensure proposal area and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long-term land use	Not applicable	Not applicable	Application of rehabilitation procedures in disturbed areas consistent with long term land uses and conservation values	EPA objective achieved Development of stable landforms which are consistent with the post-mining land use
WETLANDS	Maintain the integrity, functions and environmental values of wetlands	Natural wetlands in the area have been replaced by agricultural land use such that they currently consist of waterlogged pastures	No impact	Not applicable	EPA objective achieved No change to the status of wetlands in the area
VEGETATION COMMUNITIES	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities	Whicher Valleys vegetation is poorly represented within existing conservation reserves Other vegetation communities occurring within the project area are adequately protected within existing reserves	Clearing of 250.6 ha of native vegetation in state forest and private land required This area will include clearing of 24.2 ha of Whicher Valleys vegetation	Clearing of native vegetation kept to a practical minimum Rehabilitation of 201.6 ha to native vegetation Protect 92.0 ha of native vegetation via conservation covenants or inclusion in state forest The regional representation of Whicher Valleys vegetation within protected areas will increase from 10 % to 15 %	EPA objective achieved Although there will be some loss of native vegetation on private property, a net increase in the protection of Whicher Valleys vegetation will be achieved
DRF AND PRIORITY FLORA	Protect Declared Rare and Priority Flora, consistent with the provisions of the <i>Wildlife Conservation Act 1950</i>	No Declared Rare Flora identified within the project area Seven Priority Flora species identified within the project area	Six of the seven Priority Flora species will be affected. Impact limited to less than 40% of the species current distribution within the project area	Minimise disturbance of Priority Flora Include disturbed species in rehabilitation programme	EPA objective achieved
FAUNA	Maintain the abundance, species diversity and geographical distribution of fauna	Fauna populations occurring are typical of Jarrah forest and the Swan Coastal Plain	Impact on fauna distribution will be negligible as they are adequately represented by suitable areas of habitat elsewhere Return of a significant portion of habitat long-term increase in the protection of native vegetation areas	Minimise clearing of native vegetation Provide fauna habitat during rehabilitation.	EPA objective achieved
SPECIALLY PROTECTED (THREATENED) AND PRIORITY FAUNA	Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the <i>Wildlife Conservation Act 1950</i>	Four Schedule 1 (the Chuditch, the Western Ringtail Possum, the Long-billed Black Cockatoo and the Short-billed Black Cockatoo), two Schedule 4, and six Priority listed fauna species may utilise the area	Due to the mobility of the Threatened and Priority Fauna which are likely to utilise the area, no deaths as a direct result of mining are anticipated Clearance of native vegetation will result in Threatened and Priority Fauna having to relocate into nearby areas of native vegetation	Cable Sands' contribution to the "Western Shield" fox control programme has helped increase the prevalence of species such as the Chuditch, the Brush-tailed Phascogale and the Southern Brown Bandicoot Minimise clearing of native vegetation Provide fauna habitat during rehabilitation	EPA objective achieved

ENVIRONMENTAL FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
POLLUTION MANAGEMENT					
GROUNDWATER QUALITY	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA 1993)	The superficial aquifer (unconfined) overlies the Leederville aquifer (confined), which overlies the Yarragadee aquifer	Maximum abstraction from the Yarragadee aquifer of 2,920 ML/yr Negligible impact to existing or potential groundwater uses	Develop and implement a groundwater and surface water monitoring programme	EPA objective achieved
SURFACE WATER QUALITY	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA 1993)	Seasonal stream flow into agricultural drains, which feed into Gynudup Brook, which is a component of the Capel River catchment	Increased turbidity	Develop and implement a surface water monitoring programme Develop zones of riparian vegetation in the final land use	EPA objective achieved Establishment of riparian vegetation should improve the long term protection of surface waters within the Capel River catchment
PARTICULATES/DUST	Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem Use all practicable measures to minimise the discharge of particulate wastes	Background dust levels typical of agricultural areas on the Swan Coastal Plain	Potential dust generation on unsealed internal roads during summer Potential dust generation during movement of topsoil and overburden material	Use a water cart to control dust on roads and other disturbed areas Vegetate stockpiles and use sealants on disturbed areas where necessary	EPA objective achieved
GREENHOUSE GASES	Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem Use all reasonable and practicable measures to minimise the discharge of greenhouse gases	Currently operating mines at Yarloop and Bengier (which will be closing) produce similar amounts of greenhouse gases to the proposal.	Carbon dioxide emissions of 5.5 kt/a due to electricity consumption and 4.9 kt/a due to diesel fuel consumption	Reduce greenhouse gas emissions by improving energy efficiency Rehabilitate 201.6 ha of native vegetation	EPA objective achieved Greenhouse gas emissions less than 0.02% of state emissions
NOISE	Ensure that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards	The surrounding environment consists of agricultural land and state forest.	Noise emissions have the potential to exceed statutory levels at sensitive premises	Restrict night time operations Fit noise suppression equipment on earthmoving machinery in use after hours Construct noise reducing bunding Educate the workforce in noise awareness	EPA objective achieved Compliance with statutory noise and safety regulations
RADIATION	None specified	Background radiation levels typical of the region (less than 0.15 µG/hr)	No impact	Standard materials handling procedures to be implemented in mining, stockpiling and minerals transport	Maintain surface gamma radiation at their current low levels
SOCIAL SURROUNDINGS					
VISUAL AMENITY	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal	A rural setting including scattered trees on farmland, bluegum plantations, and trees on roadside verges	Negligible impact, though the project will be visible to surrounding areas of farmland to the west and south-west	Planting of shelter belts and vegetation clearance sensitive to landscape amenity Strategic use of earth-wall bunding to provide screening	EPA objective achieved Visual amenity will not be unduly affected
HAULAGE ROUTES	Ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements	The South Western Highway currently receives high levels of heavy haulage in the vicinity of the project area Railway Road is approved by the MRWA for heavy haulage	Negligible impact to traffic on South Western Highway or Railway Road A moderate increase in traffic on Boundary road will affect 5 rural residences	Upgrade Boundary Road to a condition suitable for heavy haulage Provide safety awareness training to truck operators, particularly in relation to any school bus drop off points in the Gwindinup area	EPA objective achieved No significant impact to users of Railway Road or the South Western Highway A significant upgrade to Boundary Road

ENVIRONMENTAL FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	ENVIRONMENTAL MANAGEMENT	PREDICTED OUTCOME
INDIGENOUS AND NON-INDIGENOUS CULTURES	<p>Ensure that the proposal complies with the requirements of the <i>Aboriginal Heritage Act 1972</i></p> <p>Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area</p> <p>Comply with statutory requirements in relation to areas of cultural or historical significance</p>	<p>Aboriginal sites unlikely to be present</p> <p>No sites of significance to non-indigenous cultures are present</p>	<p>Low risk of disturbing a site of significance to Aboriginal people</p>	<p>Qualified professionals will undertake a survey of the project area for sites of ethnographic or archaeological significance</p> <p>Where practical, Aboriginal heritage sites will be avoided</p> <p>If disturbance is unavoidable, an application to disturb the site, under Section 18 of the <i>Aboriginal Heritage Act 1972</i>, will be lodged</p> <p>If a site is discovered, operations in the immediate vicinity will cease while the site is investigated</p>	<p>Compliance with the <i>Aboriginal Heritage Act 1972</i></p>

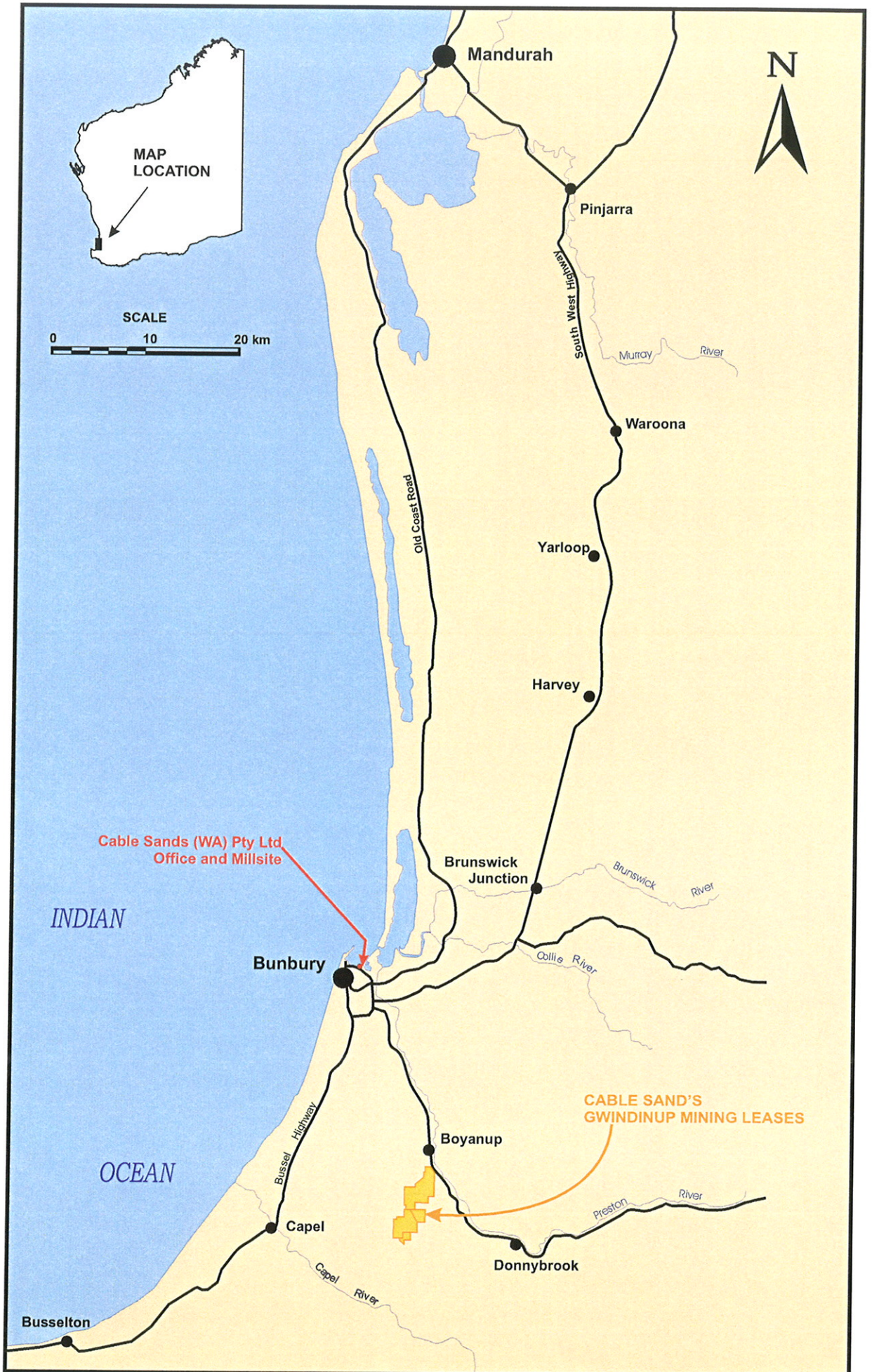


Figure 1: Location of the Gwindinup Mineral Sands Mine

1.3 RELEVANT LEGISLATION

The proposal will be subject to a number of Acts of Parliament and regulations at State and Commonwealth levels. A selection of key legislation is listed below:

- ♦ Aboriginal Heritage Act, 1972.
- ♦ Australian Heritage Commission Act, 1975.
- ♦ Conservation and Land Management Act, 1984.
- ♦ Dangerous Goods Regulations, 1992.
- ♦ Endangered Species Protection Act, 1992.
- ♦ Environmental Protection Act, 1986 as amended.
- ♦ Environmental Protection (Noise) Regulations, 1997
- ♦ Explosive and Dangerous Goods Act, 1961.
- ♦ Dangerous Goods (Storage) Regulations, 1992.
- ♦ Hazardous and Toxic Substances Regulation.
- ♦ Health Act, 1911 - 1979 and Regulations.
- ♦ Heritage of Western Australia Act, 1990.
- ♦ Mining Act, 1978
- ♦ Mines Safety Inspection Act, 1994
- ♦ Mines Safety Inspection Regulations, 1995.
- ♦ Mines Regulation Act 1946 and Regulations.
- ♦ National Trust of Australia (WA) Act 1964.
- ♦ Occupational Health, Safety and Health Act, 1984.
- ♦ Poisons Act, 1964.
- ♦ Poisons Regulations, 1965.
- ♦ Rights in Water and Irrigation Act, 1945 - 1982.
- ♦ Soil and Land Conservation Act, 1945.
- ♦ Transfer of Land Act, 1893.
- ♦ Wildlife Conservation Act, 1950.

International agreements or treaties and national agreements and State policies that may directly or indirectly affect this proposal include:

- ♦ Montreal Protocol on Substances that Deplete Ozone.
- ♦ Convention on Biodiversity.
- ♦ United Nations Framework Convention on Climate Change.
- ♦ National Greenhouse Response Strategy.
- ♦ National Strategy for the Conservation of Australia's Biological Diversity
- ♦ National Strategy for Ecologically Sustainable Development.
- ♦ Revised Greenhouse Strategy for Western Australia.

1.4 DECISION-MAKING AUTHORITIES

The decision-making authorities (DMAs) and other involved authorities that are associated with this proposal include:

1. Environmental Protection Authority (EPA)

The EPA will consider this CER pursuant to Part IV of the *Environmental Protection Act 1986*.

2. Department of Environmental Protection (DEP)

The DEP facilitates the preparation of this CER and any subsequent formal assessment of proposals in accordance with EPA procedures. Under Part V of the *Environmental Protection Act 1986*, the DEP is responsible for ensuring that owner/occupiers take all reasonable and practicable measures to control the discharge of waste to the environment.

3. Department of Conservation and Land Management (CALM)

CALM protects and manages native flora and fauna and their ecosystems through the provisions of the *Conservation and Land Management Act 1984* and the *Wildlife Conservation Act 1950*. CALM may provide advice on the management of flora and fauna and has the responsibility for managing state forests.

4. Department of Minerals and Energy (DME)

The DME controls the activities of extractive industries by the provisions of several Acts, including the *Mining Act 1978*, the *Mines Safety and Inspection Act 1994* (previously the *Mines Regulation Act 1946-1974*), *Petroleum Act 1967* and the *Explosives and Dangerous Goods Act 1961*. Additionally, the DME also administers mining operations disturbance of land through the *Soil and Land Conservation Act 1945* on behalf of the Department of Agriculture. The DME will provide advice to the EPA/DEP on environmental and mining procedures.

5. Water and Rivers Commission (WRC)

The WRC protects and manages natural waterways and their catchments through the provisions of the *Water and Rivers Commission Act, 1995*, *Water Agencies (Powers) Act, 1984* and the *Waterways Conservation Act, 1976*. The WRC has the responsibility for control of groundwater allocations. The WRC will also provide advice to the DEP on surface and groundwater protection.

1.5 LOCATION AND LAND TENURE

The proposed Gwindinup Mineral Sands Mine is located within the Shire of Capel, approximately 25km SSE of Bunbury and 2 to 10 km south of the town of Boyanup (Figure 1).

The mining leases are in an area immediately southwest of the South Western Highway and east of Boundary Road, with areas of orebody north and south of Gavin's Road (Figure 2). The proposed mining area is approximately one kilometre from the northern extent of the Yoganup Extended mine operated by Iluka Resources Pty Ltd (Iluka).

The project area for the proposal consists of four mining leases. Two of these leases (M70/895 and M70/899) occur over freehold land while the other two (M70/900 and M70/901) occur within state forest. Ownership of the land affected by these leases is indicated in Table 1.

Table 1 Mining leases and affected land owners

Mining Lease	Land owner	Land	
M70/895	Bunnings Forest Products	Boyanup AA Lot 63	
		Boyanup AA Lot 101	
		Boyanup AA Lot 105	
		Boyanup AA Lot 107	
		Boyanup AA Lot 109	
		Boyanup AA Lot 110	
		Boyanup AA Lot 287	
		Boyanup AA Lot 393	
		Boyanup AA Lot 395	
		Wellington Loc. Pt 576	
		Wellington Loc. 3287	
		Payne	Boyanup AA Lot 104
		Bryce	Boyanup AA Lot 106
		Capel Excavations	Boyanup AA Lot 214
		Ryan	Boyanup AA Lot 216
Denham	Boyanup AA Lot 217 Lot1		
Richards	Wellington Loc. Pt 576		
Humphries	Wellington Loc. 612 Lot 3		
Van De Wyngaard	Wellington Loc. 612 Lot 4		
Johnson	Wellington Loc. 1957		
M70/899	Cable Sands	Wellington Loc. 3829	
	Cain	Wellington Loc. 4485	
	Baljeu	Wellington Loc. 4965	
M70/900	CALM	State Forest No. 27 (Argyle Forest Block)	
M70/901	CALM	State Forest No. 27 (Argyle Forest Block)	

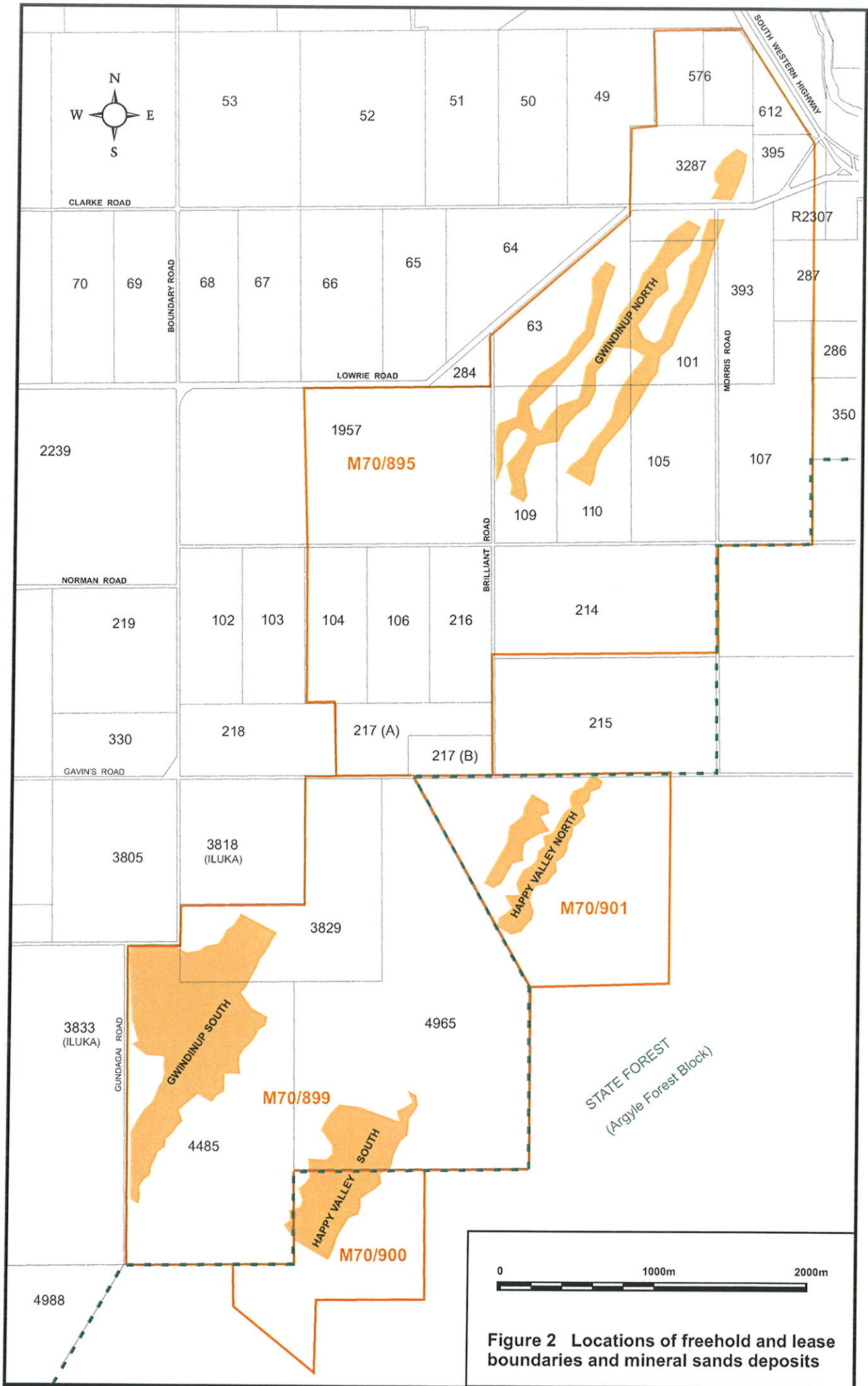


Figure 2 Locations of freehold and lease boundaries and mineral sands deposits

2 Description of the Proposal

Mining and mineral processing in south-western WA is a \$2.8 billion industry based largely around the alumina and titanium mineral industries and is an important contributor to the regional economy. The development of mining operations at Gwindinup allows for continuity of employment for current personnel and helps to ensure the long-term viability of Cable Sands with the intrinsic benefits to the country, state and local community.

2.1 GWINDINUP MINERAL SAND DEPOSITS

The Gwindinup mineral sand deposits are located at the boundary between the Swan Coastal Plain and the north-eastern extent of the Blackwood Plateau. The plain is an area of low relief, which is made up of a sequence of shallow marine, estuarine, lacustrine and fluvial sediments deposited during the Tertiary by a series of sea level fluctuations.

The deposits were formed when heavy minerals were concentrated by current, wave and wind action to form strandlines within shoreline and dunal deposits during periods of relative sea level stability. The deposit is made up of two distinct strandlines, the Yoganup and Happy Valley Strands. Previous fluvial action has interrupted the continuity of these strandlines by erosional incisement at various points, thus the deposit is now represented by a series of isolated 'pods' of varying size. These deposits are indicated in Figure 2 and are: Gwindinup South and Gwindinup North (from the Yoganup Strand); and Happy Valley South and Happy Valley North (from the Happy Valley Stand).

The Gwindinup mineral sands deposits have been estimated to consist of approximately 16.3 million tonnes of ore (Table 2), with the heavy minerals composed primarily of ilmenite with minor amounts of leucoxene, garnet, zircon and monazite.

2.2 MINE SITE LAYOUT

The layout for the proposed Gwindinup Mineral Sands Mine is indicated in Figure 3. This layout has been developed with a primary consideration being to minimise the disturbance of native vegetation.

In addition to recognising areas of environmental value, the mine site layout is influenced by a number of parameters, as indicated in Table 3 below. These parameters are described further in Section 2.3.

Table 2 Key characteristics of the Gwindinup Mineral Sands Mine

Element	Deposit ¹				Total Project
	Gwindinup South	Gwindinup North	Happy Valley South	Happy Valley North	
PROJECT CHARACTERISTICS					
<u>Minesite production</u>					
Mining period (months)	47	30	27	17	10 yrs
Ore body size (tonnes)	6,300,000	4,000,000	3,800,000	2,200,000	16,300,000
Depth of mine pit (m)	28	28	24	20	-
Overburden (bcm)	9,100,000	6,900,000	1,500,000	700,000	18,200,000
HMC produced (tonnes)	565,000	376,000	309,000	183,000	1,433,000
<u>Disturbance areas (ha)</u>					
Mine pits	85	68	41	30	224
Overburden	94	52	16	8	170
Fines dams	27	38	24	16	105
Topsoil/subsoil	18	17	11	12	58
Tailings dams	16	17	0	2	35
Infrastructure	23	11	18	17	69
Mining Lease²					
	M70/899	M70/895	M70/900	M70/901	Total Project
Native vegetation clearance	165.0	26.3	22.3	37.0	250.6
Native vegetation rehabilitation	116.2	26.1	22.3	37.0	201.6
MINESITE OPERATION (per plantsite)³					
Operating hours	24hr 7day/week commencing in late 2002 or early 2003				
Approximate ore extraction rate (tonnes/hour)	220				
Max. HMC production (tonnes/year)	240,000				
Water Supply: source	Yarragadee aquifer				
Max. hourly use (L)	180,000				
Max. annual use (ML)	1,460				
Fuel: Maximum storage (kL)	100				
Maximum use (kL/year)	1,700				

¹ Mining characteristics such as overburden, tailings, fines and HMC production relate to the source orebodies rather than mining lease boundaries

² Areas of native vegetation clearance and rehabilitation were determined by analysis of a Geographical Information System (GIS) developed as part of the baseline vegetation survey performed by ESM (1999).

³ Either one or two plants may be in operation at any time

Table 3 Constraints affecting the Gwindinup mine site layout

Parameter	Constraint
Tailings pumping distance	750m maximum;
Fines pumping distance	1,000m maximum;
Ore pumping distance	850m maximum;
Mining width	70m minimum;
Fines dams wall height	5m maximum;
Initial tailings stockpile height	8m maximum;
Overburden stockpile height	10m maximum
Topsoil stockpile height	4m maximum for farmland 2m maximum for native vegetation

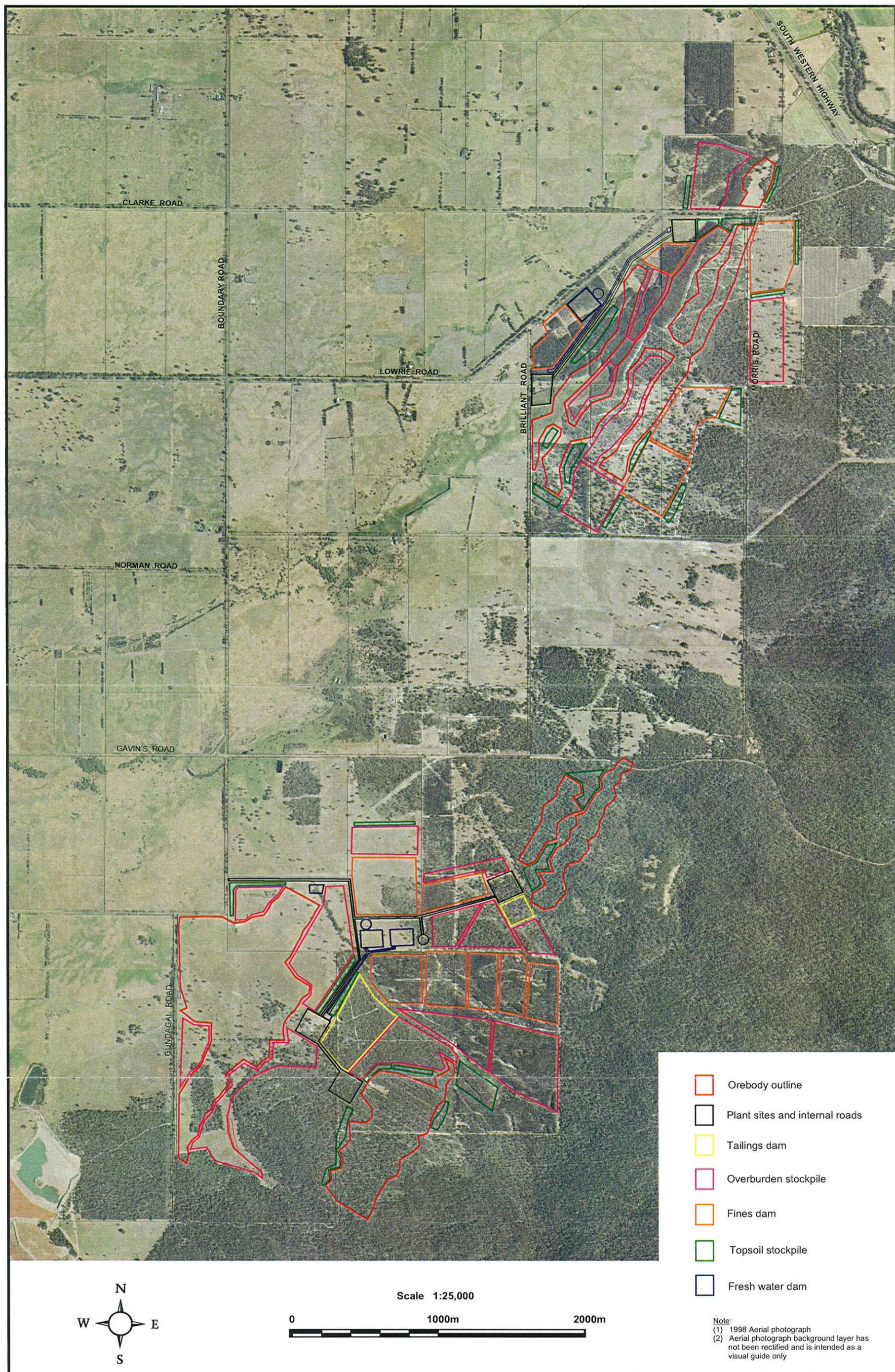


Figure 3 Gwindinup mine site layout

2.3 MINING PROCESS

The deposits will be dry mined using earthmoving equipment (loaders, scrapers and bulldozers) similar to that currently in use at the Yarloop and Bengier mines. The maximum depth of mining is anticipated to be 28m, 28m, 24m and 20m in the Gwindinup South, Gwindinup North, Happy Valley South and Happy Valley North deposits, respectively (Table 2). A process flow chart is indicated in Figure 4, which illustrates the steps in the process of extraction of heavy mineral sands. Other activities associated with mining are described briefly below.

2.3.1 VEGETATION CLEARANCE AND TOPSOIL REMOVAL

Planning

Mining leases M70/899, M70/895, M70/900 and M70/901 define the project area. These are the only areas available for the placement of infrastructure and consequently are the only areas in which vegetation clearing will occur. Locations 3818 and 3833 are owned by Iluka (see Figure 2) and thus are not available for the placement of Cable Sands mining infrastructure or stockpiling of mining by-products (see Section 2.3.4).

Mine planning adopted the policy of minimising clearing of native vegetation within state forest (M70/900 and M70/901). This is reflected in the mine plan (Figure 3), with only the orebody and topsoil stockpiles occurring within state forest. To achieve this outcome, infrastructure and by-products associated with these orebodies were located on private land within M70/899.

In addition to minimising vegetation clearing, some areas of native vegetation of medium to high conservation value on private property will be avoided entirely. Approximately 97 ha of land within M70/899 will be set aside as conservation areas and will not be disturbed. As a consequence of these initiatives, it has been necessary to utilise a greater part of the remaining available areas of lease M70/899.

Implementation

Prior to clearing of native vegetation for mining, collection of suitable native seed resources will be undertaken for later use in rehabilitation. Clearing of native vegetation will be kept to a practical minimum and appropriate use made of any timber harvested. Commercial timber in areas of state forest will be harvested by CALM. On private land, the landowner will retain rights to sell any timber that would otherwise be disturbed by mining. Cable Sands will liaise with the relevant landowners to ensure the harvesting of commercial timber is planned in advance of minesite development.

Non-commercial timber and tall shrubs will be stockpiled for use as mulch and fauna habitat during the rehabilitation phase. Any cleared vegetation debris that cannot be used in rehabilitation areas (eg. for fauna habitat or mulching) or otherwise salvaged will be burnt in accordance with fire restrictions and relevant smoke control guidelines.

In farmland areas, the upper topsoil and pasture, and then the lower topsoil, will be stripped to a depth of up to 30 cm using scrapers. These materials will be stored in separate stockpiles (maximum height of 4 m) stabilised with a grass cover.

In areas of native vegetation, topsoil will be stripped in two stages, where practicable. The top 10 cm will be removed first along with the lower understorey vegetation and stored separately. The next 20 cm of topsoil will also be removed and stored separately.

Further discussion of topsoil management procedures, and other techniques such as block translocation, is given in Section 5.3.4.

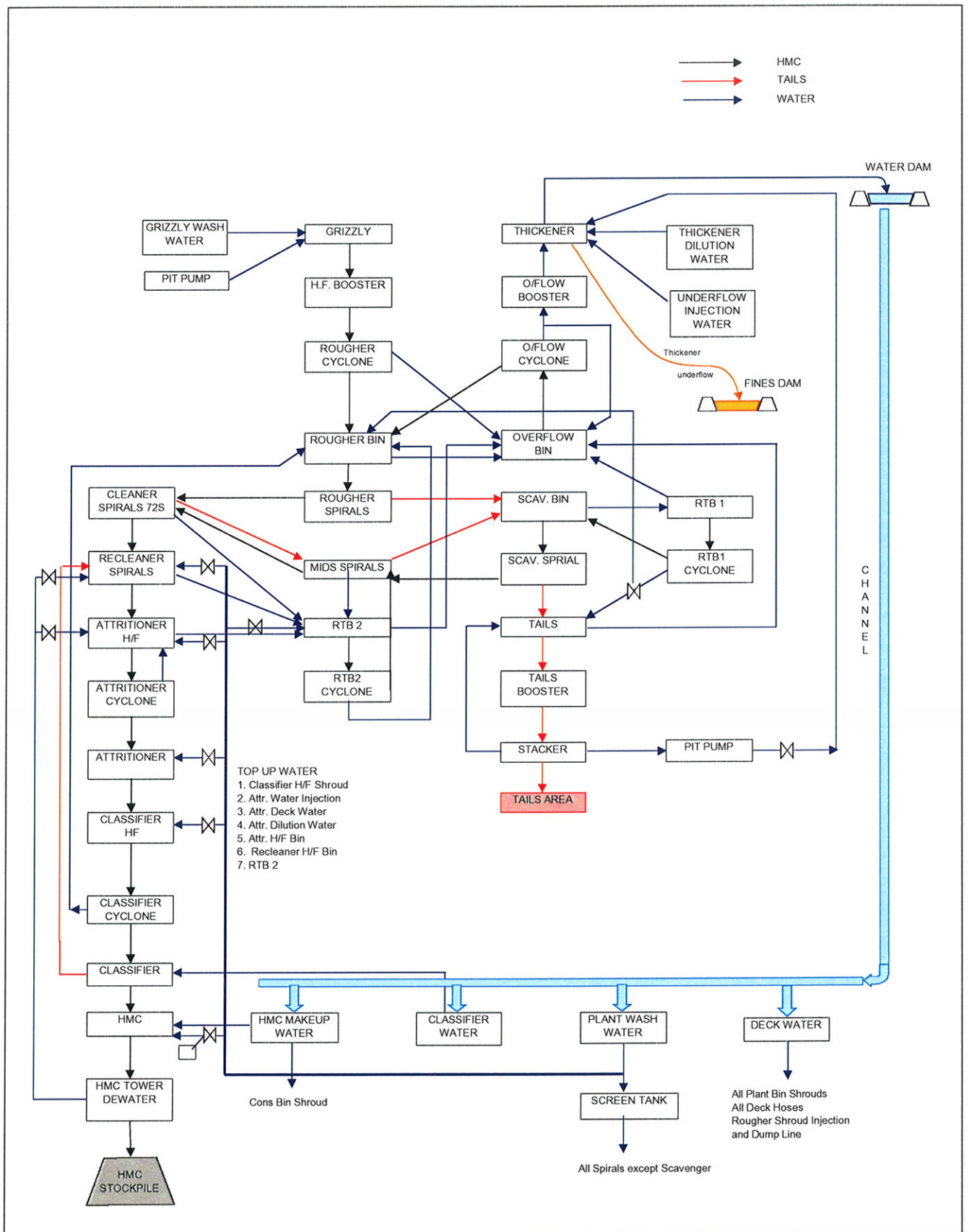


Figure 4 Process flow chart

2.3.2 OVERBURDEN AND ORE REMOVAL

Overburden, which is of sufficient depth to be handled independently of the ore, will be removed by earthmoving equipment (e.g. front-end loaders, bulldozers, scrapers and dump trucks). The overburden will either be used in the construction of fines dams, stockpiled for later replacement, or used to fill areas already mined. In total it is anticipated that a maximum of approximately 18,200,000 bcm ('bank' [*in situ*] cubic metres) of overburden will be removed.

The ore will be mined using similar earthmoving equipment and fed into rotary trommels with 50 mm and 4.5 mm screens to reject large rocks, roots and gravel.

2.3.3 HMC PRODUCTION

Following initial removal of oversize material, the finer fraction is pumped as a slurry to the wet separation plant where HMC will be separated by conventional wet gravity methods. It is currently planned to use two plants for mineral separation. One plant will be used to process ore from the Gwindinup South and Happy Valley South deposits, while the other plant will process ore from the Gwindinup North and Happy Valley North deposits. Depending on Cable Sands progress with other mine sites and mining proposals, it is also possible that only one plant will be used to process ore from all of the deposits.

Plant production of HMC will tend to vary between 130,000 and 170,000 tonnes/year, depending upon the nature of the deposit and market demands. Periodically, in zones of high grade ore, it is possible that plant production could rise to a maximum level of 240,000 tonnes/year of HMC. The HMC produced by these plants will be stockpiled at the mine site prior to being trucked to Cable Sand's dry separation plant at North Shore, Bunbury.

2.3.4 BY PRODUCTS

Tailings

Primary (or mine) tailings are produced in the wet separation plant following removal of HMC. Due to the lack of a suitable mining void, these tailings will initially be pumped to a tailings storage area. After approximately one year of mining, there will be sufficient room in the mine pit that tailings can be returned directly to the mine pit. Stockpiled tailings are returned to the mining void as part of the rehabilitation process.

Approximately 65,000 tonnes per year of secondary (or mill) tailings from the dry separation plant at North Shore (Bunbury) will be returned to the Gwindinup minesite. This material will be trucked back to the Gwindinup minesite and returned to the mine pit. The majority of this material consists of silica sand that was unable to be removed from the HMC stream during initial processing at the wet separation plants. The remainder of the mill tailings will consist of small amounts of HMC that can not be separated into saleable mineral, fly-ash, collected dust, oversize material and fines. The mill tailings will contain less than 200 ppm of radioactive elements and thus do not require special radiation management.

Approximately 29,000 tonnes per year of monazite tailings from the North Shore mill will be disposed of at Gwindinup. This material consists of silica sands with approximately 20% of monazite mineral. The concentration of low-level radioactive elements in these tailings is expected to be approximately 180ppm of Uranium and 2300ppm of Thorium. Special management required for the transport and disposal of this material is described in Section 6.5.4.

Fines

A thickened slurry, consisting of the clay and silt fractions of the process stream, is known as "fines". This material will be removed from the process stream using a thickener tank and allowed to dry in one of a number of fines dams constructed for this purpose. Clean water will be decanted from the thickener and recycled for reuse in the mining process.

Fines dams will be constructed to allow for drying of the fine clay and silt material separated by the thickener. In addition to mine pit areas, these dams will cover approximately 105 ha (Table 2). The fines dams will be up to 5 m deep. No fines will be discharged from the site. Dried clay and silt from the fines dams will be incorporated with tails and overburden during landform re-development.

The fines dams for the Gwindinup North and Gwindinup South deposits will initially be located on agricultural land. After tailings have been returned to the mine pit, fines will then be located over mined areas.

Fines dams associated with the Happy Valley South and Happy Valley North deposits have been excluded from state forest. Consequently, it has been necessary to fully utilise the only available land within M70/899, which is also within a 1 km radius of the orebodies (in accordance with the constraints listed in Table 3). This land consists of farmland, bluegum plantations and native vegetation.

2.3.5 REHABILITATION

Rehabilitation will be undertaken in accordance with a Rehabilitation Plan that will be finalised prior to commencement of mining. This plan will be developed in consultation with the DEP and CALM (see Section 4.3). An overview of the conceptual land use plan and the intended rehabilitation procedures is given in Section 5.3. These concepts will be subject to any changes arising from the Rehabilitation Plan.

2.4 MINING SCHEDULE

Development of the Gwindinup minesite represents a continuation of the company's operations in south-western WA. In order to provide continuity of employment for minesite staff, and to allow returns on capital investments associated with plant and machinery to be continued, it is planned that the Gwindinup mine will replace existing operations on the Swan Coastal Plain.

A description of the current schedule for mining at Gwindinup follows, however market forces and progress at other mine sites may alter this. Consequently, a total mining period for the project of 10 years is stipulated in Table 2, although given favourable conditions mining may be completed in an earlier timeframe.

Two mining sequences will be in operation, with mining and primary separation operations planned to be undertaken on a 24 hours per day and 7 days per week basis. This requirement may vary depending on production scheduling requirements.

Mining of the Gwindinup South deposit is planned to commence in late 2002 or early 2003 and will take nearly four years, completing in 2006. The plant will then be moved to a new location for mining of Happy Valley South, which is expected to take approximately 27 months to complete, finishing in 2009. Variation in production rates and ore throughput may alter this timing.

Mining of the Gwindinup North deposit is planned to commence in mid-2003 and will take less than three years, completing in late 2005. The plant will then be moved to a new location for mining of Happy Valley North. This deposit is expected to take approximately 16 months to mine, finishing in mid-2007. Variation in production rates and ore throughput may also alter this timing.

2.5 INFRASTRUCTURE

2.5.1 WATER

Process water will be pumped into storage dams from bores in the Yarragadee aquifer. Cable Sands has negotiated with the WRC for a licenced groundwater allocation in this aquifer and currently has an exploration drilling licence for two bores into the Yarragadee aquifer. Following exploration drilling, a groundwater well licence will be required from the WRC prior to the implementation of any groundwater abstraction. Subject to test drilling, the bores will be located on farmland within Mining lease M70/899.

Cable Sands' peak projected rate of water abstraction will be 180,000 L/hr when only one wet separation plant is in use. When both wet separation plants are in operation, the maximum abstraction rate may rise to 360,000 L/hr. As the requirement for process water is reduced during the winter period, the maximum projected annual abstraction of groundwater would be 1,460 ML for operation of a single wet separation plant, or 2,920 ML when both plants are operating.

If bore water is unsuitable, requirements for potable water will be serviced either by collection in rainwater tanks or by purchase from a commercial supplier.

Dam construction will predominantly use on-site materials. Three separate water storage dams will be constructed which will service all phases of the operation. Two of these dams will be located centrally within M70/899 and will service mining of the Gwindinup South and Happy Valley deposits. The third dam will be located in M70/895 and will service the Gwindinup North deposit.

2.5.2 THICKENER TANK

Three thickener tanks will be constructed to remove fine clay and silt from the water circuit. These thickeners use a non-toxic commercial flocculant (eg. "Optimer 9965") to encourage settling of the fines. They will be located adjacent to the water storage dams.

2.5.3 INTERNAL ROADS

Internal roads are required to facilitate transportation within the mine site for mining and service operations. The road from the minesite entrance to site offices will be sealed while other internal roads will be constructed from gravel or limestone obtained from local quarries or from oversize material obtained on site. To control dust during the summer months these roads will be wetted down as required. A water cart will be located on site for this purpose.

2.5.4 PLANT SITES

A single plant site will be established prior to mining, for each of the mineral deposits except Gwindinup North, which will utilise two locations for its plant. Facilities will include workshops, store, site office, toilets and a lunchroom. HMC towers and hydrocarbon storage areas will be located adjacent to the plant sites. Plant sites for the Gwindinup deposits will be located on farmland. Plant sites for the Happy Valley deposits will be located in areas of remnant vegetation on private land.

2.5.5 STORAGE OF HYDROCARBONS

Hydrocarbons kept on site for the fuelling of earthmoving equipment will be kept in impermeable bunded areas capable of holding 110% of the largest vessel capacity. All related process

equipment, such as pumps, valves and gauges, will be contained within the bunded area. At any plant site the diesel storage requirement will be 100 kL.

2.5.6 WORKFORCE

The sequential nature of Cable Sands mining operations provides the opportunity for continuity of employment for current personnel. The operating mine sites will usually employ about 30 people and include those people currently employed at the Yarloop and Bengier mine sites. When both wet separation plants are in operation the total labour requirement will increase to approximately 60 people. An additional 60 people employed at Cable Sands' North Shore dry separation plant, rely directly on continued supply of HMC from the mine sites.

2.6 TRANSPORTATION OF HEAVY MINERAL CONCENTRATE

2.6.1 HAULAGE REQUIREMENT

Transportation of the HMC will be by truck and trailer units similar to those currently used to transport HMC from Cable Sand's existing operating mine sites. At estimated production rates and truck payloads between 42 and 59 tonnes, an average of 6-12 truckloads per day would occur over the 10 year life of the mine. At times, trucking may be undertaken as a batch run with actual trucking frequency being determined by the requirements of Cable Sands' North Shore dry separation plant. During these periods trucking may increase to a frequency of approximately 20 truckloads per day.

The transport of monazite tailings will be subject to the *Mine Safety and Inspection Act 1994*, which is administered by the DME. In addition, internal controls for management of radioactive materials will be implemented. These controls are specified in Cable Sands' DME approved Radiation Management Plan (Cable Sands 1999a). This plan specifies that trucking will utilise full all-weather tarps, sealed tailgates and radiation signposting conforming with the *Code of Practice for the Safe Transport of Radioactive Substances* (Commonwealth of Australia 1990).

2.6.2 HAULAGE ROUTE OPTIONS

Four route options for heavy haulage between the Gwindinup mine site and the secondary processing plant in Bunbury were evaluated in terms of environmental and economic considerations. These routes are indicated in Figure 5 and described below based on haulage from the minesite entrance on Gundagai Road, which will service three of the four deposits.

The other minesite entrance is at the intersection of Brilliant Road and Lowrie Road and would be used for the Gwindinup North deposit. This entrance is separated from the southern entrance by a 3.6 km section of Boundary Road and a 2.1 km section of Lowrie Road.

Railway Road and Boundary Road are gazetted as heavy haulage routes by MRWA. Railway Road is managed by MRWA whilst Boundary Road is administered by the Shire of Capel. Heavy haulage permits for both roads are issued by MRWA. In respect to Boundary Road, MRWA would consult with the Shire of Capel before issuing a heavy haulage permit. The South Western Highway is a MRWA approved heavy haulage route and thus is an appropriate road for the haulage of Cable Sands' HMC.

Option 1. Boundary-Boyanup Route (33.4 km):

- ◆ N 7.0 km on Gundagai Road and Boundary Road to Railway Road;
- ◆ ENE 3.4 km on Railway Road to the South Western Highway;

- ◆ N 23.0 km to the North Shore processing plant via Main Roads Western Australia (MRWA) approved heavy haulage routes of the South Western Highway (passing through Boyanup), Robertson Drive and Koombana Drive.

Option 2. Boundary-Stratham Route (39.6 km):

- ◆ N 7.0 km on Gundagai Road and Boundary Road to Railway Road;
- ◆ ENE 1.5 km on Railway Road to Boyanup West Road;
- ◆ W 11.1 km on Boyanup West Road to Bussell Highway;
- ◆ N 20.0 km to the North Shore processing plant via MRWA approved heavy haulage routes of the Bussell Highway, Robertson Drive and Koombana Drive.

Option 3. Lowrie-Boyanup Route (34.6 km):

- ◆ N 3.6 km on Gundagai Road and Boundary Road to Lowrie Road;
- ◆ ENE 4.9 km on Lowrie Road to the South Western Highway;
- ◆ N 26.1 km to the North Shore processing plant via MRWA approved heavy haulage routes of the South Western Highway (passing through Boyanup), Robertson Drive and Koombana Drive.

Option 4. Gavins-Capel Route (42.9 km):

- ◆ N 1.0 km on Gundagai Road to Gavin's Road;
- ◆ W 11.9 km on Gavin's Road to the Bussell Highway (bypassing Capel);
- ◆ N 30.0 km to the North Shore processing plant via MRWA approved heavy haulage routes of the Bussell Highway, Robertson Drive and Koombana Drive.

Selected Haulage Route

The Boundary-Boyanup Route (Option 1) was selected as the preferred haulage route. The Lowrie-Boyanup Route (Option 3) was estimated to be the lowest cost route for heavy haulage, however due to the close proximity of a railway crossing, the Lowrie Road/South West Highway intersection was considered by MRWA to be an unsuitable entry point to the highway.

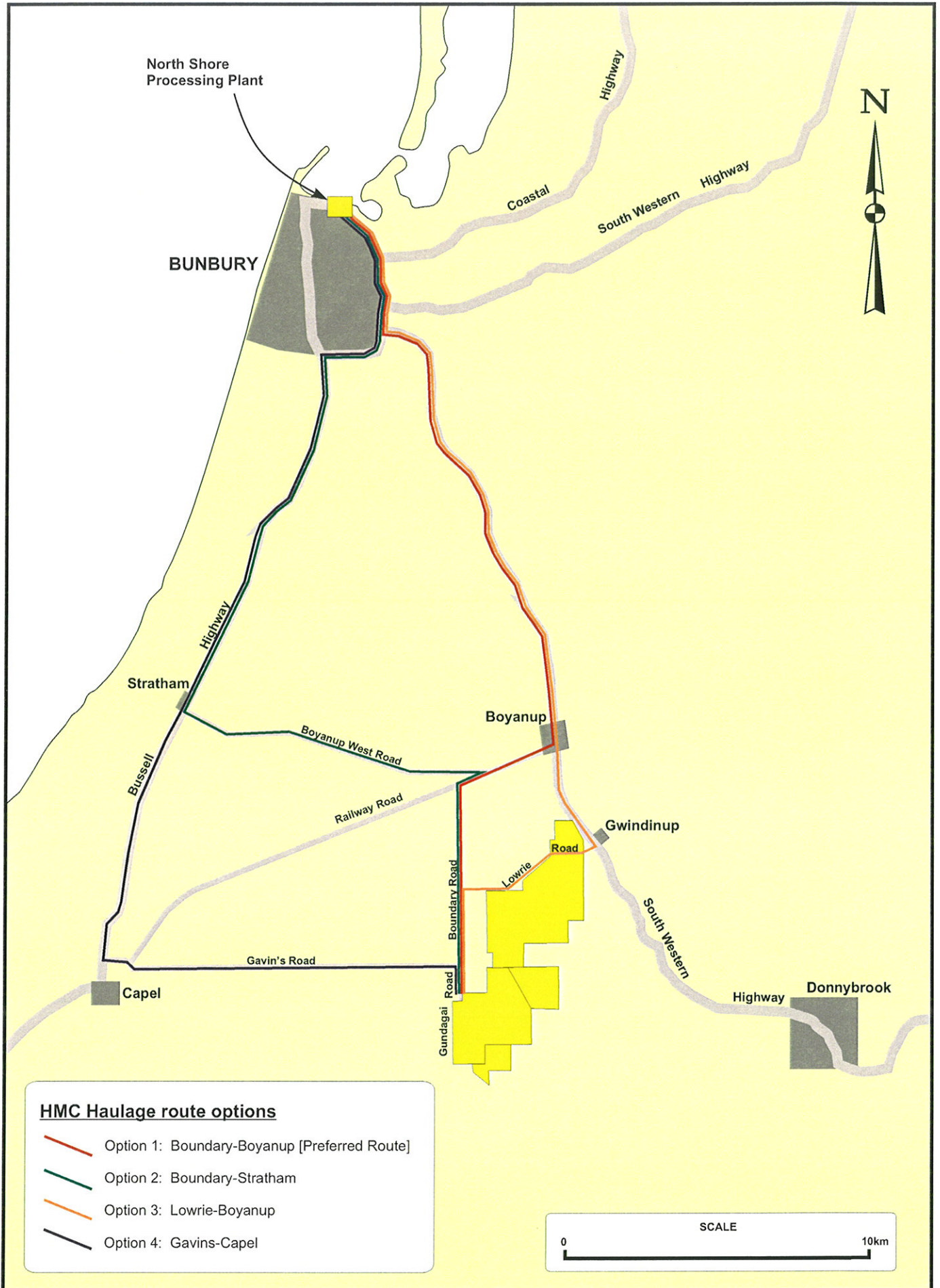


Figure 5 Haulage route options

3 Existing Environment

3.1 REGIONAL SETTING

The south-west region of Western Australia is an important mining, processing, agricultural, manufacturing, timber and tourism area centred around the town of Bunbury. Bunbury has a population of approximately 28,000 and acts as a service city and port for the industries within the area.

Mining and mineral processing is a \$2.8 billion industry, based largely around the alumina and titanium mineral industries. In the Bunbury Region these industries are represented by: Cable Sands' Yarloop and Bengier mineral sands mines; Iluka's Yoganup and Yoganup Extended mineral sands mines; Iluka's synthetic rutile plants at Capel; and Alcoa's Wagerup alumina refinery.

3.2 CLIMATE

The project area experiences a Mediterranean climate with hot, dry summers and cool, wet winters. Winter storms bring squally winds from the north-west to south-west and summer afternoon sea-breezes are from the south-west. Hot dry easterly winds of moderate strength occur at night and early in the day during summer.

The nearest meteorological station to the project area is located at Donnybrook, approximately 10 km to the east. Median annual rainfall at this station is 986 mm, with rainfall peaking in June and July, when median monthly rainfall exceeds 180 mm (Figure 6). Mean daily maximum temperatures range from 30.4 °C in January to 16.4 °C in July. Mean daily minimum temperatures range from 14.1 °C in February to 5.6 °C in July.

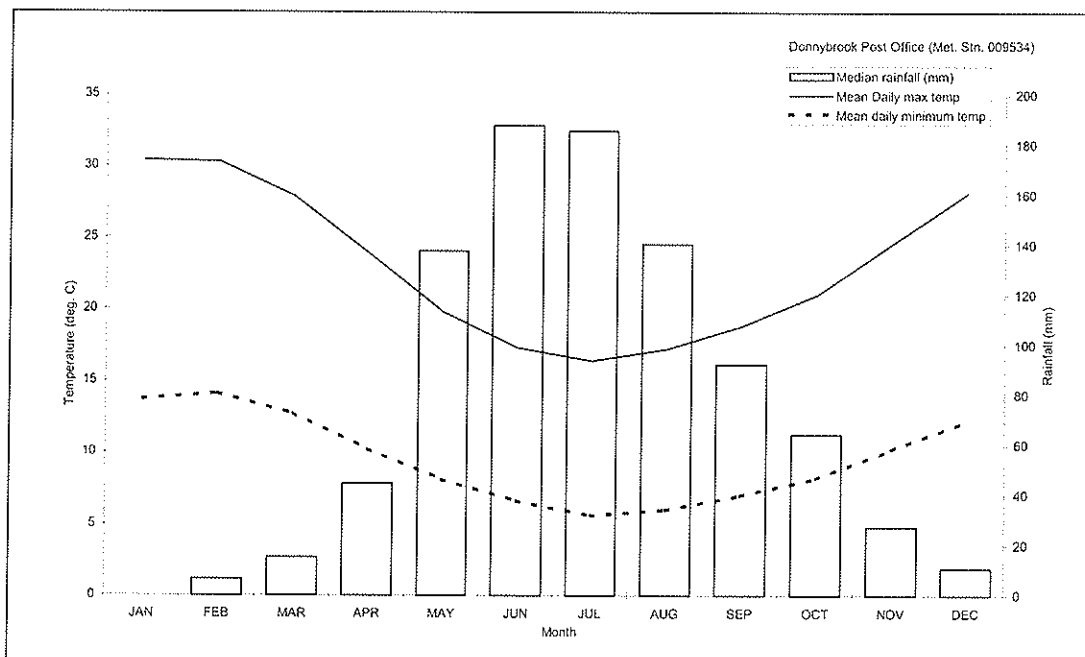


Figure 6 Summary climatic data for the Donnybrook Meteorological Station.

3.3 GEOLOGY

The geology of the Gwindinup area has been described by Welch (1964), Playford *et al.* (1976), Baxter (1977), Smith (1984) and GSWA (1990) and is summarised here.

The area occurs within the Bunbury Trough, a deep graben defined by two north-south striking faults: the Busselton Fault to the west; and the Darling Fault to the east. The Bunbury Trough contains at least 10,000 m of Phanerozoic sediments, though only the uppermost (to 1,100 m depth) formations have been described here. Near the Gwindinup deposits, these formations range in age from Jurassic to Holocene, as indicated below:

- ◆ Cockleshell Gully Formation - deposited in a non-marine environment during the early Jurassic. The unit consists of approximately 2,000 m of interbedded sandstone and shale with minor siltstone and coal that dip to the east.
- ◆ Yarragadee Formation - conformably overlies the Cockleshell Gully Formation and was developed in the middle to late Jurassic in a high energy, fluvial environment. In the Gwindinup area the Yarragadee consists mainly of medium to very coarse grained quartz sand, with abundant fine pebbles, minor thin interbeds of clay and rare, thin coal seams and is at least 700 m thick.
- ◆ Bunbury Basalt - this unit unconformably overlies the Yarragadee and represents an early Cretaceous lava flow that can be up to 85 m thick. In some areas at Gwindinup the Basalt has been weathered from a fresh micro-porphyrific basalt into a green clay.
- ◆ Leederville Formation - deposited during the early Cretaceous in a near shore non-marine environment and unconformably overlies the Bunbury Basalt or Yarragadee Formation. This formation consists mainly of medium to very coarse-grained sand and gravel with thin interbedded clay. The Leederville Formation fills a synform that has resulted from differential subsidence of the underlying formations. As a result the Formation wedges out to the west of the project area while thickening to the east. Near the Gwindinup deposit it is likely to be 50-100 m thick. East of the Whicher Scarp the unit outcrops and has a deep, weathered lateritic profile.
- ◆ Superficial Formations - in the Gwindinup area, five Quaternary units are evident which unconformably overlie the deeper formations. The Ridge Hill Sandstone and the Yoganup Formation host the heavy mineral resource.
 1. The Ridge Hill Sandstone rests on a wave cut platform (Ridge Hill Shelf) incised into the Leederville Formation and overlapping the Whicher Scarp. The unit is a podsolised beach ridge and dune system of early Pleistocene to late Tertiary age up to 20 metres thick and consists of sand, clayish sand and clay with a basal conglomerate. A hard Laterite cap is generally present.
 2. The Yoganup Formation is made up of a number of Pleistocene or Late Tertiary shoreline deposits generally consisting of sand and lenticular clay beds with a basal conglomerate overlying the Leederville Formation or Bunbury Basalt. The shoreline sequences have a complex internal structure, and have been interpreted as superimposed siliclastic barrier sediments (Baxter, 1981) deposited at varying heights above current sea level. The formation is up to 18 m thick.
 3. The Guildford Formation is a layer of lenticular interbeds of sand, silt, clay and conglomerate generally of a fluvial origin but with estuarine and shallow marine incursions. Exposure of this formation corresponds with lower lying, more water logged areas immediately north west of the deposit and are about 10 m thick.
 4. The Bassendean Sands form a thin (~5 m) veneer of fine to medium grained sand of aeolian origin. In the Gwindinup area these sands are very light grey at the surface, grading into yellow at depth with some localised coffee rock development.

5. Colluvial deposits overlay the Yoganup and Guildford formations in some areas. The deposits vary in composition and consist of sandy silt, gravelly/sandy silt or sand.

Acid Sulfate Soil formation

Acid sulfate soils have been noted to develop in association with mineral sands deposits in some parts of the south coast of Western Australia (BHP Titanium Minerals Pty Ltd 1995). Acid sulfate soils form by natural processes under specific environmental conditions. They require the presence of iron rich sediments, sulfate (usually from seawater), removal of reaction products such as bicarbonate, the presence of sulfate reducing bacteria and a plentiful supply of organic matter. These conditions generally limit the occurrence of acid sulfate soils to low lying parts of coastal floodplains, rivers and creeks (Stone *et.al.* 1998).

The Yoganup Deposit is located immediately to the south-west of the proposed Gwindinup Mineral Sands Mine and is currently being mined by Iluka Resources Pty Ltd. The Yoganup, Gwindinup North and Gwindinup South deposits all form part of the same sedimentary sequence, the Yoganup Shoreline. The Happy Valley deposits form part of a more elevated shoreline, located about one kilometre further to the east, however the environmental conditions described below remain relevant.

Studies of the Yoganup Deposit by Baxter and Collins (1982) have shown that sediments of the orebody consist primarily of quartz sand and heavy minerals deposited in thin sequences of wave generated upper shore face, beach and backshore facies. Subsequent to this deposition, colluvial fans of sand silt and gravel had covered large portions of the shoreline. No backswamp or estuarine sediments, needed for the generation of sulfidic sediments, were evident.

The absence of acid sulfate soils in the Gwindinup and Happy Valley deposits (see Section 6.1.3) is thought to be a consequence of the shoreline forming on a piedmont slope. Any significant drop in sea level would have resulted in a marked regression of the sea, resulting in a similar drop in the water table onshore. This, coupled with the high colluvial input, seems to have limited the potential for the formation of any environments suitable for the development and preservation of *in situ* sulfate deposits.

3.4 SOILS AND LANDFORM

3.4.1 OVERVIEW OF EXISTING INFORMATION

The coastal area south of Bunbury is dominated by three main landforms - the Swan Coastal Plain, the Blackwood Plateau and the Darling Plateau. The Swan Coastal Plain extends for approximately 25 km from the plateaux to the ocean. It is composed of a series of sedimentary materials of different ages deposited over millions of years. The boundary between the plain and the Blackwood and Darling plateaux is marked by the Whicher Scarp and the Darling Scarp, respectively. The project area occurs on a gradation of gently sloping land between the Swan Coastal Plain and the Whicher Scarp.

Earlier mapping that encompassed the project area was undertaken by McArthur and Bettenay (1956), while pedology of the same area was discussed by Bettenay and Hingston (1957). The concepts developed by McArthur and Bettenay were developed further by Churchwood and McArthur (1980) in mapping of landforms and soils at a scale of 1:250,000 as part of the production of the *Atlas of natural resources, Darling System, Western Australia*.

This mapping has been further refined in land resources surveys undertaken in recent years by Agriculture WA as part of the National Landcare Programme. Two surveys are relevant to the project area:

- ♦ *Wellington-Blackwood Land Resources Survey* (Tille 1996);
- ♦ *Land resources from Harvey to Capel on the Swan Coastal Plain* (Barnesby *et.al.* In prep.).

These surveys indicate that four land systems are relevant to the project area. These systems are briefly described below.

Blackwood Plateau System

The Blackwood Plateau System occupies the highest terrain within the project area. It is a system dominated by broad lateritic divides of the Kingia subsystem, however only relatively small areas of this subsystem occur within the project area. The Kingia subsystem consists of gently undulating divides with gradients of less than 15%. The soils are typically sandy gravels, though areas of deep pale or yellow sands also occur.

Goodwood Valleys System

In the project area the Goodwood Valleys System developed as a result of the dissection of the Blackwood Plateau by the Preston River and the Capel River. The only subsystem of the Goodwood Valleys which is represented within the project area is the Rosa subsystem. This subsystem is comprised of valley side slopes with gradients between 3% and 25% and are covered with lateritic gravels and sands. Parts of this subsystem were previously mapped as the Cartis land unit by Churchwood and McArthur (1980).

The Preston subsystem occurs along the valley floors of the Capel River and the Preston River, to the south and north of the project area respectively. The subsystem is comprised of river terraces with alluvial brown deep sands and alluvial brown loamy earths.

Whicher Scarp System

This land system consists of the gentle lateritic slopes with gravels, which form a low scarp separating the Blackwood Plateau and the Swan Coastal Plain. In the project area the Whicher subsystem is relevant. This subsystem is similar to parts of the Cartis land unit mapped by Churchwood and McArthur (1980).

Forrestfield System

The Forrestfield System is similar to the Ridge Hill Shelf described by McArthur and Bettenay (1974) and parts of the Cartis land unit mapped by Churchwood and McArthur (1980). It is a narrow strip of land which occurs along the foot of the Darling and Whicher scarps. Though considered an element of the plain, its substrates are generally gravelly and sandy fluvial deposits derived from the scarp.

3.4.2 LANDFORM/SOIL SURVEY OF THE PROJECT AREA

The landform and soils of the study area were assessed in field studies undertaken by Environmental Survey and Management Pty Ltd (ESM 1999). Soils were assessed in terms of structure, colour and texture and related to soil-landscape subsystems of Tille (1996) and Churchward and McArthur (1980). A generalised description of soil profiles occurring within the project area is given in Table 4. The distribution of the different soils series often occurs independently of the mapped soil-landscape subsystems: several different soil series often occur in several different subsystems.

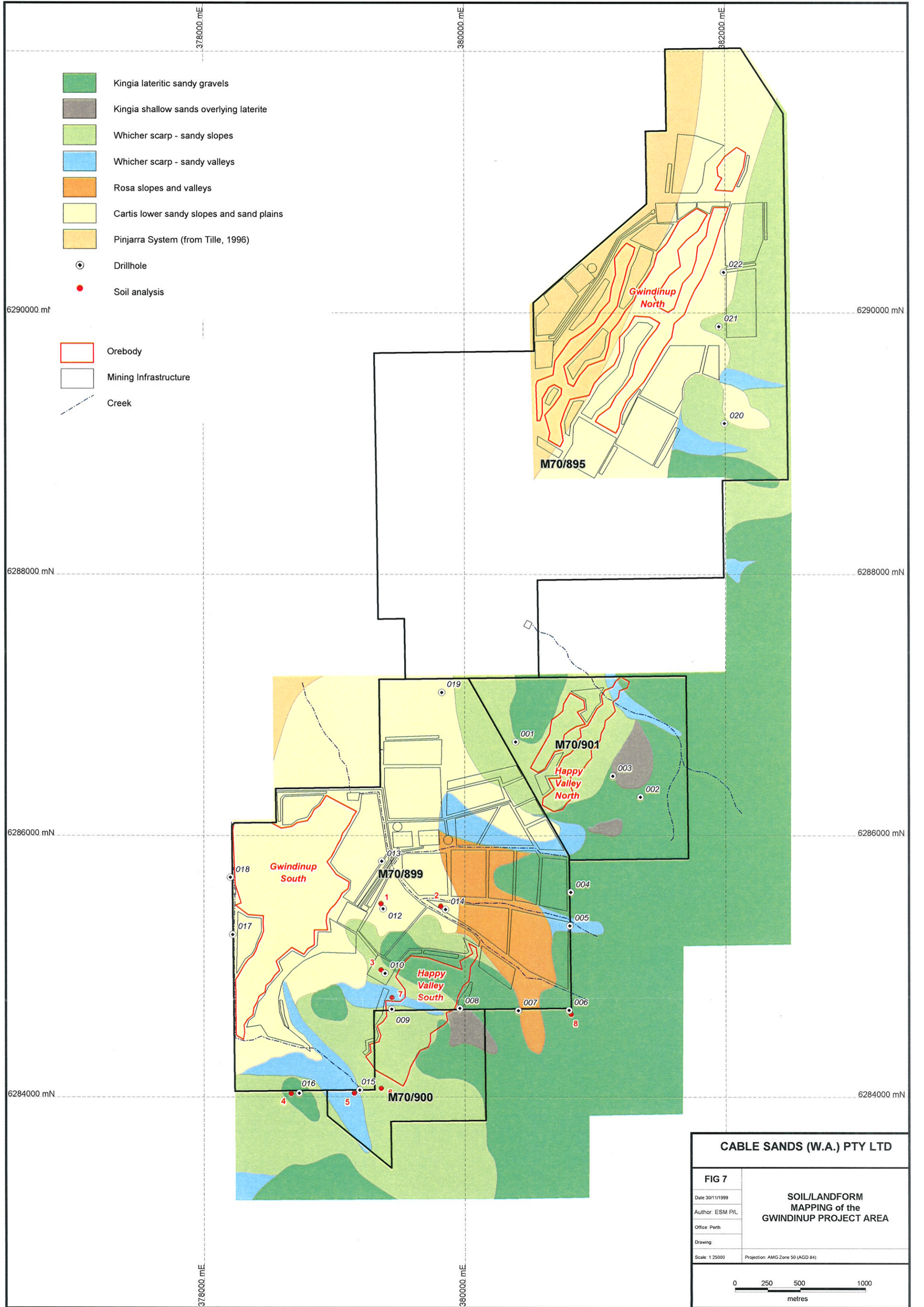
Mapping of landform-soil units within the project area at a scale of 1: 25,000 scale is shown in Figure 7. The principal landform-soil units represented in the study area are Kingia, Rosa, Whicher Scarp and Cartis. The map illustrates the catenary sequence of upland Kingia soils through gentle mid-slope Whicher Scarp or Rosa landform-soil units.

The Kingia landform-soil units are dominated by lateritic sandy gravels, however in some areas a sub-unit of shallow sands over laterite has been differentiated. The Whicher Scarp landform-soil units have also been differentiated into sub-units. These units reflect differences between the lower slopes and the valleys

The Cartis soil-landform unit forms the lowest slopes of the escarpment foothills in the study area, and merges with the Pinjarra soil units (Barnesby *et.al.* in prep.) to the west. The boundary between these soil-landform units has been inferred from Tille (1996) and is shown in Figure 7.

Table 4 Generalised soil profile descriptions of the study area (from ESM 1999).

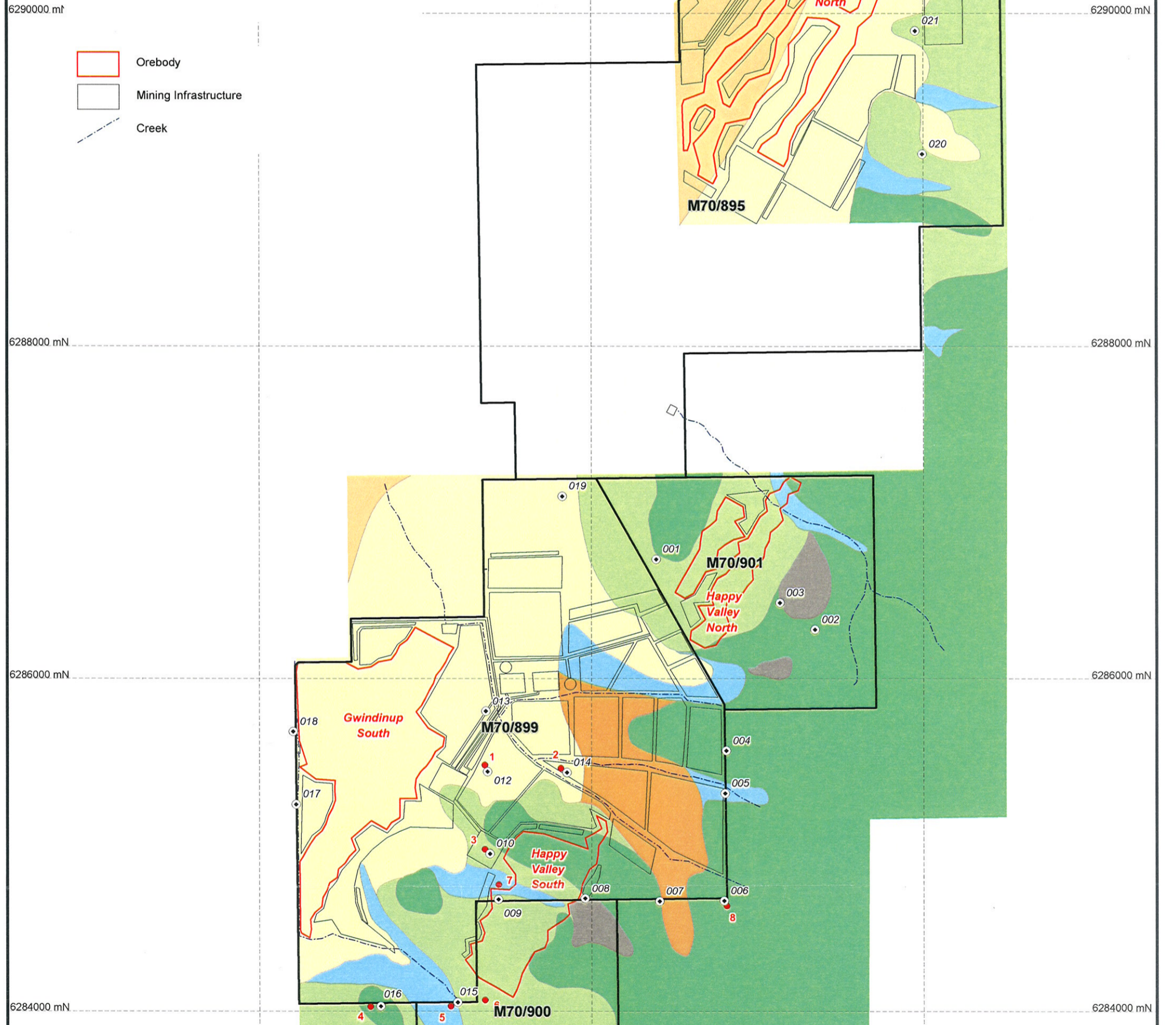
1	<u>Kingia</u>	0.0 - 0.3m	light brown loamy sand, 50% lateritic gravel, some massive laterite
		0.3 - 1.1m	pale yellow gravel sand
		1.1 - 2.1m	brown yellow clay loam sand, weak red mottles or well structured light grey red mottled light clays.
2a	<u>Whicher sandy slopes</u>	0.0 - 0.3m	grey sand, occasional heavy laterite
		0.3 - 1.3m	light grey or white sand
		1.3 - 1.8m	light yellow brown gravel sand
		1.8 - 2.1	light yellow brown clay loam sand, light grey and orange mottles
2b	<u>Whicher valleys</u>	0.0 - 0.3m	grey sand
		0.3 - 1.3m	pale yellow sand
		1.3 - 1.8m	brownish yellow
		1.8 - 2.1+	brownish yellow or pale yellow gravel sand
3	<u>Rosa</u>	0.0 - 0.3m	grey greyish brown sand
		0.3 - 0.8m	light grey sand to clayey sand
		0.8 - 1.2m	light yellow brown gravel sand
		1.2 - 1.7m	pale yellow sandy clay loam, heavy clay or densipan
4	<u>Cartis</u>	0.0 - 0.3m	grey sand
		0.3 - 2.1m	white sand



- Kingia lateritic sandy gravels
- Kingia shallow sands overlying laterite
- Whicher scarp - sandy slopes
- Whicher scarp - sandy valleys
- Rosa slopes and valleys
- Cartis lower sandy slopes and sand plains
- Pinjarra System (from Tille, 1996)

- Drillhole
- Soil analysis

- Orebody
- Mining Infrastructure
- Creek



CABLE SANDS (W.A.) PTY LTD	
FIG 7	SOIL/LANDFORM MAPPING of the GWINDINUP PROJECT AREA
Date: 30/11/1999	Author: ESM P/L
Office: Perth	Drawing:
Scale: 1:25000	Projection: AMG Zone 50 (AGD 84)

3.5 GROUNDWATER

The proposed mine occurs within the Elgin-Capel River Sub-area of the Busselton-Capel Groundwater Area and overlies groundwater resources from superficial formations, the Leederville Formation, the Yarragadee Formation and the Cockleshell Gully Formation.

3.5.1 SUPERFICIAL AQUIFER

Shallow groundwater (0.5-2 m below surface level) is held within an unconfined aquifer that comprises a variable succession of Cainozoic sediments known collectively as the superficial formations. In the vicinity of the Gwindinup deposit these sediments are dominated by the Yoganup Formation.

Recharge of water within the superficial aquifer is dominated by infiltrating rainfall. Groundwater discharge occurs near the coast into existing streams and drains. Elsewhere, groundwater is utilised by transpirative draw of vegetation and also for domestic or farm water supplies, where soaks, wells or bores have been installed.

Groundwater salinity in the superficial aquifer gradually increases as it flows towards the coast. Salinity values range from 500 to 1,000 mg/L TDS (Total Dissolved Solids) near the Whicher Scarp, to over 1,000 mg/L TDS near the coast (WAWA 1995). As the Gwindinup deposit is relatively close to the scarp, it is likely that the shallow groundwater salinity in this area will be relatively low.

Table 5 below reveals that, the majority of groundwater from the superficial aquifer remains unallocated.

Table 5 Groundwater resources within the Elgin-Capel River groundwater sub-area (Data: WRC, Bunbury, pers. comm. 1999)

	Aquifer (kL/year)		
	Superficial	Leederville	Yarragadee
Allocated:	170,180	839 725	12,171,575
Unallocated:	8,129,820	160,275	2,828,425
Total availability:	8,300,000	1,000,000	15,000,000

3.5.2 LEEDERVILLE AQUIFER

Recharge of the Leederville aquifer occurs in the Blackwood Plateau. Near the Whicher Scarp, some recharge also occurs by downward leakage from the superficial aquifer. Groundwater flow is towards the coast, where discharge occurs into the superficial aquifer.

Groundwater salinity in the Leederville aquifer tends to increase in the direction of flow, ranging from less than 500 mg/L TDS near the Whicher Scarp, to over 1000 mg/L TDS near the coast (WAWA 1995). As the Gwindinup deposit is relatively close to the scarp, it is likely that groundwater salinity in this area will be low.

Over 80% of the groundwater in the Leederville aquifer has been allocated.

3.5.3 YARRAGADEE AQUIFER

The Yarragadee Aquifer is a 600-1,200 m deep multi-layered confined aquifer dominated by weakly consolidated sandstone, with siltstone and shale interbeds.

Recharge to the Yarragadee aquifer generally occurs by downwards leakage from the Leederville

aquifer, particularly in the northern half of the Blackwood Plateau. The flow pattern for groundwater within this aquifer is similar to the Leederville aquifer, generally trending towards the coast. The formation has a hydraulic conductivity of 13-18 m/day and flows in a north-westerly direction, from the Blackwood Plateau towards the coast (Dames and Moore 1998). Discharge from the formation is thought to occur offshore and also by upwards leakage into the Leederville aquifer near the coast.

Groundwater quality in the Yarragadec aquifer is closely related to the Leederville aquifer, thus salinity tends to increase towards the coast. In the Gwindinup area, which is near the Whicher Scarp, ground water salinity is likely to be less than 300 mg/L TDS.

The majority of the Yarragadec resource is allocated to mine processing activities. The remaining allocation in this aquifer is mostly to dairy and pasture irrigation.

A discussion paper prepared by Dames and Moore (1998) evaluated groundwater resources in the region and provided an alternative groundwater resource allocation strategy to meet the mineral sands industries' demands for the short to medium term. The report showed that the hydraulic boundary between the Elgin-Capel River Sub-area and the Ludlow-Capel Sub-area, as defined by the Darradup Fault, is not justified with no significant barrier to groundwater flow between these areas actually existing. Considering the projected low future demand for Yarragadec Formation groundwater within the Capel-Ludlow Sub-area, diversion of these allocations to the Elgin-Capel River Sub-area was possible. This resulted in an increase in the Yarragadec availability from 5,500,000 kL/year (WAWA 1995) to 15,000,000kL/year in the Elgin-Capel River Sub-area, and a corresponding decrease in the Capel-Ludlow Sub-area.

3.6 SURFACE WATER

The project area is located within the Capel River catchment area, close to its boundary with the Preston River catchment. Both of these catchment areas are dominated by agricultural and horticultural land uses. Significant areas of state forest, managed by CALM, also occur in parts of the Whicher Scarp and Darling Range.

Surface water flow within the project area is seasonal, flowing along natural drainage lines in a north-westerly direction down the lower slopes of the Whicher Scarp. As these flows reach the plain, drainage patterns often become indistinct as a result of winter flooding. Drainage in these areas has been assisted in places by the construction of agricultural drains, which lead into Gynudup Brook. The Gynudup Brook merges with the Capel River downstream of Capel (Figure 8). Water and Rivers Commission water quality data indicates that stream flows typically have a salinity of less than 500 mg/L TDS, though on occasion, salinities of up to 1,800 mg/L TDS have been experienced (WRC, Bunbury, pers. comm. 1999). The Capel River discharges into the Indian Ocean approximately 23 km south of Bunbury.

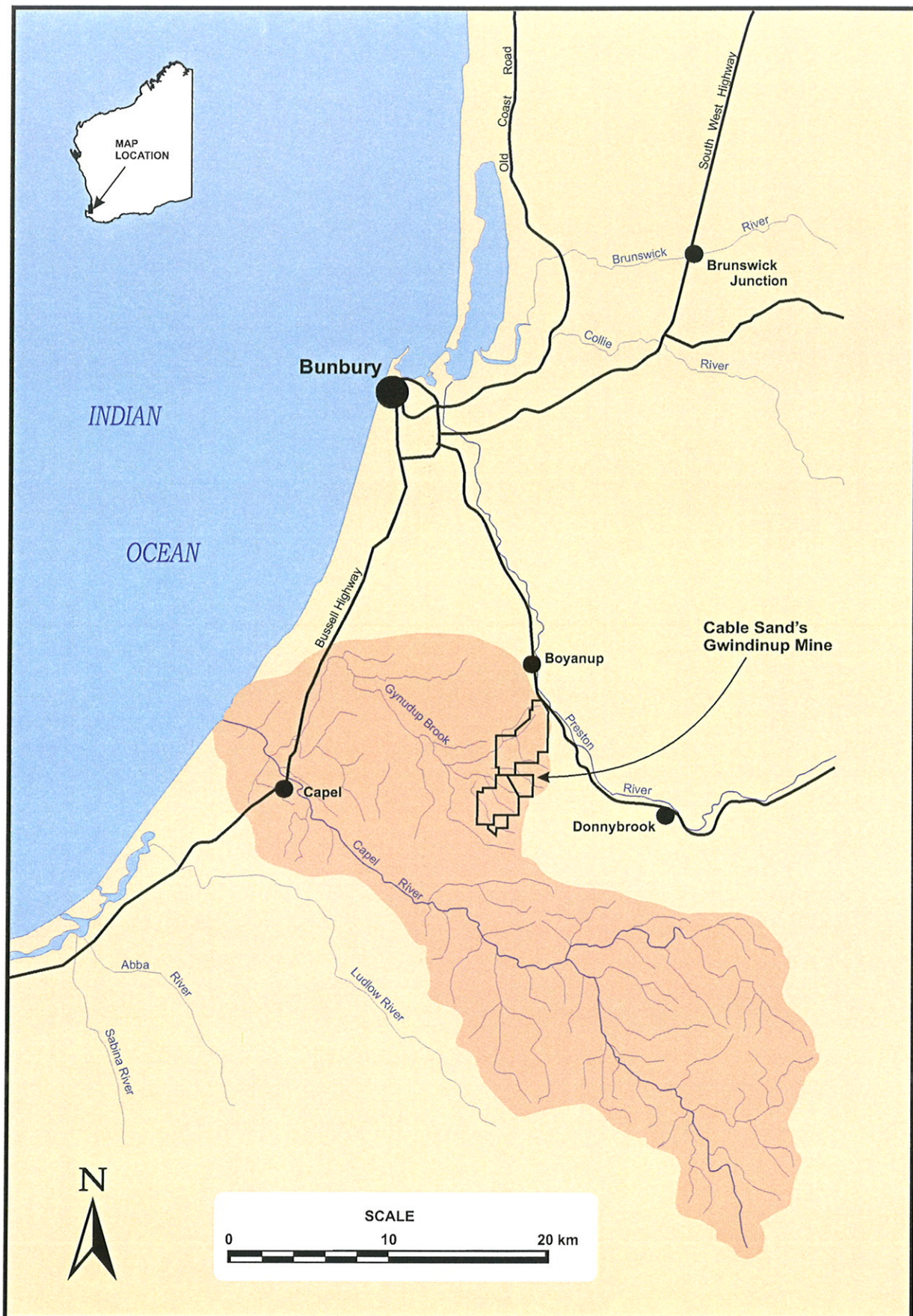


Figure 8 Capel River catchment

3.7 NATIVE VEGETATION AND FLORA

3.7.1 REGIONAL VEGETATION DISTRIBUTION

Forest Ecosystems

A *Comprehensive Regional Assessment* (CRA, Commonwealth of Australia and WA Government 1998) was prepared as the basis for negotiating a Regional Forest Agreement (RFA) for Western Australia's south-west forest region. Consistent with nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia (JANIS 1997), forest ecosystems were used in the CRA as an appropriate unit for analysis of regional representation of forests in the south-west.

The distribution of different forest ecosystems within crown land in south western WA is indicated within the CRA. The Jarrah Blackwood forest ecosystem is the only forest ecosystem affected by the proposal and a simplified representation of this ecosystem is illustrated in Figure 9 below. This ecosystem currently covers 281,805 ha on crown land, or eighty-one percent of the pre-1750 distribution (347,200 ha). Sixteen percent of the pre-1750 distribution is retained within formal or informal reserves.

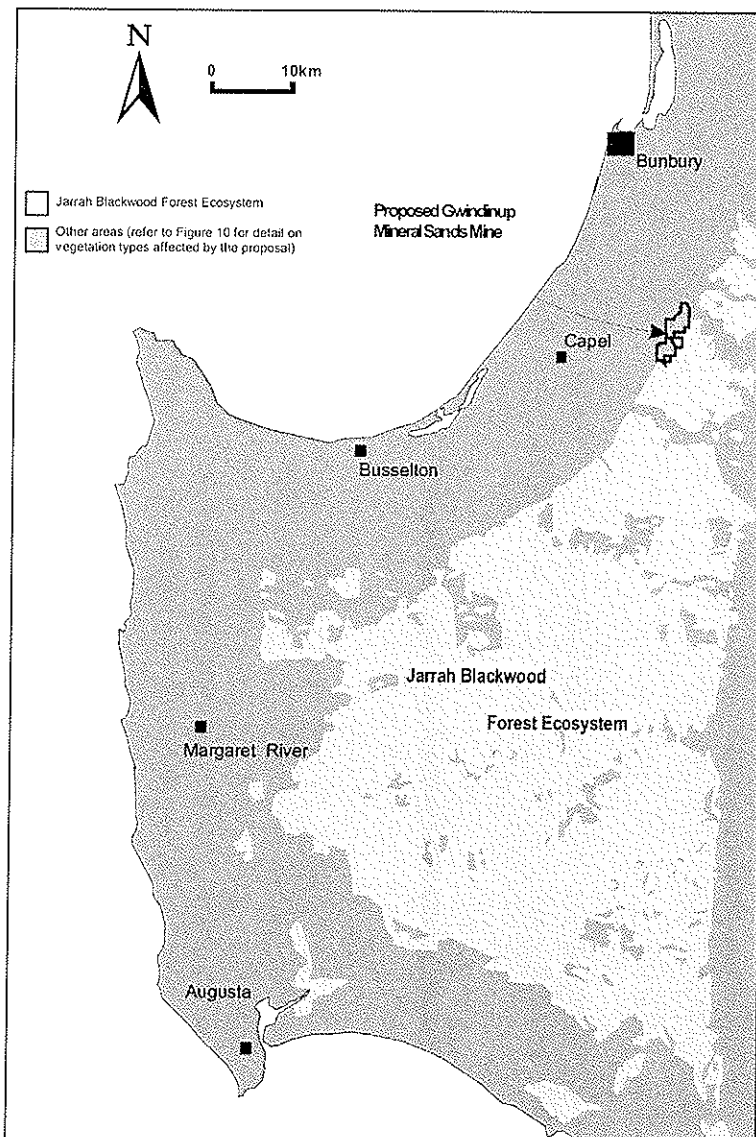


Figure 9 Distribution of the Jarrah Blackwood forest ecosystem on Crown Land
 (Map adapted from the *Comprehensive Regional Assessment*, Commonwealth of Australia & WA Government 1998)

Vegetation Complexes

The landforms and vegetation of the project area were described and mapped by Heddle, *et al.* (1980) at a scale of 1: 250,000, as Kingia Complex on upland lateritic sands and gravels, and Cartis Complex vegetation on escarpment slopes. More recently, Mattiske and Havel (1998) defined these vegetation complexes further into Kingia, Whicher Scarp, Whicher Scarp Valley, Rosa and Cartis Complexes. These vegetation complexes are described below, while their regional representation is summarised in Table 6. Over 70% of the pre-European distribution of these vegetation complexes is still represented in reserves, crown land and private land.

1. **Whicher Scarp (WC)** open forest of *Eucalyptus marginata* and *Corymbia calophylla* on escarpment with some *Corymbia haemotoxylon*, *Banksia attenuata* and *Xylomelum occidentale*. This vegetation is relatively restricted within existing reserves with 14% (526 ha) of the pre-European distribution represented. However, 47% of the pre-European distribution (1,831 ha) still occurs on crown land.
2. **Whicher Valleys (WCv)** open forest of *Eucalyptus marginata* and *Corymbia calophylla* on valleys dissecting escarpment, with some *Xylomelum occidentale* on escarpment slopes. This vegetation is inadequately represented within existing reserves, with only 10% (40 ha) of pre-European distribution protected. An additional 43% (175 ha) of the pre-European distribution is still represented on Crown land.
3. **Cartis (CSs)** low open forest of *Eucalyptus marginata*, *Corymbia calophylla* and *Corymbia haemotoxylon* with some *Banksia attenuata* and *Xylomelum occidentale* on escarpment slopes. This vegetation is adequately represented, with 56% of the pre-European distribution still represented within existing reserves.
4. **Kingia (KI)** open forest of *Eucalyptus marginata*, *Corymbia calophylla*, *Allocasuarina fraseriana*, *Banksia grandis* and *Xylomelum occidentale* on lateritic uplands. The conservation value of the vegetation generally relates to its regional extent, representation within reserves and the uniqueness of its component flora. The Kingia vegetation complex occurs extensively on the uplands of the Blackwood Plateau between Bunbury and the Scott Coastal Plain. Approximately 14,300 ha is known to occur in reserves and a further 82,456 ha occurs in Crown land outside of reserves.
5. **Rosa (RO)** woodland to open forest of *Corymbia calophylla*, *Eucalyptus marginata* and *Xylomelum occidentale* on slopes with a tall shrubland of *Agonis linearifolia* in valley floors. This vegetation is relatively extensively represented within the landscape and is adequately represented within existing reserves, with approximately 3,300 ha within reserves and a further 8,300 ha on Crown land.

Table 6 Regional representation of selected vegetation complexes
(Data: A. Walker, R. Wilson, CALM, pers. comm.)

Vegetation complex	Pre-European Distribution ha (100%)	Current Distribution			
		Reserves ha (%)	Crown land ha (%)	Private land ha (%)	Total ha (%)
Whicher Scarp (WC)	3,861	526 (14)	1,831 (47)	373 (10)	2,730 (71)
Whicher Valleys (WCv)	409	40 (10)	175 (43)	75 (18)	290 (71)
Rosa (RO)	16,514	3,295 (20)	8,368 (51)	469 (3)	12,132 (73)
Kingia (KI)	102,240	14,317 (14)	82,456 (81)	639 (<1)	97,412 (95)
Cartis (CSs)	7,541	4,218 (56)	385 (5)	931 (12)	5,534 (73)

A floristic survey of the southern Swan Coastal Plain (Gibson, *et.al.* 1994) identified thirty principal community types associated with landform types described by Churchward and McArthur (1980). These vegetation communities were not mapped in their study however floristic communities were identified which were associated with the escarpment slopes and coastal sandplain interface in the vicinity of the project study area. These floristic communities were not restricted to vegetation-landform complexes mapped by Heddle *et.al.* (1980), however they were commonly associated with Ridge Hill Shelf and Ridge Hill/Pinjarra Landforms.

3.7.2 VEGETATION WITHIN THE PROJECT AREA

A preliminary vegetation assessment for the mining lease M70/899 was undertaken by Environmental Survey and Management Pty Ltd (ESM 1998). This survey revealed a Jarrah (*Eucalyptus marginata*) woodland on the upper slopes, grading to a mixed woodland of Jarrah, Marri (*Corymbia calophylla*), *Corymbia haemotoxylon*, *Allocasuarina fraseriana*, *Banksia attenuata*, *B. grandis*, *Persoonia elliptica*, *P. longifolia* and *Xylomelum occidentale* on the lower slopes. The vegetation reflects its ecotonal position in the landscape between the Swan Coastal Plain and the Blackwood Plateau.

Generally, the native vegetation was in good condition, containing a diverse understorey, however in some areas degradation was evident. Areas of remnant vegetation occurring within farmland have suffered from degradation at their interface with pasture or bluegum woodlots. Reduction in vegetation cover and species richness, as well as encroachment of exotic weeds, has occurred. This effect generally only persists for a distance of approximately 10 m, thus it is not differentiated in the mapping in Figure 14 (D. Backshall, ESM, pers. comm. 2000). In addition, some areas of vegetation within the state forest have been affected by dieback as a result of logging, firewood gathering and quarrying (see Figure 13).

A more extensive survey of the project area was undertaken by ESM in 1999. Vegetation was mapped via aerial photographic interpretation and confirmed by the establishment of 45 separate vegetation and flora sampling plots. Floristic data from these sites was analysed using a statistical pattern analysis package (PATN) developed by CSIRO (Belbin 1983) and used to examine relationships between the sites. Mapped vegetation units are indicated in Figure 10 with their interaction with the proposed mine plan indicated.

The areas of vegetation occurring within the project area are summarised in Table 7. Sixty percent of the project area has been cleared of native vegetation. Whicher Scarp vegetation is the most common native vegetation type remaining within the project area, with 146.9 ha occurring on private land and 121.2 ha in state forest. Whicher Valleys vegetation is less widely distributed with only 68.2 ha occurring in the project area, the majority on private land. Virtually all of the 138.4 ha of Cartis vegetation occurs on private property.

At the 1:25,000 scale of vegetation mapping used by ESM (1999), Kingia vegetation was further differentiated into two separate units by the PATN analysis. The KI (2) vegetation is a variant of the typical Kingia (KI (1)) vegetation and occurs on shallow grey sands over laterite or clay where drainage is impeded and results in a wetter winter-spring period. About 20 ha of KI (2) vegetation occurs within the project area, mostly within state forest.

A small (<1ha) example of Rosa vegetation was mapped within the project area. This vegetation is more typical of Jarrah forest further east of the project area.

Table 7 Vegetation types occurring within the project area

Mining Lease:	Private Property (ha)		State Forest (ha)		Total (ha)
	M70/899	M70/895	M70/900	M70/901	
Vegetation:					
Whicher Scarp (WC)	82.0	64.9	56.8	64.4	268.1
Whicher Valleys (WCv)	46.2	5.3	8.5	8.2	68.2
Cartis (CSs)	87.3	50.9	0	0.2	138.4
Rosa (RO)	0.5	0	0	0	0.5
Kingia (KI1)	41.4	12.6	16.6	85.7	156.3
Kingia (KI2)	0.2	0	6.8	13.3	20.3
Pasture	204.4	654.8	0	0	859.2
Bluegums	103.1	48.5	0	0	151.6
Quarry	0.3	0	0	7.5	7.8
Remnant vegetation*	-	50.3	-	-	50.3
Total	565.4	887.3	88.7	179.3	1,720.7

* Remnant vegetation in the southern portion of M70/895 was not included in the vegetation survey as it will not be affected by the proposal

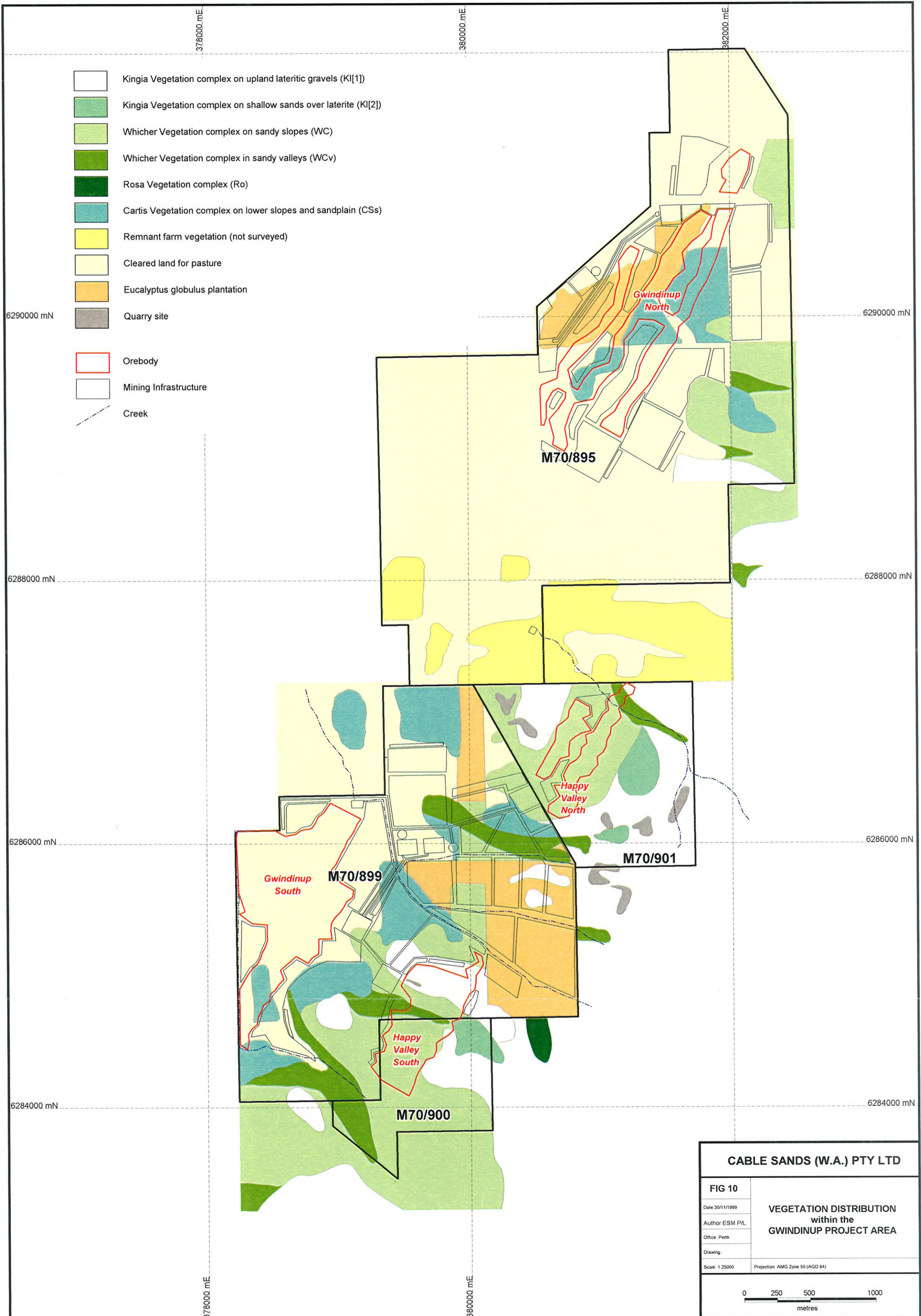
3.7.3 WETLAND VEGETATION

Wetlands of the Swan Coastal Plain have been mapped by Hill *et.al.* (1996). This mapping shows that no wetlands protected by the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* are designated within the project area. The western fringe of the project area includes areas of seasonally inundated sumpland, floodplain and palusplain (Figure 11). The distribution of seasonal waterlogging was confirmed in field surveys by ESM (1999). East of the area that was mapped by Hill *et.al.* (1996), seasonal drainage flows were identified originating from the escarpment slopes.

The wetlands identified by Hill *et.al.* (1996) have few remaining natural attributes. They are dominated by pastures, which are used for livestock production. Figure 11 shows that, due to the lack of any remnant vegetation, these areas have no conservation status. Similarly, no conservation status is attributed to these wetlands by Hill *et.al.* (1996).

The wetlands are used by waterbirds during winter and spring (Bamford 1999), but as these areas tend to dry out over the summer months, they are not suitable as drought refuge. The habitat value of this area for water birds is further limited by the presence of an extensive network of agricultural drains in the area, which would encourage drainage of these areas.

Human-use attributes associated with these wetlands are limited. The land is generally used for agricultural production, however in the areas subject to winter waterlogging, these values are diminished.



CABLE SANDS (W.A.) PTY LTD

FIG 10

Date: 30/11/1999

Author: ESM P/L

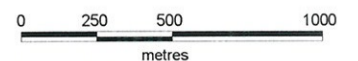
Office: Perth

Drawing:

Scale: 1:25000

Projection: AMG Zone 50 (AGD 84)

**VEGETATION DISTRIBUTION
within the
GWINDINUP PROJECT AREA**



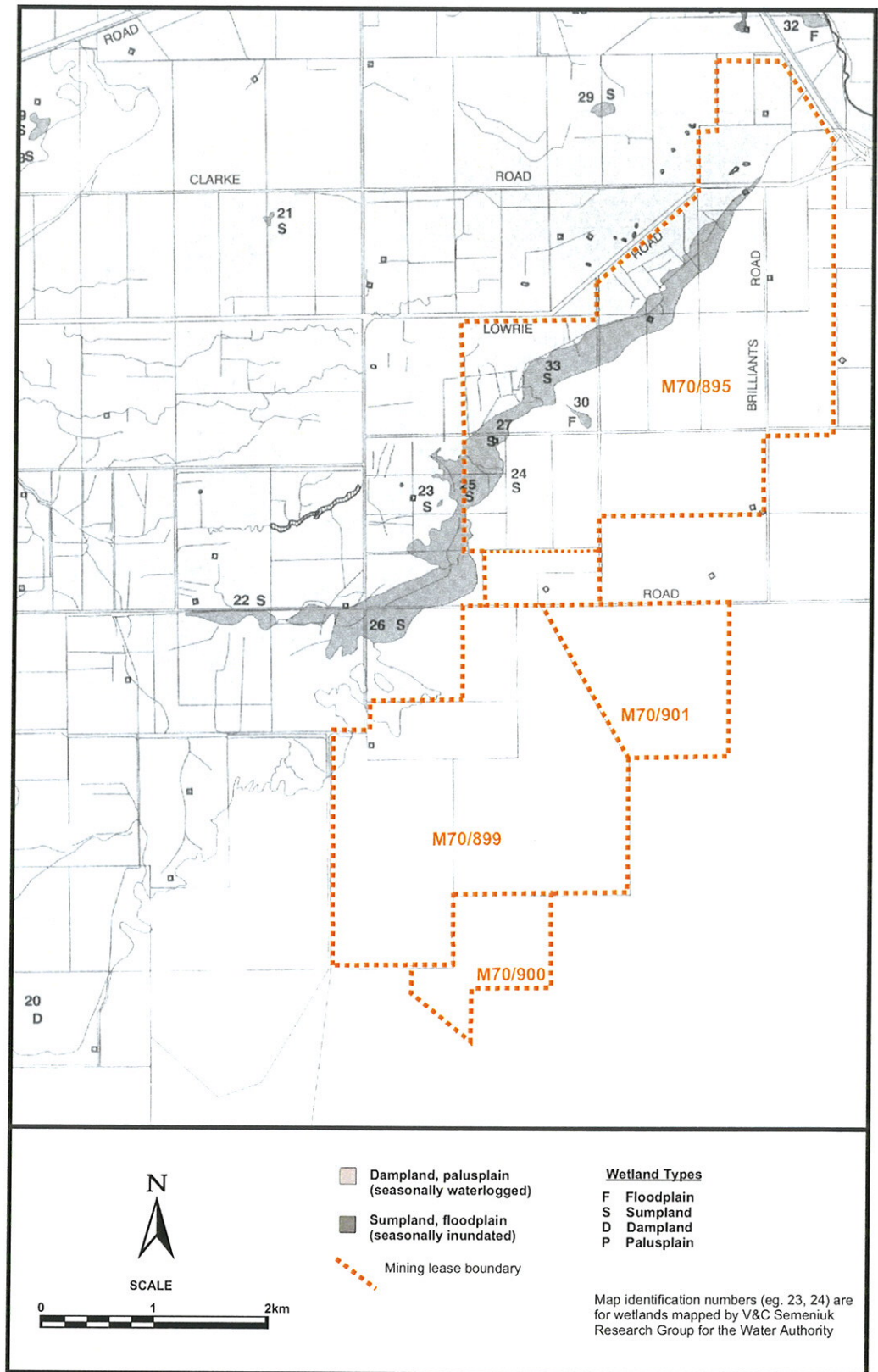


Figure 11 Basin and flat wetlands occurring in the Gwindinup area
(Mapping from Hill et. al. 1996)

3.7.4 FLORA

Flora occurring within the study area has been recorded in sample plots and opportunistically by ESM from July 1998 to November 1999 (ESM 1999). The methodology for quantitative plot sampling was comparable with that of Gibson *et.al.* (1994), thus allowing comparison of the results with those contained within the floristic survey of the southern Swan Coastal Plain.

Approximately one hundred and ninety taxa from thirty three families were identified within the study area, with *Proteaceae*, *Mimocaceae*, *Papilionaceae*, *Myrtaceae* and *Epacridaceae* being important. A complete list of the flora species sampled to date is given in Appendix B. The majority of the species were perennial shrubs or subshrubs, with only 15% annually regenerating from seed or subterranean (perennate) organs. *Hibbertia* ssp., particularly *Hibbertia hypericoides*, *Hibbertia huegelii* and *Hibbertia amplexicaulis* are common throughout the vegetation of the study area, as is *Hypocalymma robusta* and *Boronia spathulata*. Also common in forest areas were *Adenanthos barbigerous*, *Isopogon sphaerocephalus* and *Phlebocarya ciliata*. Common tree species included *Eucalyptus marginata*, *Corymbia haematoxylon*, *Corymbia calophylla*, *Xylomelum occidentale*, *Allocasuarina humilis* and *Banksia grandis*.

Declared Rare Flora (DRF) and Priority Flora

Targeted searches of the project area for Declared Rare and Priority Flora were undertaken by ESM in winter and spring of 1998 and 1999 (ESM 1999). No Declared Rare Flora were revealed by these searches, however, seven species listed by CALM (1998) as Priority Flora were observed. These species are described below.

PRIORITY 1: POORLY KNOWN TAXA, WHICH ARE KNOWN FROM ONE OR A FEW POPULATIONS WHICH ARE UNDER THREAT

- ◆ *Boronia humifusa* - a low shrub observed in lateritic outcrops in Kingia vegetation at the southern end of the project area and in numerous locations within the Argyle Forest Block (state forest, see Figure 2).

PRIORITY 2: POORLY KNOWN TAXA, TAXA WHICH ARE KNOWN FROM ONE OR A FEW POPULATIONS, AT LEAST SOME OF WHICH ARE NOT BELIEVED TO BE UNDER THREAT

- ◆ *Acacia mooreana* - an erect shrub (0.5 m) occurring infrequently within Kingia and Whicher Valley vegetation in the project area and in numerous locations within the Argyle Forest Block.

PRIORITY 3: POORLY KNOWN TAXA, TAXA WHICH ARE KNOWN FROM SEVERAL POPULATIONS, AT LEAST SOME OF WHICH ARE NOT BELIEVED TO BE UNDER THREAT

- ◆ *Acacia semitrullata* - an erect shrub (0.5 m) occurring infrequently within Cartis vegetation. This species was uncommon in the project area, occurring in two small populations on private land immediately south of Gavin's Road and approximately 1.6 km south of Gavin's Road.
- ◆ *Jacksonia sparsa* - an erect shrub (1.5-2.0 m) occurring infrequently within Cartis and Whicher Valley vegetation types in southern parts of the project area and in adjacent parts of the Argyle Forest Block.
- ◆ *Synaphea whicherensis* - a low shrub with a patchy distribution within Whicher vegetation types in the southern parts of the project area and adjacent parts of the Argyle Forest Block
- ◆ *Lambertia multiflora* ssp. aff. *Darlingensis* - a rounded shrub to 1.5 metres occurring on lateritic sandy and loamy sands. Observed in one location in the project area in Whicher Valley vegetation near a seasonal creek. Another larger population, also in Whicher Valley vegetation, was observed south of the project area.

PRIORITY 4: RARE TAXA, TAXA WHICH ARE CONSIDERED TO HAVE BEEN ADEQUATELY SURVEYED AND WHILST BEING RARE, ARE NOT CURRENTLY THREATENED BY ANY IDENTIFIABLE FACTORS

- ◆ *Acacia flagelliformis* - an open spreading shrub (1.5-2.0 m) occurring infrequently within Whicher Valley vegetation and on the road verge on the western side of the project area.

To develop a better understanding of the importance of Priority Flora that occur within the project area, an additional search in adjacent areas of the Argyle Forest Block was undertaken in November 1999. This search was requested by CALM's Principal Botanist (K. Atkins, pers. comm. 1999), to improve the knowledge of the distribution of local genotypes of these species. The distribution of observed Priority Flora populations is mapped in Figure 12.

The search through Argyle Forest Block was undertaken on an opportunistic basis along forestry tracks south of the project area. The search represents a sample only; actual distribution of these species may be more widespread than indicated. By contrast, searches for DRF and Priority Flora in the proposed mining areas were more intensive, involving traverses of such areas on foot.

Other flora of botanical interest

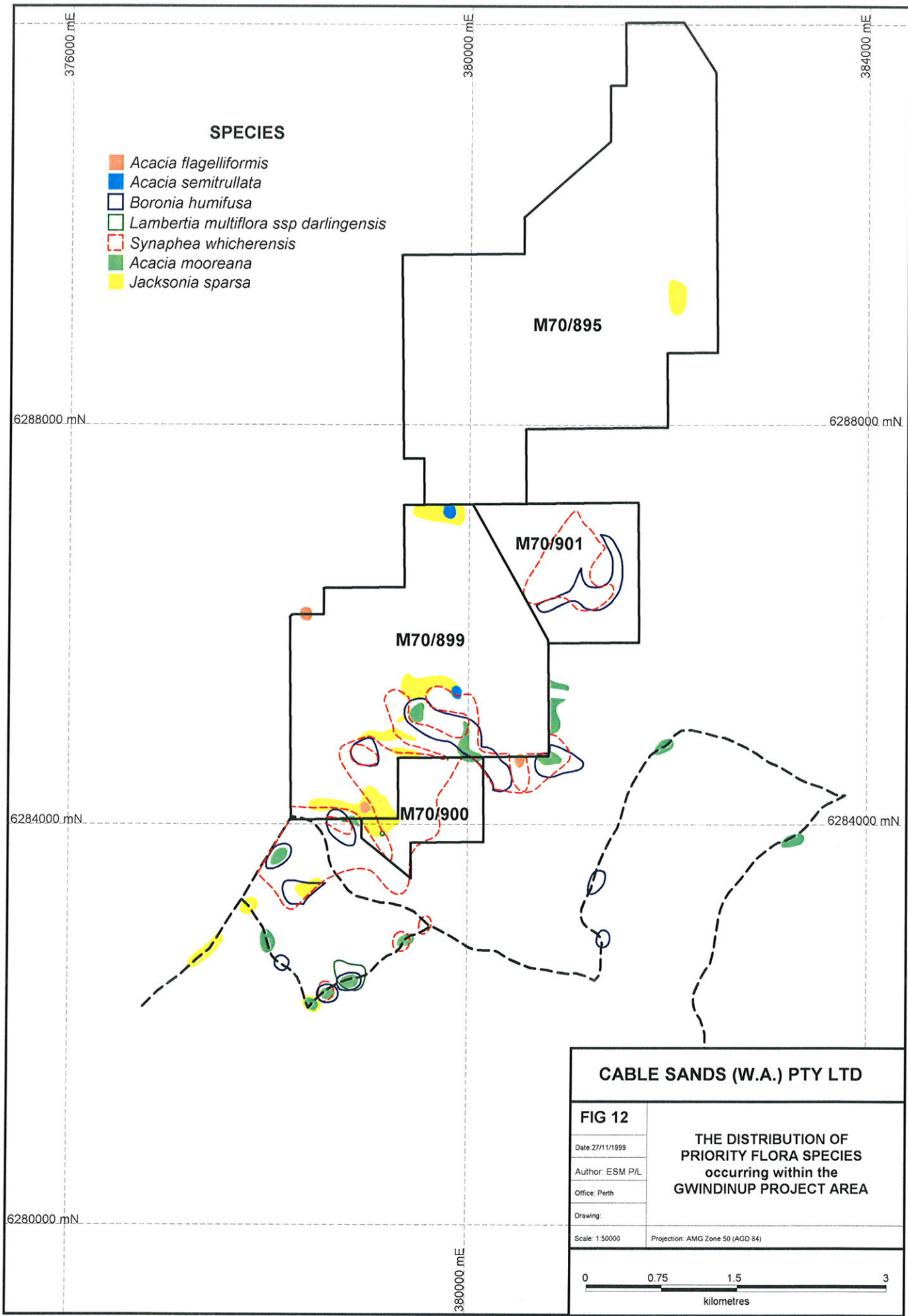
A small creeping shrub, *Actinostrobus acuminatus*, was observed in Cartis vegetation within the project area. This species is widespread between Three Springs and Perth, however it has not previously been recorded south of Pinjarra.

Two species in the flora list (Appendix B), *Haemodorum ? spicata* and *Acacia ? amputa*, were indeterminate at the time of collection. Ongoing collections and observations will clarify their taxonomy prior to any ground disturbing activities taking place.

Introduced flora

The presence of introduced flora was essentially restricted to farmland areas affected by livestock grazing. Introduced species observed were those commonly associated with poor agricultural soils (eg. *Vulpia*, *Bromus*, *Lolium*, *Actotheca*, and *Hypochaeris* spp.), being non-aggressive herbaceous annuals which generally require some degree of degradation and/or eutrophication of natural vegetation before they can successfully establish. No aggressive exotic colonizers such as *Ehrharta* (perennial veldt grass) or *Watsonia* spp. were observed.

Introduced flora has not become established to any extent in the areas of state forest near private property. The forest tracks and firebreaks, which normally serve as dispersal routes for exotic species, are virtually free of weeds.



CABLE SANDS (W.A.) PTY LTD	
FIG 12	THE DISTRIBUTION OF PRIORITY FLORA SPECIES occurring within the GWINDINUP PROJECT AREA
Date: 27/11/1999	
Author: ESM P/L	
Office: Perth	
Drawing:	
Scale: 1:50000	Projection: AMG Zone 50 (AGD 84)

3.7.5 DIEBACK

A survey for the presence of the dieback pathogen, *Phytophthora cinnamomi*, was undertaken in the project area by Casuarina Forest Services in 1993. Areas infected by dieback are indicated in Figure 13 and showed large numbers of deaths of indicator species such as *Banksia attenuata*, *Banksia grandis*, *Persoonia longifolia*, *Xanthorrhoea gracilis*, *Xanthorrhoea pressii*, *Xylomelum occidentale* and *Isopogon sphaerocephalus*. Several areas of high impact were observed with large numbers of jarrah (*Eucalyptus marginata*) trees affected.

The CALM forest area was burned during spring 1997 as part of a fuel reduction programme. This burn made much of the area uninterpretable for dieback, however further investigations by Casuarina Forest Services and ESM (ESM 1999) revealed that no new large or active dieback infections were occurring in the area.

Much of the dieback infection occurs in elevated slopes. As the *Phytophthora cinnamomi* fungi will be dispersed within soil water, downslope locations will be prone to subsequent infection. The rate of infection is likely to be reduced in well drained sandy soils such as the Whicher and Cartis subsystems.

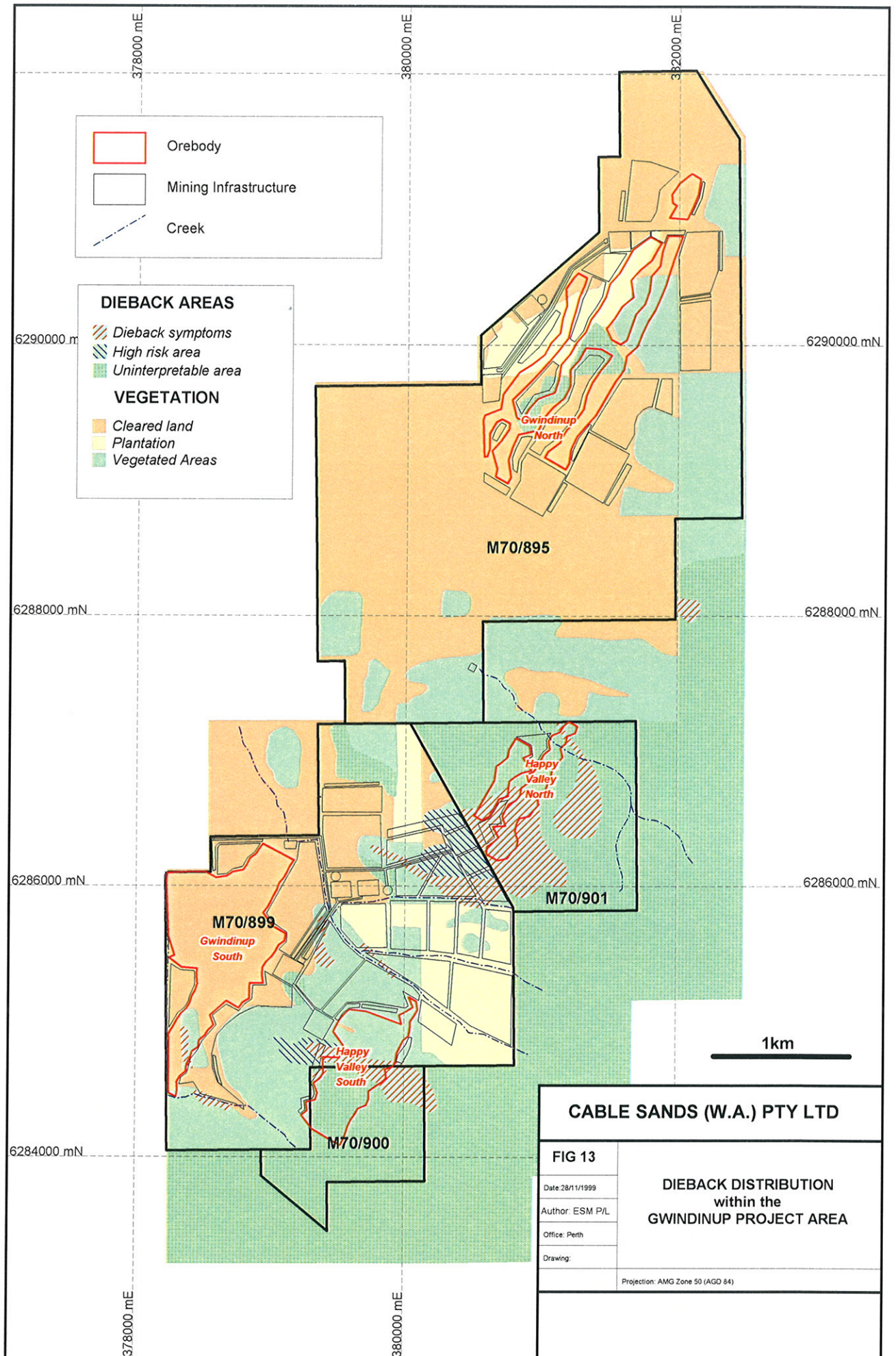
3.7.6 CONSERVATION SIGNIFICANCE OF THE VEGETATION

A range of human activities has affected the condition of the vegetation of the study area, however the impacts are generally localised. The most visual of the impacts are numerous small quarries and associated access tracks in state forest. The overstorey structure of the state forest has also been modified in the past by timber extraction. Other impacts observed are the result of clearing for farming and forestry, intrusion into vegetated areas by livestock, exploration track clearing and scattered areas of dieback infection.

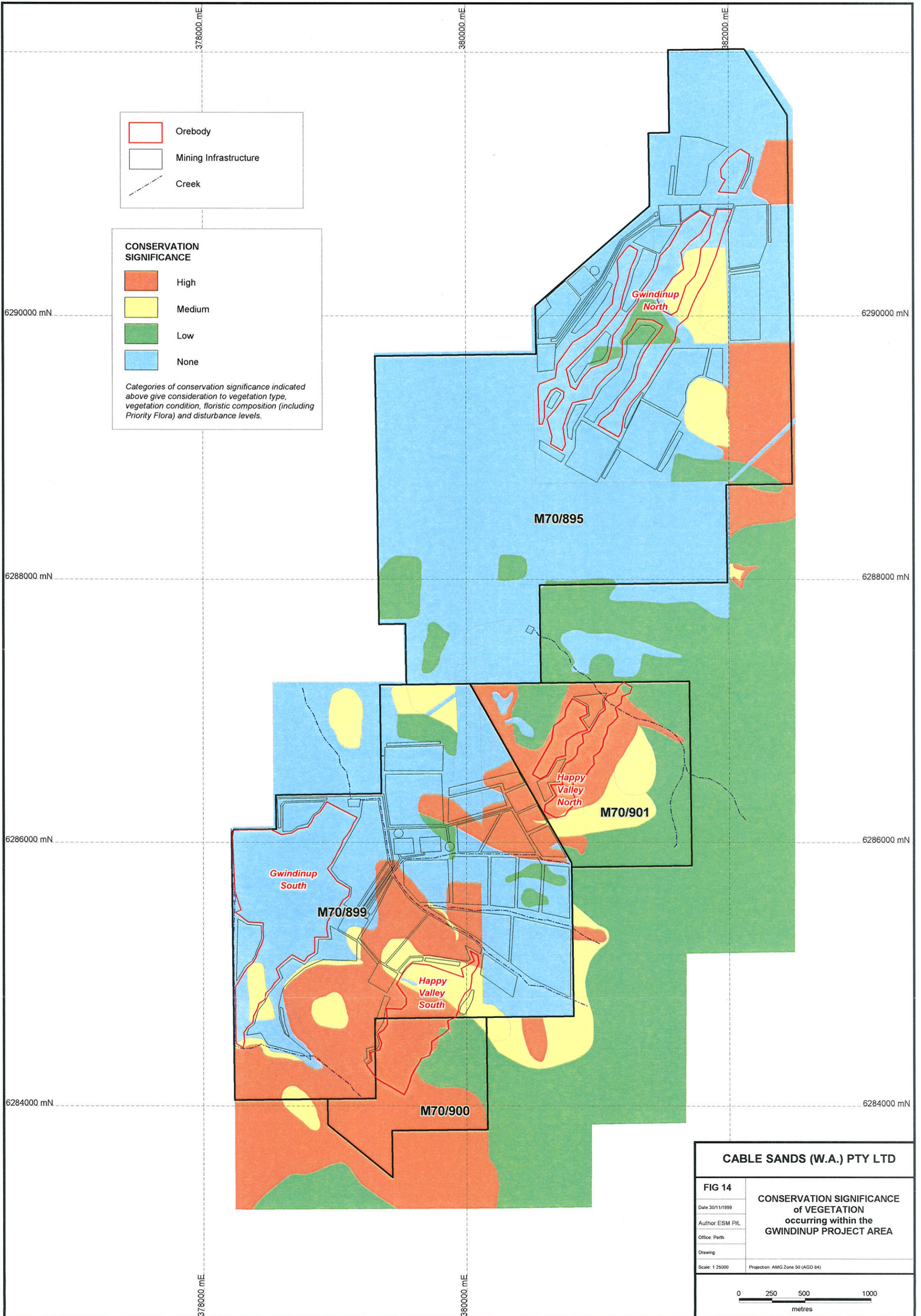
The conservation status of vegetation within the project area was inferred by ESM (1999) by consideration of the regional representation of vegetation complexes and floristic communities within proposed or formal reserves. The condition of the vegetation types in the study area, and the expression of the vegetation continuum from the upland escarpment vegetation to the lowland slopes and sand plain were also important factors, together with the distribution of Priority Flora.

Whicher Scarp and Whicher Valley vegetation in good condition within the project area was given a high conservation status. Where contiguous to Whicher vegetation, Cartis vegetation was also accorded a high conservation status, thereby providing an example of escarpment coenocline (continuum) from lateritic uplands to the sandplain. Isolated Cartis remnants were ranked as medium conservation status. Kingia vegetation, being widespread regionally, was given the lowest conservation ranking in the study area except where it was contiguous with the Whicher vegetation and also contained Priority Flora.

The survey by ESM (1999) showed that most of the vegetation in the study area has retained diversity of structure, high diversity of the understorey and very low levels of exotic weed establishment. Consequently, large portions of the study area have been rated as being of high conservation value (Figure 14). The areas with low condition status include vegetation adjacent to pastured areas reflecting past intrusion by livestock, and some forest areas significantly affected by dieback infection (Figure 13). The genesis of most of the infection in the area is associated with access tracks to quarry sites and logging operations.



CABLE SANDS (W.A.) PTY LTD	
FIG 13	DIEBACK DISTRIBUTION within the GWINDINUP PROJECT AREA
Date: 28/11/1999	
Author: ESM P/L	
Office: Perth	
Drawing:	Projection: AMG Zone 50 (AGD 84)



- Orebody
- Mining Infrastructure
- Creek

CONSERVATION SIGNIFICANCE

- High
- Medium
- Low
- None

Categories of conservation significance indicated above give consideration to vegetation type, vegetation condition, floristic composition (including Priority Flora) and disturbance levels.

CABLE SANDS (W.A.) PTY LTD

FIG 14

**CONSERVATION SIGNIFICANCE
of VEGETATION
occurring within the
GWINDINUP PROJECT AREA**

Date: 30/11/1999
 Author: ESM P/L
 Office: Perth
 Drawing:
 Scale: 1:25000 Projection: AMG Zone 50 (AGD 84)

0 250 500 1000
metres

3.8 FAUNA

A survey of fauna occurring within the project area was undertaken by Bamford Consulting Ecologists in July-August and December of 1999 (Bamford 2000). Fauna were trapped using CALM's 'Kingston Block Grid' design to allow comparability of the results with CALM's regional database. This programme resulted in the capture or observation of 18 mammal species, 9 frog species, 17 reptile species and 72 bird species (see Appendix C). Different habitat types identified during the survey were:

- ♦ jarrah forest on mid to upper slopes;
- ♦ jarrah forest in lower slopes of drainage lines;
- ♦ open farmland;
- ♦ isolated remnant Jarrah forest on the plain;
- ♦ bluegum woodlots.

3.8.1 MAMMALS

The Gwindinup region may support 29 mammal species, 18 of which were recorded by Bamford (2000) in the project area. The number of captures during the survey were too low to allow analysis of habitat preferences, however it is likely that all the native mammal species except for the Western Grey Kangaroo (*Macropus fuliginosus*) would show a preference for native vegetation.

Six of the observed species are introduced species, and as such, they either compete with, or predate native fauna. The Red Fox (*Vulpes vulpes*) and the Feral Cat (*Felis catus*) are particularly effective at hunting native fauna. The Western Shield fox control program has helped reduce the prevalence of these animals and is probably largely responsible for the presence of mammals of conservation significance such as the Chuditch (*Dasyurus geoffroii*). Including the Chuditch, there are 5 species of conservation significance that are expected to occur within the project area. These species are discussed in Section 3.8.6.

3.8.2 BIRDS

The Gwindinup region may support 121 species of birds, 72 of which were recorded by Bamford (2000) in the project area. The range of species encountered is particularly diverse as the habitats sampled ranged from the farmland on the plain to jarrah forest on the Whicher Scarp. Due to the mobility of birds, it is possible that the species observed may be found in any habitat, however some species have distinct habitat preferences.

The clearest distinction in habitat utilisation was observed between Cartis vegetation on sandplain and eucalypt woodland on laterite or sand. For example, the spotted Pardalote (*Pardalotus punctatus*), the Striated Pardalote (*Pardalotus striatus*) and the Golden Whistler (*Pachycephala pectoralis*) showed a preference for eucalypt woodland, whereas the Silvereye (*Zosterops lateralis*), the Scarlet Robin (*Petroica multicolor*) and the Grey Shrike-Thrush (*Colluricincla harmonica*) preferred Cartis vegetation.

Thirty-six of the bird species expected to occur in the region are largely restricted to farmland areas. These species include waterbirds which utilised flooded pastures and farm dams.

Two bird species showed a preference for Bluegum plantations: the Western Yellow Robin (*Eopsaltria griseogularis*) and the White-naped Honeyeater (*Melithreptus lunatus*).

Eight bird species of conservation significance are expected to occur within the project area. These species are discussed in Section 3.8.5.

3.8.3 REPTILES

Seventeen of the 36 reptile species that are expected to occur within the Gwindinup region, were recorded in the survey by Bamford (2000).

Habitat preferences for reptiles are divided between the sandy soils of the coastal plain and the Whicher Scarp, and the lateritic soils of the escarpment. Reptile species which are expected to be restricted to sandy soils include the Sandplain Worm-lizard (*Aprasia repens*), *Lerista elegans* and Jan's Bandy-bandy (*Simoselaps bertholdi*). Examples of reptile species which are expected to be restricted to lateritic soils include the Barking Gecko (*Underwoodisaurus milii*), the Red-legged Skink (*Ctenotus labillardieri*) and *Morethia obscura*.

One reptile species of conservation significance, the Carpet Python (*Morelia spilota imbricata*) is expected to occur within the project area. This species is discussed in Section 3.8.5.

3.8.4 AMPHIBIANS

Nine of the 12 species that are expected to occur within the Gwindinup region were recorded in the survey by Bamford (2000). All of these species have aquatic larvae, thus their numbers tended to be highest around seasonal wetlands on the coastal plain, even though it has been mostly cleared for farming.

None of the frog species expected or recorded are of special conservation significance.

3.8.5 FISH

An introduced species, the Goldfish (*Carassius auratus*), was observed in a farm dam within M70/899 by Bamford (2000) during the December 1999 survey. Despite specific searches for fish, no other species were observed during the surveys.

3.8.6 SIGNIFICANT FAUNA

In Western Australia, rare or endangered species are protected by the Wildlife Conservation (Specially Protected Fauna) Notice 1998 under the *Wildlife Conservation Act 1950*. Schedules 1 and 4 in this notice are relevant to this assessment. In addition, CALM maintains a reserve list of Priority Fauna, nominating other species requiring special consideration.

A search of the Department of Conservation and Land Management's (CALM) database of threatened fauna in the area surrounding the project revealed several species of conservation significance which possibly utilise the area. These species are indicated below.

Schedule 1 - fauna which is rare or likely to become extinct

- **Chuditch (*Dasyurus geoffroii*)** The Chuditch was formerly widespread, utilising a range of habitats, including woodlands, mallee shrublands, sclerophyll forests and coastal areas. Habitat loss has been largely responsible for a decline in the species such that it now only occurs in low densities in the south west of WA (Maxwell *et al.* 1996).

More recently, fox baiting in areas of state forest has resulted in increases in the distribution and abundance of this species, which is now regularly sighted in the Boyanup-Donnybrook area. Three individuals were captured in the survey of the project area.

- **Western Ringtail Possum (*Pseudocheirus occidentalis*)** The Western Ringtail Possum was formerly distributed through a range of woodlands and forests throughout the south west of Western Australia. Habitat alteration and predation by foxes is thought to be the main cause in the decline of this species WA (Maxwell *et al.* 1996).

Populations of this species now occur in patchy distributions in near coastal areas between Bunbury and Albany, where forests include Peppermint (*Agonis flexuosa*) (Strahan 1995). This species has been sighted south of Boyanup in jarrah-marri forest and a single individual was observed in remnant vegetation within M70/895 during the December survey of the project area (Bamford 2000).

- ♦ **Long-billed Black Cockatoo (*Calyptorhynchus baudinii*)** This species occurs in low to moderate numbers in this part of the central jarrah forest and may be an infrequent visitor to the project area. These birds feed primarily on eucalypt seeds and may breed in large hollows in eucalypts.
- ♦ **Short-billed Black Cockatoo (*Calyptorhynchus latirostris*)** This species is an irregular seasonal visitor to parts of the jarrah forest and cleared farmland in the western parts of the Darling Scarp. Although observed within the project area, this species is not expected to breed in the area.

Schedule 4 - otherwise specially protected fauna

- ♦ **Peregrine Falcon (*Falco peregrinus*)** This species is an occasional visitor to areas of open woodland and along margins with farmland. In areas of state forest it is uncommon, but widespread. A pair of Peregrine Falcons were observed hunting Galahs over farmland in the project area.
- ♦ **Carpet Python (*Morelia spilota imbricata*)** This species is common in native vegetation in the areas along the edge of the Darling Scarp where remnant woodland and rocky outcrops occur. The distribution of the Carpet Python has been reduced by a number of factors, mainly the loss of habitat with land clearing for agriculture (Cogger et.al. 1993).

Priority 3 – taxa with several, poorly known populations, some on conservation lands

- ♦ **Brush-tailed Phascogale (*Phascogale tapoatafa*)** This species is moderately common within the jarrah forest in the general area, largely as a result of the "Western Shield" fox control programme. The abundance of this mammal was confirmed in the recent survey of the project area, with 3 captures made.
- ♦ **Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)** This species occurs in low to moderate numbers in this part of the central jarrah forest and the Swan Coastal Plain, and is known to breed in the area. These birds feed primarily on eucalypt seeds and may breed in large hollows in eucalypts.

Priority 4 – taxa in need of monitoring.

- ♦ **Southern Brown Bandicoot (*Isodon obesulus fusciventer*)** This species is moderately common in jarrah forest and woodland along densely vegetated stream lines. Habitat particularly suitable for this species is a dense shrub layer in the 0-1m height interval. Five individuals were captured at three of the five trapping sites during surveys by Bamford (2000).
- ♦ **Western Brush Wallaby (*Macropus irma*)** This species occurs regionally in low numbers in areas of dense vegetation. Populations of this species are declining significantly, the major cause of which is thought to be habitat fragmentation and possible predation of juveniles by foxes (Maxwell et.al. 1996, Strahan 1995). This species was not observed during surveys by Bamford (2000).
- ♦ **Square-tailed Kite (*Lophoictinia isura*)** Although not observed in the project area, this species may be present at low population densities in the region and individuals may range over large areas, including farmland. These birds require large trees for nesting sites.
- ♦ ***Westralunio carteri*** This species of freshwater mussel occurs in streams with low turbidity and salt levels. It has declined significantly as a result of surface water salinisation, siltation

and pollution. Bamford (2000) undertook specific searches for this species in flowing streams, but no observations were recorded. It is likely that the seasonal flow characteristics of the streams in the area are unsuitable for this species.

3.9 LAND USE

The western portions of Cable Sands' mining leases at Gwindinup have largely been cleared for agriculture. Some of this cleared land has subsequently been planted to bluegums.

The eastern areas of the mining lease occur within State Forest No. 27, the Argyle Forest Block, which is managed by the Department of Conservation and Land Management (CALM) for the purposes of logging, quarrying and wildlife conservation. Some quarries are evident which are now disused, but have not been rehabilitated.

The project area includes parts of the Whicher Scarp. These areas were identified in the *Bunbury-Wellington Region Plan* (WAPC 1995) as being important landscape elements which must be used in a sensitive manner in order to preserve the visual amenity of surrounding parts of the plain.

3.10 ABORIGINAL CULTURE AND HERITAGE

Aboriginal people with cultural associations with the project area are represented by the Noongar Land Council. Areas of state forest within the project area are subject to the Gnarla Karla Booja Native Title Claim, which was accepted for registration under s190A of the *Native Title Act, 1993* on 5 March 1999.

A search of the Aboriginal Affairs Department's (AAD) Register of Aboriginal Sites was undertaken on 16 November 1999, for an area encompassing the proposed Gwindinup Mineral Sands Mine. This search recorded a single interim register with the following details:

- Site: S01484, Grindstone Site.
- Status: Interim Register.
- Access: Open.
- Reliability: Unreliable.
- Site type: Artefact.

Surveys within the project area will be undertaken in conjunction with the native title negotiations. These surveys will determine the extent and significance of this site, or any other sites of ethnographic or archaeological significance discovered during the investigations. These searches will comply with the *Aboriginal Heritage Act, 1972* and will use Aboriginal consultants accepted by the both the Gnarla Karla Booja native title claimants and the Noongar Land Council. Notwithstanding the outcome of these searches, Cable Sands believes that it is unlikely that there are any modern Aboriginal uses of the land which are likely to be compromised by the proposal.

Previous communication with the AAD has indicated that the prevalence of sites of significance to Aboriginal people is usually influenced by a number of factors. These factors include considerations such as availability of water, access to raw materials (eg. quartz or chert), the presence of prominent features and the level of prior disturbance or development of the land. Based on these considerations Cable Sands believes it is unlikely that there are unrecorded sites in the project area.

3.11 EUROPEAN HERITAGE

The Heritage Council of WA provided information on heritage places occurring within the Gwindinup locality. There have been no sites of heritage significance identified as occurring within the proposed mining area. Four heritage places near the proposal were listed in the Capel Shire's municipal inventory:

- Riverbend Homestead, Gwindinup Rd, Boyanup (Heritage Place No. 15176);
- Gwindinup Townsite, Gwindinup (Heritage Place No. 15185);
- Runnymead Mill, Lot 24, South West Hwy, Gwindinup (Heritage Place No. 15186);
- Runnymead School, Res. 17915, lot 28, Shenton Rd, Gwindinup, (Heritage Place No. 15187).

Being listed in the municipal inventory means that these places are considered to be of heritage importance to the local community. These places are not afforded special protection under the *Heritage of Western Australia Act 1990*. These places are located outside of the project area.

4 Environmental Management

4.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Cable Sands has an Environmental Management System (EMS) with ISO 14001 certification. Cable Sands was the first mineral sands mining company in the world and the first Australian mining company to have mining operations certified to that standard.

Cable Sands developed an environmental policy as part of the development of its EMS. This policy is included in Appendix D, with key commitments being:

- complying with environmental legislation, regulations and codes of practice;
- preventing pollution;
- reducing environmental impacts from operations wherever practicable;
- regularly auditing and monitoring environmental performance;
- continual improvement in environmental management practices and performances.

Cable Sands' EMS will help ensure that best practice environmental management for the Gwindinup mine will be implemented during all phases of the project, including construction, operation and decommissioning/rehabilitation.

4.2 NATIVE VEGETATION PROTECTION STRATEGY

A strategy to minimise the long-term impacts of the proposal on native vegetation was developed during the mine planning phase. This strategy focused on three main mechanisms, which are discussed below.

4.2.1 CONSERVATION AREAS

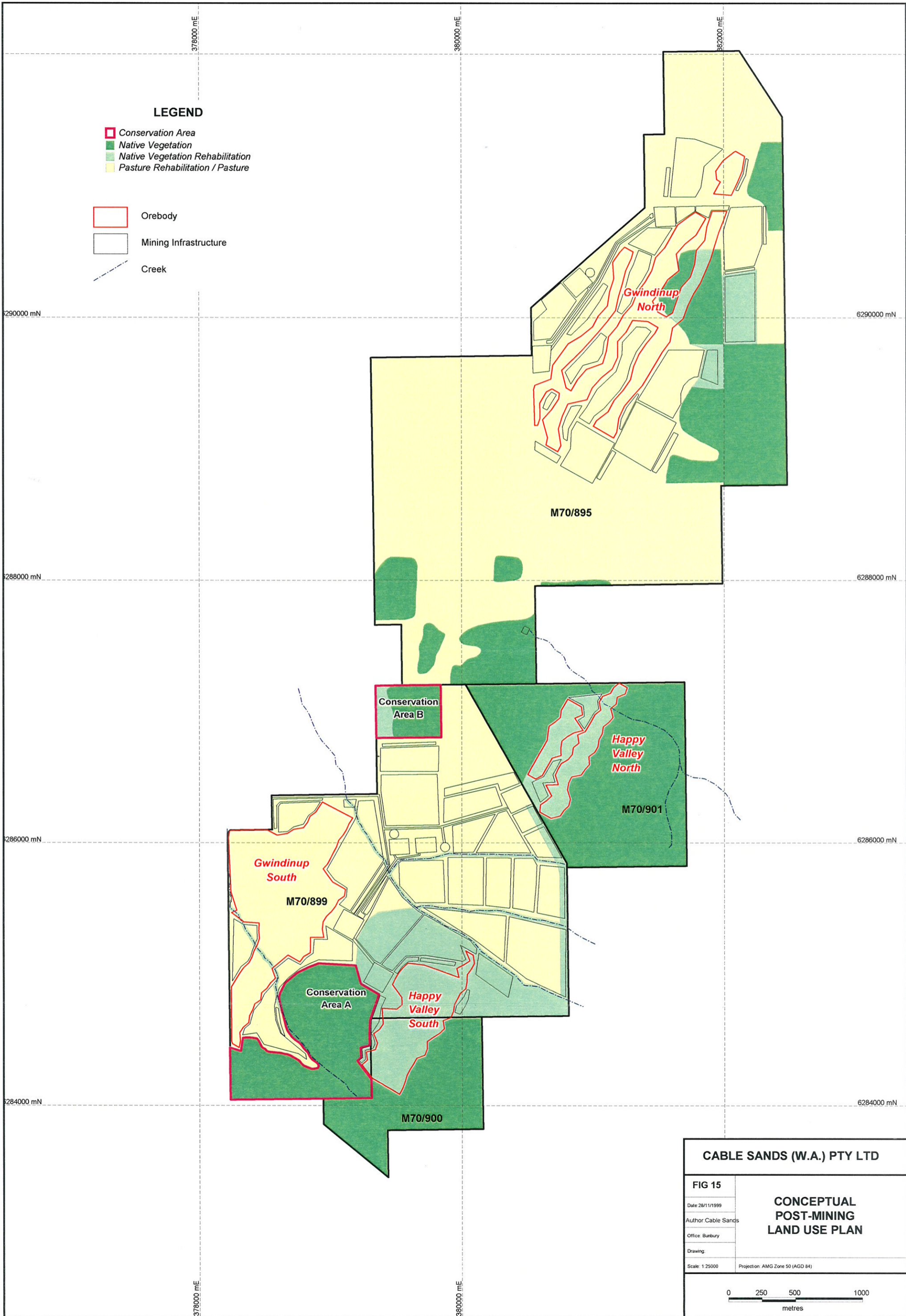
Two areas of native vegetation with moderate to high conservation significance have been designated for protection as conservation areas (Figure 15). Conservation Area A is 77.0 ha in size and encompasses 23.4 ha of high conservation value Whicher Valleys vegetation adjacent to state forest (Table 8). This area would be fenced to restrict unauthorised access into the area.

Conservation Area B is an area 19.8 ha in size within Location 3829, which has already been fenced by Cable Sands to protect it from degradation by livestock. As is indicated in Table 8, this area includes 15.0 ha of Cartis vegetation. Due to ongoing negotiations with the landowner, the adjoining Cartis vegetation east of this area (within Location 4965) is not at this stage available for inclusion in Conservation Area B.

These areas will either be protected by conservation covenants or by inclusion into CALM estate.

Conservation Covenants

Conservation Covenants are primarily designed to protect nature conservation values but are individually designed to recognise human needs in living in harmony with nature. A conservation covenant can apply to all or part of a property.



CABLE SANDS (W.A.) PTY LTD	
FIG 15	CONCEPTUAL POST-MINING LAND USE PLAN
Date: 28/11/1999	
Author: Cable Sands	
Office: Bunbury	
Drawing:	
Scale: 1:25000	Projection: AMG Zone 50 (AGD 84)

Table 8 Change in vegetation distribution as a result of the proposal

(1) PROJECT AREA					
<i>Native vegetation</i>	Private land		Crown land		TOTAL
	M70/899	M70/895	M70/900	M70/901	
Vegetation clearing:					
Whicher Scarp (WC)	57.2	1.6	21.0	34.6	114.4
Whicher Valleys (WCv)	22.6	0.0	0.5	1.2	24.2
Cartis (CSs)	50.7	24.7	0.0	0.0	75.4
Rosa (RO)	0.5	0.0	0.0	0.0	0.5
Kingia (KI1)	33.8	0.0	0.7	1.2	35.7
Kingia (KI2)	0.2	0.0	0.1	0.0	0.3
Total clearing	165.0	26.3	22.3	37.0	250.6
Total Rehabilitation	116.2	26.1	22.3	37.0	201.6

(2) REGIONAL DISTRIBUTION*													
	pre-European	BEFORE MINING						AFTER MINING					
	ha	Reserves ha	%**	Crown land ha	%	Private land ha	%	Reserves ha	%	Crown land ha	%	Private land ha	%
<i>Native Vegetation</i>													
Whicher Scarp (WC)	3861	526	14%	1,831	47%	373	10%	526	14%	1775	46%	314	8%
Whicher Valleys (WCv)	409	40	10%	175	43%	75	18%	40	10%	173	42%	52	13%
Cartis (CSs)	7541	4218	56%	385	5%	931	12%	4218	56%	385	5%	856	11%
Rosa (RO)	16514	3,295	20%	8,368	51%	469	3%	3295	20%	8368	51%	469	3%
Kingia (KI)	102240	14,317	14%	82,456	81%	639	1%	14317	14%	82454	81%	605	1%

(3) CONSERVATION AREAS***			
<i>Vegetation</i>	Area A (ha)	Area B (ha)	Total (ha)
Whicher Scarp (WC)	24.4	0	24.4
Whicher Valleys (WCv)	23.4	0	23.4
Cartis (CSs)	21.5	15.0	36.5
Kingia (KI1)	7.6	0	7.6
Pasture	0.0	4.8	4.8
	77.0	19.8	96.8

Note:
 * Data from A. Walker and R. Wilson, CALM, 1999, pers. comm.
 ** Percentage of pre-European distribution
 *** Conservation areas are as indicated in Figure 15

Conservation Covenants are legally binding agreements between the land-owner and the WA government. They are statutory covenants that have the force of an Act of Parliament, and enable a body to enforce the covenant. Covenants are registered on the title for the land and bind present and future owners to comply with the terms of the covenant. Ownership and control of the property remains with the owner. Most covenants are designed to be permanent although they can, if desired, be specified for a particular period.

Three organisations in Western Australia have developed covenanting schemes:

- **Agriculture Western Australia** has assisted owners to covenant land since 1990. Their conservation covenants are irrevocable and apply for an agreed period or in perpetuity. Grants to assist with fencing costs are available under the Remnant Vegetation Protection Scheme. This scheme operates under the *Soil and Land Conservation Act, 1945*.
- **CALM** provides covenants that are normally permanent and designed to protect nature conservation values on private land. This opportunity commenced in 1999 under the *Conservation and Land Management Act, 1984* and the *Transfer of Land Act, 1893*.
- **National Trust of Australia (WA)** covenants are normally permanent and can be designed to protect conservation and heritage values. The National Trust program commenced in 1999 and operates under the *National Trust of Australia (WA) Act, 1964*.

Inclusion into CALM Estate

A portion of Conservation Area A could be incorporated into CALM Estate and subsequently managed by CALM. If this option was not realised, the whole of Conservation Area A would be specified for inclusion in a Conservation Covenant.

4.2.2 MINIMISATION OF CLEARING REQUIREMENT

The mine site layout indicated in Figure 3 reflects a pro-active approach taken by Cable Sands' mine planning staff to minimise the requirement to clear native vegetation. The project area (M70/899, M70/895, M70/900 and M70/901) is the only area available for the placement of infrastructure. Locations 3818 and 3833 are owned by Iluka (see Figure 2) and thus are not available for the placement of Cable Sands mining infrastructure or stockpiling of mining by-products.

Mine planning adopted the policy of minimising clearing of native vegetation within state forest (M70/900 and M70/901). This is consistent with CALM comments on the proposal (see Section 7.4) and is reflected in the mine plan (Figure 3), with only the orebody and topsoil stockpiles being located within state forest. To achieve this outcome, infrastructure and by-products associated with these orebodies were located on private land within M70/899.

Cable Sands also endeavoured to minimise clearing of native vegetation of medium to high conservation value on private property. The outcome of this strategy was the avoidance of areas now defined as Conservation Areas A and B (see Section 4.2.1 above).

The benefits of the initiatives discussed above are evident, with large areas of native vegetation within the project area being avoided. However, it is necessary to reach a compromise between avoidance of native vegetation and practical mining constraints (see Table 3). This is reflected in the necessity to utilise a greater proportion of the remaining available parts of lease M70/899.

4.2.3 NATIVE VEGETATION REHABILITATION

Approximately 62% of native vegetation rehabilitation will occur on areas which have only been subject to surface disturbance (eg. topsoil and overburden stockpiles). The underlying substrates required for redevelopment of the pre-mining vegetation in these areas will remain unchanged.

Approximately 38% of the native vegetation rehabilitation will occur over mined areas (mainly Happy Valley South and Happy Valley North). In these areas the underlying substrates will be altered, however, as is described in Section 5.3.4, landform reconstruction will endeavour to create a substrate that is not restrictive to plant growth.

Rehabilitation of native vegetation in state forest

A total area of 59.3 ha of state forest (M70/900 and M70/901) will be disturbed by the proposal. This area will be rehabilitated to a native vegetation type with a similar species composition to that which previously occurred.

Rehabilitation of native vegetation on private land

On private land, 142.3 ha of native vegetation will be established. This will include 116.2 ha within M70/899, the location for which was selected to be contiguous with the surrounding native vegetation in state forest. An additional 26.1 ha of native vegetation rehabilitation within M70/895 was located to provide improved linkage between currently isolated remnants of native vegetation (see Figure 10 and Figure 15). To facilitate early commencement of rehabilitation, fines dams have been excluded from the native vegetation rehabilitation areas, except for orebody areas.

The native vegetation rehabilitation within M70/899 will also include the development of buffer and riparian zones within farmland areas:

- A 50 m wide buffer zone of native vegetation will be developed along the eastern boundary of M70/899. This buffer zone will help to provide protection to the adjacent state forest from edge effects such as weed encroachment.
- Streams in farmland areas of M70/899 will have a 30 m wide riparian zone developed to provide environmental benefits of water quality protection, erosion control and wildlife corridor provision.

4.3 ENVIRONMENTAL MANAGEMENT PROGRAMME

An Environmental Management Programme (EMP) will be developed to cover all aspects of the proposal where environmental issues have been identified. Rehabilitation prescriptions will be developed in the Rehabilitation Plan (see Section 4.4) and then summarised in the EMP. The EMP will be developed in consultation with the DEP and CALM and is likely to include a broad range of management prescriptions, for example:

- protection of ground and surface water quality by having hydrocarbon storage in bunded areas, approved sewerage systems and appropriate waste disposal systems (see Section 6.2.4);
- noise control strategies such as restricting earthmoving operations to within the pit where-ever practical and substituting reversing beepers with flashing lights at night-time (see Section 6.4.5);
- dust control strategies such as watering internal roads and, where practical, maintaining a vegetative cover on stockpiles (see Section 6.3.4);
- A strategy for the cleanup of any contaminated sites. Waste disposal and hydrocarbon spillage management is discussed in Section 6.2.4.
- protection of native flora and fauna by implementation of the Native Vegetation Protection Strategy (see Section 4.2), minimising vegetation clearing, retaining non-commercial timber for use as fauna habitat, and leaving occasional habitat trees in infrastructure areas.

- Fire control strategies such as the maintenance of firebreaks and the provision of an on-site firefighting unit. As the project area encompasses state forest, these strategies will be developed in consultation with CALM.

Commitments

1. Cable Sands will prepare an Environmental Management Programme for the proposal prior to development of project infrastructure. This programme will include prescriptions for the management of wind and water erosion, noise, hydrocarbons, fire, dieback, weeds, and native flora and fauna.

4.4 REHABILITATION PLAN

Planning for rehabilitation will commence prior to mining with the development of the Rehabilitation Plan, which will be developed in consultation with the DEP and CALM. The Rehabilitation Plan will be an underlying document supporting the EMP, however it will be more detailed and will be an integral part of the mine planning process. The Rehabilitation plan will cover a range of items including:

1. A plan showing final landuse(s), and pattern of vegetation (prepared in consultation with relevant stakeholders).
2. Relevant biophysical baseline information (e.g. existing land use, remnant vegetation, soil profile, hydrology), which will be used to define rehabilitation completion criteria.
3. A topsoil management plan describing topsoil movements and volumes. This plan will be integrated with the mining schedule. Rehabilitation procedures will be implemented as soon as is practical following mining, however practical limitations to this implementation will include the requirement to allow adequate drying time for fines prior to final landform redevelopment.
4. Pre and post mining contour plans.
5. Mining and tailings return schedules.
6. Plans for the management of weeds and dieback, with the principle of minimising the spread of weeds and dieback (these items are discussed in Section 5.3.4).
7. Plans for the control of erosion (erosion control is discussed in Section 5.2 and Section 6.2.4).
8. A section on infrastructure removal. This section will indicate that infrastructure for mining and primary processing will be located on cleared land where-ever practical. On completion of mining, all infrastructure will be removed from site other than roads, fences or dams which are accommodated within the final land use plan.
9. Rehabilitation methods (these methods are discussed in Section 5.3.4).
10. Priority Flora management. Seed and/or cuttings from affected Priority Flora will be collected prior to disturbance and included in rehabilitation. Prior to disturbance of any DRF or Priority Flora, an appropriate management strategy will be developed in consultation with CALM.
11. Rehabilitation completion criteria (completion criteria for rehabilitation of farmland and native vegetation are discussed in Section 5.3.4).
12. A rehabilitation monitoring programme will be developed in consultation with the DEP and CALM. This monitoring will focus on the composition and condition of re-established native flora, however to demonstrate that a self-sustaining ecosystem has been developed, this monitoring will include assessment of soil, landform and groundwater conditions.

13. Reporting requirements. Cable Sands will undertake annual audits of rehabilitation and report the results to the DEP and CALM. To facilitate continual improvement in rehabilitation performance, the annual reporting mechanism will also allow Cable Sands, DEP and CALM, collaboratively, to review and amend the content of the Rehabilitation Plan.

Commitments

2. Cable Sands will prepare a Rehabilitation Plan prior to development of project infrastructure. The plan will include final landuse(s), biophysical baseline data, topsoil management plan, pre and post mining contour plans, mining and tailings return schedules, weed and dieback management plans, erosion control plans, and sections on infrastructure removal, rehabilitation completion criteria and rehabilitation monitoring.

5 Biophysical Environment: Impacts and Management

This section evaluates the potential for the proposal to cause adverse impacts to the biophysical environment, for factors which the EPA has a policy or position. Management strategies to avoid or minimise any adverse environmental impacts are also given.

5.1 BIODIVERSITY

5.1.1 EPA OBJECTIVE

- Maintain biological diversity, where that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.
- Through studies carried out for the following environmental factors, demonstrate that biodiversity will not be compromised by this proposal.

5.1.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this environmental factor is the EPA objective, which is derived from the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996). In addition to the strategies' goals to conserve biological diversity, this strategy accepts the guiding principles of the National Strategy for Ecologically Sustainable Development. These principles include the need for decision-making processes to integrate economic, environmental, social and equity considerations. Additionally, the need to develop a strong, growing and diversified economy that can enhance the capacity for environmental protection, should also be recognised.

As a result of the Western Australian government becoming a signatory to the National Strategy for the Conservation of Australia's Biological Diversity, in December 1999 the EPA released a preliminary position statement for the environmental protection of native vegetation in Western Australia (EPA 1999). This report offers the following elements for consideration when assessing a proposal's impact on biodiversity:

- A comparison of development scenarios or options to evaluate protection of biodiversity at the species and ecosystems levels.
- No known species of plant or animal is caused to become extinct as a consequence of the development and the risks to threatened species are considered to be acceptable.
- No association or community of indigenous plants or animals ceases to exist as a result of the project.
- There is comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or in areas that are biologically comparable to the project area, protected in secure reserves.
- If the project is large the project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity is secure and protected.

- The on-site and off-site impacts of the project are identified and the proponent demonstrates that these impacts can be managed.

5.1.3 PREDICTED IMPACT

The proposal to mine mineral sands at Gwindinup will require clearance of native vegetation. This clearance consists of approximately 191.3 ha on private land, 59.3 ha in state forest. The impacts on vegetation, flora and fauna are discussed further in Sections 5.4, 5.5 and 5.7 respectively and are summarised below:

- Vegetation: in terms of forest ecosystems, the Jarrah Blackwood ecosystem will be affected by the proposal. Eighty-one percent of the pre-1750 distribution (347,200 ha) still remains and 16% of the pre-1750 distribution is retained within formal or informal reserves (Commonwealth of Australia and WA Government 1998). The proposed clearing of 250.6 ha of native vegetation will not significantly change this scenario (ie. the result will be an areal change of less than 0.1 %).

In terms of the vegetation complexes identified by Mattiske and Havel (1998), all of the vegetation complexes affected by the proposal have a current distribution greater than 70% of their pre-European distribution. (see Table 6). All of these complexes, except for Whicher Valleys vegetation, are adequately represented within existing reserves. Whicher Valleys vegetation is inadequately represented within existing reserves, however its protection will be improved by the proposal due to the inclusion of 23.4 ha of this vegetation in a conservation area.

No forest ecosystems or vegetation complexes will cease to exist as a result of the proposal.

- Flora: six species of Priority Flora will be disturbed by the proposal. These species are adequately represented elsewhere in the Argyle Forest Block (Table 9), but will also be included in the rehabilitation programme.

No flora species will become extinct as a result of the proposal. There is considered to be negligible risk to Declared Rare Flora. The risk to Priority Flora is low and can be managed (see Section 5.5.4).

- Fauna: fauna habitat will be removed by clearance of native vegetation. The rehabilitation programme will encourage the long-term return of fauna to the area.

No fauna species will become extinct as a result of the proposal. The project is considered to represent a low risk to Threatened Fauna as adequate habitat for these species exists adjacent to the project area (jarrah forest in Argyle Forest Block), and the prevalence of some of these species has been encouraged in recent years by CALM's Western Shield fox-baiting programme.

5.1.4 MANAGEMENT

The Native Vegetation Protection Strategy, as discussed earlier (Section 4.2), is a key feature of Cable Sands' mechanism for managing the EPA's objective for biodiversity. This strategy includes the provision of conservation areas to protect some areas of valuable remnant vegetation. This strategy also includes the development of riparian vegetation zones that will function as habitat corridors in land that currently consists of open pastures.

The Native Vegetation Protection Strategy also indicates that the mine planning phase has included the requirement to minimise vegetation clearing. Consequently, the mine layout presented in Figure 3 represents the development scenario with the least possible impact to natural ecosystems.

In addition to the Native Vegetation Protection Strategy, other management actions that will assist

to minimise impacts on biodiversity, both on-site and off-site are indicated in the following evaluation of biophysical factors and pollution control factors.

5.1.5 PREDICTED OUTCOME

The EPA's objective for biodiversity will be achieved through implementation of the Native Vegetation Protection Strategy and other environmental management actions prescribed for biophysical factors and pollution control factors.

The following outcomes are anticipated for biodiversity within the Gwindinup project area as a result of the proposal:

- Long term protection of biodiversity for 92.0 ha of private property included within conservation covenants (Conservation Areas A and B).
- A permanent net decrease in biodiversity on private property of 49.0 ha of native vegetation (not accounting for the conservation areas indicated above).
- Improved biodiversity in farmland areas due to the development of riparian vegetation zones and shelterbelt vegetation.
- A short to medium term reduction in biodiversity for 59.3 ha of the Argyle Forest Block which will be disturbed.
- In the long-term (10+ years), rehabilitation will result in no significant loss in biodiversity within the Argyle Forest Block.

Consistent with the National Strategy for Ecologically Sustainable Development, these outcomes should be viewed in balance with the economic benefits to the region that will result from the proposal.

5.2 LANDFORMS

5.2.1 EPA OBJECTIVE

- Establish stable and sustainable landforms consistent with surroundings.

5.2.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this environmental factor is the EPA objective.

5.2.3 PREDICTED IMPACT

Mining of the Happy Valley and Gwindinup ore deposits will result in disturbance to the existing landform for the duration of mining. 437 ha will be affected by surface disturbance, while 224 ha of mine pit area will require landform reconstruction (Table 2).

The period of mining will range from approximately 16 months for Happy Valley North to nearly 4 years for Gwindinup South. The risk of destabilisation of landforms by erosion from either fluvial or aeolian forces during this period should be considered.

Fluvial erosion may occur as a result of surface runoff or by stream flow. In the project area, this risk is considered to be relatively low as the existing slopes range from very gently inclined on the western side of the project area, to gently inclined near the eastern boundary of the project area. Where mining activities result in the creation of steeper slopes, or exposed areas, or where existing

stream lines are disturbed, appropriate erosion control measures will need to be developed.

Aeolian (wind) erosion is only likely to occur during high wind conditions in exposed areas which are not vegetated. In these areas, the risk of wind erosion will be highest during summer, when dry soil surface conditions are expected. During these periods appropriate erosion control measures will be required.

No long term adverse impact on landforms is expected as landform reconstruction and revegetation of disturbed areas during the rehabilitation phase will result in the reinstatement of a landform which is stable, non-eroding and blends in with the surrounding environment.

5.2.4 MANAGEMENT

The post-mining landform will be developed to be compatible with the surrounding environment. Further prescriptions for landform design will be developed in the Rehabilitation Plan, in consultation with the DEP and the relevant landowner.

During operation of the minesite a number of erosion control measures will be implemented to minimise the risk of fluvial erosion. These measures include the installation of diversion bunds to prevent surface runoff from affecting disturbed soils within the minesite area. These bunds will incorporate sediment basins that attenuate diverted surface flows and reduce their sediment load.

To reduce the risk of wind erosion on windy days, stockpiles will be re-vegetated or stabilised with fines or other sealing agents. In other disturbed areas either a water cart or a sealing agent will be used to promote surface stability.

Long term erosion control will be facilitated by the re-development of self-sustaining vegetation communities. To provide post-mining erosion control in the short to medium term, erosion control measures will be incorporated into the rehabilitation programme. Deep ripping and secondary cultivation will be undertaken on the contour to encourage infiltration and reduce the intensity of surface runoff. Rock and brush material may be used to stabilise soils on steeper slopes, or in drainage lines.

Commitments

Commitments 3 and 4, for the development of a Rehabilitation Plan (Section 4.4), are relevant.

5.2.5 PREDICTED OUTCOME

The EPA's objective for landforms will be achieved, with rehabilitation resulting in the development of a stable landform that is revegetated to a standard consistent with the post-mining land use.

5.3 REHABILITATION

5.3.1 EPA OBJECTIVE

- ♦ To ensure the proposal area and any other area affected by the proposal is rehabilitated to a standard consistent with the intended post mining long-term land use.

5.3.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this environmental factor is the EPA objective.

5.3.3 PREDICTED IMPACT

Rehabilitation of areas disturbed by mining activities will alleviate impacts on factors such as landforms, surface waters and visual amenity. These impacts are discussed separately. The impact of rehabilitation is expected to be the development of a stable landform that is revegetated to standard consistent with the post-mining land use.

Conceptual Post-mining Land Use Plan

A conceptual post-mining land use plan is indicated in Figure 15. The plan indicates that areas temporarily disturbed by mining will be rehabilitated to a mixture of farmland and native vegetation. The plan proposes restoring original farmland, bluegum plantations and land covered by fines dams to pasture. All infrastructure will be removed from site other than roads, fences or dams which are accommodated within the final land use plan.

On private land within M70/899, approximately 116.2 ha of native vegetation will be established. The location for this vegetation was selected so that it will be contiguous with the surrounding native vegetation in state forest. Thus, along the eastern boundary of this mining lease, the vegetation will consist of a 50 m wide strip of native vegetation. This buffer zone will help to provide protection against edge effects such as weed encroachment. Additionally, all streams in farmland areas of M70/899 will have a 30 m wide riparian vegetation zone developed to provide environmental benefits of water quality protection, erosion control and wildlife corridor provision.

On private land within M70/895, approximately 26.1 ha of native vegetation will be established. The location for this vegetation is strategically placed so that it will improve the linkage between areas of remnant vegetation on the eastern side of the Gwindinup North orebody (see Figure 15).

A total area of approximately 59.3 ha of state forest (M70/900 and M70/901) will be disturbed by the proposal. This area will be rehabilitated to a native vegetation type with a similar species composition to that which previously occurred. The specific requirements for rehabilitation in these areas will be determined by consultation with DEP and CALM during the development of a Rehabilitation Plan for the proposal (described in Section 4.4).

5.3.4 MANAGEMENT

Farmland

Cable Sands has extensive experience in rehabilitating farmland on the Swan Coastal Plain. Rehabilitation procedures proposed for re-establishment of farmland at Gwindinup will follow those currently used at Cable Sands' Yarloop and Bengier minesites, and previously used successfully at Waroona.

The focus of the rehabilitation programme will be to rapidly stabilise restored landforms with agricultural pastures and some shelterbelts. The shelterbelts will be developed to enhance the amenity of the land for livestock and crop production.

Fines dams will be located on the mined areas to provide clayey material in the upper soil profile prior to topsoil replacement. This application of fines material facilitates moisture retention and substantially enhances the success of rehabilitation.

The mined areas will be re-contoured to blend in with the existing landscape using the dried fines, overburden and tailing sand. In areas currently subject to waterlogging, land contours may be modified to improve the land's drainage characteristics.

All topsoil will be conserved and returned to areas of compatible land use. Following re-contouring of the landform, topsoil will be respread evenly and, subject to landowner requirements, a clover-ryegrass mix sown. Fertiliser will also be applied to ensure a vigorous re-establishment of the pasture.

Rehabilitation completion criteria for farmland will be developed in consultation with the relevant landowner, thus indicative targets for vegetation cover can not yet be provided. It is expected that, as a minimum, the rehabilitated farmland will have to demonstrate a level of agricultural productivity comparable to pre-mining levels. The maximum level of weed presence allowed will be that which is typical for the region, given comparable landuses.

Other components of the agricultural system, such as soil profiles, groundwater levels and landform will also be assessed to ensure the land's productivity can be expected to be sustainable over the long term.

Native Vegetation

The following items will be relevant to the mining and rehabilitation of native vegetation areas, but may be refined during the development of the Rehabilitation Plan.

1. Seed collection

A seed collection program, which will target local provenance seed, will be implemented prior to mining. This seed will be collected from as many plants as possible from the area to be mined. Each collection will be labelled and stored in an appropriate manner. If insufficient seed is collected from the proposed mine area, permission will be sought from CALM to collect seed from adjacent areas of state forest. The same methods of collection will be applied.

In addition to seed collection, rootstock material from species difficult to germinate by seed will be collected prior to clearing areas. This material will be taken directly to Cable Sands' North Shore nursery where it will be treated with rooting hormone, transferred to pots and then placed in a glasshouse.

2. Timber removal

Clearing of vegetation will commence with the commercial harvesting of timber. The remaining timber will be cleared and stockpiled for later use as habitat logs. Low shrub and sedge material will be left with the topsoil to assist the rehabilitation process by providing a source of mulch and some vegetative regeneration.

3. Block translocation

Block translocation is a technique that allows the removal of an intact section of topsoil and understorey vegetation. This technique is particularly valuable for the propagation of species that are hard to generate from seed (eg. sedge species) and is currently used at Cable Sands' Jangardup mine site. A front-end loader is used to excavate the plants and topsoil to a depth of 30-40cm.

Block translocation is a very labour and time intensive operation and requires large areas for storage. Consequently, a balance between topsoil spreading and block translocation will be undertaken with approximately 10 % of native vegetation areas being translocated prior to disturbance.

4. Landform Reconstruction

Landform re-construction will be required following mining of the orebodies. Tailings, fines and overburden will be used to develop post-mining contours that are compatible with the surrounding environment. Topsoil will then be replaced and vegetation re-established to a standard consistent with the conceptual land use. To enhance the success of native vegetation re-establishment, the following constraints will be imposed on the fines layout:

1. In state forest, maintaining the mine pit area utilised for fines to a practical minimum.
2. Maximum thickness of fines to be 0.5 m. The entire thickness of this layer can then be deep ripped, ensuring that root systems are able to penetrate into underlying substrates.
3. Fines to be covered by a 2 m thick minimum layer of overburden. This freely draining

overburden will ensure that native plants are able to develop extensive root systems deep into the soil profile.

Relevant erosion control measures are discussed in Section 5.2.4.

5. Topsoil management

On sites supporting native vegetation, all topsoil that remains after vegetative harvesting and block translocation will be removed in two stages using scrapers wherever possible. The top 10 cm of topsoil, including any unharvested understorey vegetation, will be removed and stockpiled to a maximum depth of 2 m. A further 20 cm of subsoil will also be stockpiled.

Direct topsoil replacement may encourage greater recruitment of native species from the soil seed bank than if the topsoil undergoes a storage phase. Using conventional techniques (scraper removal), it is not possible to directly replace topsoil during rehabilitation due to the relatively short mining life of the deposits. During the development of the Rehabilitation Plan for the proposal, new techniques such as topsoil sieving will be investigated as possible mechanisms for facilitating the direct replacement of topsoil. Topsoil sieving is a technique where topsoil is passed through a screen to remove coarse gravel, rocks and sticks. In gravelly topsoils, this technique may achieve a significant reduction in volume, effectively concentrating the seed bank in the resultant product. The sieved topsoil may then be spread thinly over the surface of re-made ground during the latter stages of rehabilitation.

Although direct replacement of topsoil is not yet possible for the Gwindinup proposal, the length of stockpiling will be kept to a practical minimum. Progressive rehabilitation of mined areas will help to ensure the duration of topsoil stockpiling is minimised, preferably to a period of less than 12 months.

After the landform surface has been shaped to the desired post-mining contour the lower topsoil, followed by the upper topsoil, will be spread as evenly as practical across the surface. The application of the upper topsoil layer will be undertaken with particular care to ensure that viable seed and propagules contained within are not buried too deeply for regeneration. To encourage the early establishment of vegetation on rehabilitated areas the target for respreading of the upper topsoil layer will be 10 cm depth.

6. Seeding and planting

Native species are expected to regenerate from the transplanted, translocated and respread topsoil on rehabilitation areas. However, experience has shown that regeneration response can be quite variable and may need to be supplemented by nursery propagated seedlings and hand seeding.

The nursery propagation program will involve the production of potted seedlings from collected seed in addition to shoot and root cuttings. This will be undertaken at Cable Sands' nursery and, on a contract basis, through commercial nurseries. It is expected that less than 20% of the species requiring regeneration (see Appendix B) will require nursery propagation. Examples of species that may be propagated in this manner include *Hibbertia* spp., *Leucopogon* spp. and *Synaphea* spp.

At the time of planting, tree species other than *Banksia* species will be fertilised with a 60 g mixture of NPK with trace elements and Dynamic Lifter. Understorey species planted out in the restored area will receive either this nutrient and trace element mixture or Dynamic Lifter only.

7. Plant propagation

Most of the species recorded within the project area are readily propagated from seed or cuttings and a number of plants eg *Macrozamia riedlei* and *Xanthorrhoea* spp. may be transplanted into rehabilitation areas. Propagation by cuttings requires the taking of cutting material and treatment with plant hormone before planting in soil. Regular watering (preferably misting) of cuttings will be maintained and the cuttings transplanted into large pots and grown on when they have developed roots. Once the cuttings are well established they will be planted in rehabilitation areas, preferably, at the break of season.

8. Weed management

Cable Sands will apply a protection and management regime to the area that will remove weeds as part of the programme of native vegetation re-establishment. The weed status of rehabilitated sites will be assessed regularly and eradication will be undertaken promptly by spot spraying or manual removal. In view of the seed stock of introduced species that may occur in the upper layers of the soil, monitoring and control may be required for several years.

The success of the weed control program will be monitored on a regular basis as a component of the overall vegetation monitoring programme. This programme will be developed as part of the Rehabilitation Plan prior to the commencement of mining. Examples of weed management procedures that may be included in the Rehabilitation Plan are:

- clean down of all machinery before commencing rehabilitation work in areas of native vegetation;
- storage of topsoil from areas of native vegetation separately to topsoil from adjacent farmland areas;
- no topsoil from previously pastured areas will be used for rehabilitation of native vegetation;
- restriction of grazing and unauthorised 4WD and motorcycle access to the project area.

Completion criteria for weed control will also be developed in the Rehabilitation Plan, in consultation with DEP and CALM.

9. Dieback management

Dieback management procedures will be developed as part of the Rehabilitation Plan. These procedures will aim to protect areas of native vegetation which are dieback free, or are uninterpretable. Examples of dieback management procedures that may be included in the Rehabilitation Plan are:

- Thorough clean down of all machinery before commencing work in areas of native vegetation;
- topsoil from areas of dieback free native vegetation will be stored separately from topsoil from all other sources.
- rehabilitation of dieback free areas will only use topsoil confirmed as originating from dieback free native vegetation.
- restriction of unauthorised 4WD and motorcycle access to the project area.

10. Completion criteria

Completion criteria for state forest will be developed in consultation with DEP and CALM during development of the Rehabilitation Plan, and are likely to address a range of ecosystem components including vegetation, soil profile, groundwater and landform. Targets for the composition of the rehabilitated native vegetation will be set (eg. 95% return of floristic composition, with a minimum of 80%), by comparison with analogue sites in undisturbed areas. These targets will include maximum levels of weed presence allowed, which will also be determined by comparison with analogue monitoring sites.

11. Research into rehabilitation of native vegetation

Widespread bauxite mining within Jarrah forest in WA has stimulated extensive research into the nutrient and water relationships of its vegetation and subsequent implications to site rehabilitation (e.g. Ward and Koch 1996, Hingston *et.al.* 1981, Carbon *et.al.* 1981, Dell *et.al.* 1983, and Ruprecht and Schofield 1990). Cable Sands will draw on this knowledge to facilitate the progressive improvement of its rehabilitation practices in areas requiring re-establishment of native vegetation.

Cable Sands has extensive experience in mine site rehabilitation, and is continuing to develop its

skills in rehabilitation of native vegetation (eg. mining and rehabilitation of Location 13471, Jangardup, Cable Sands 1999b).

Relevant work currently planned by Cable Sands, or in progress, includes:

- preparation of a document including: a review of the current knowledge of forest processes and their relevance to the rehabilitation of native vegetation; a review of current practices for rehabilitation of native vegetation following mineral sands mining; and identification of future techniques which may improve the success of rehabilitation;
- development of a system for the co-disposal of fines and sandy tailings within the mine pit;
- testing of seedling recruitment from varying depths and ages of native vegetation topsoil stockpiles. The use of smoke-water on the respread topsoil will also be tested;
- ongoing native seed viability and germination testing by professional consultants;
- refinement of the block translocation technique.

Commitments

Commitments 3 and 4 (Section 4.3) are relevant.

5.3.5 PREDICTED OUTCOME

Rehabilitation will be implemented to a standard that will meet the EPA's objective. Rehabilitation will result in the development of a stable landform that is revegetated to a standard consistent with the post-mining land use.

5.4 VEGETATION COMMUNITIES

5.4.1 EPA OBJECTIVE

- ♦ Maintain species diversity, geographic distribution and productivity of vegetation communities.

5.4.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The document, *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*, was developed by the Commonwealth of Australia and the states (JANIS 1997). This document proposes that, as a general criterion, 15% of the pre-1750 distribution of each forest ecosystem should be protected in the comprehensive, adequate and representative reserve system.

Three methods have been developed recently for assessing proposals to clear native vegetation. These methods are:

1. Urban Bushland Strategy (Ministry for Planning 1995), prepared principally for the Perth metropolitan area, which prescribed criteria that indicated that the Government's aim is to conserve a minimum of 10 % of each vegetation complex which should be regionally reserved in not less than five separate areas. The highest level of protection is in a Crown Reserve but the Strategy does not dismiss other mechanisms available in the planning system.
2. Environmental Evaluation of Native Vegetation in the Wheatbelt of Western Australia - Principles and Criteria Used to Appraise Land Clearing Proposals (Safstrom and Craig 1996). This method was developed for evaluation of applications to clear land for agricultural

purposes in the Wheatbelt. This method prescribes the following relevant representation criteria for threatened plant communities:

- Local level - remnant vegetation should be retained if, within a 15 km radius, less than 20% of the original cover of any plant community is in national parks and reserves and on other Crown land or Remnant Vegetation Protection Schemes covenants.
 - Regional level - remnant vegetation should be retained if it includes vegetation communities not well conserved in the region compared to the cover represented in the Interim Biogeographical Representation in Australia.
3. Welker Environmental Consultancy (1998) developed the above EPA procedures further by also giving consideration of existing threatening processes that will continue to degrade the conservation values of native vegetation if not given appropriate management.

5.4.3 PREDICTED IMPACT

Clearing requirement

The proposal was specifically designed to avoid areas of high conservation value, and to minimise the overall clearing of native vegetation. Despite these aims, certain practical constraints to mining practice (Table 3) result in the requirement to clear areas of native vegetation.

The reduction in the distribution of native vegetation complexes within the project area as a result of the proposal is detailed in Table 8. On private land 191.3 ha of native vegetation will be cleared, while within state forest 59.3 ha of land will be cleared. This clearing will result in the following impact to the regional representation of vegetation complexes:

- A reduction in the distribution of Whicher Scarp vegetation on Crown and private land from 57% to 54% of its pre-European extent;
- A reduction in the distribution of Whicher Valleys vegetation on Crown and private land from 61% to 55% of its pre-European extent;
- A reduction in the distribution of Cartis vegetation on private land from 12% to 11% of its pre-European extent;
- No significant impact on Kingia or Rosa vegetation;
- No impact on the representation of vegetation complexes within reserves.

In terms of forest ecosystems, the proposed clearing of 250.6 ha from the Jarrah Blackwood ecosystem will result in a reduction to this ecosystem of less than 0.1 %. Eighty-one percent of the pre-1750 distribution (347,200 ha) still remains and 16% of the pre-1750 distribution is retained within formal or informal reserves (Commonwealth of Aust. and WA Government 1998).

Threatening processes

The following processes represent a risk to native vegetation within the project area, and may act to degrade its value in the long term:

- Livestock grazing - cattle entering remnant native vegetation on privately owned land is damaging understorey vegetation by trampling and foraging.
- Adjacent land use - farmland herbicide and fertiliser applications can drift into nearby native vegetation and alter its species composition. Increased populations of vertebrate and invertebrate fauna utilising the farmland pastures, place greater pressure on native vegetation.
- Weeds - the risk of invasive weeds such as *Ehrharta* spp. and *Watsonia* spp. being introduced to areas of native vegetation is increased in areas of private land not subject to special management.

- **Dieback** - without special management, areas of native vegetation within private land may become affected with dieback as a result of uncontrolled access by vehicles or livestock.

5.4.4 MANAGEMENT

The Native Vegetation Protection Strategy, as discussed in Section 4.2, is Cable Sands' principle mechanism for ensuring the EPA objective for vegetation communities is achieved. Aspects of this strategy are discussed further below:

Conservation areas

The conceptual post-mining land use plan (Figure 15) for the project area includes the allocation of 92.0 ha of land for native vegetation conservation. The allocated conservation areas include examples of important vegetation communities, not yet given special legal protection.

As indicated in Table 6, Whicher Valleys vegetation is currently inadequately represented within existing reserves. If the conservation areas are given special legal protection, a 23.4 ha net increase in the protection of Whicher Valleys vegetation would be achieved. This would result in the regional representation of this vegetation in protected areas being increased from 10 % to 15 % of its pre-European distribution.

To ensure these areas are legally protected, one or a combination of the following options will be implemented prior to the proposal proceeding:

1. Placement of conservation covenants over the conservation areas to enforce the exclusion of livestock grazing and other land uses (see Section 4.2.1).
2. Inclusion of part of Conservation Area A into CALM estate

Conservation Area B affects a portion of Location 3829 and Conservation Area A affects land within Location 4485 (Figure 2). Cable Sands currently owns Location 3829 and has secured an agreement with the current owner of Location 4485, for an option to buy this land if the proposal proceeds.

Conservation areas would be fenced off to ensure their long-term protection from unauthorised disturbances. Cable Sands fenced off Conservation Area B for the purpose of livestock exclusion in September 1999.

Native vegetation rehabilitation

Rehabilitation activities that will be undertaken in areas of native vegetation, including dieback and weed control, were discussed earlier (Section 5.3.4). The aim of the rehabilitation program will be to re-establish ecological values in these areas by:

- encouraging a comparable diversity of local native species;
- establishing, over a longer period, a vegetation structure that is compatible with the surrounding environment;
- establishing a comparable density of native species;
- reducing the number, abundance and occurrence of weed species.

Native vegetation rehabilitation will result in the development of vegetation communities comprising a similar range of native species to the current native vegetation. Re-established vegetation will benefit the environment by providing habitat for a range of native flora and fauna species, including those listed as rare or threatened. Where riparian vegetation is to be established within farmland, additional benefits to stream water quality and visual amenity will result.

Commitments

Refer also to environmental management commitments (Commitments 1 and 2, Section 4) and rehabilitation commitments.

3. Cable Sands will provide legal protection for Conservation Areas A and B within M70/899 (see Figure 15) prior to mining.
4. Cable Sands will fence Conservation Areas A and B prior to mining to exclude livestock and unauthorised access.

5.4.5 PREDICTED OUTCOME

The EPA's objective for vegetation communities will be achieved as the proposal will result in a net increase in the protection of native vegetation communities, thus encouraging the long term maintenance of species diversity, geographic distribution and productivity of vegetation communities in the project area.

5.5 DECLARED RARE AND PRIORITY FLORA

5.5.1 EPA OBJECTIVE

- ♦ Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*.

5.5.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

Declared Rare Flora (DRF) are protected by CALM under the provisions of the *Wildlife Conservation Act 1950*. A search of the area to be disturbed for Declared Rare and Priority Flora must be undertaken by suitably qualified professionals. Then, if populations are observed which require disturbance, a "Permit to Take Rare Flora" must be applied for under Section 23F of the Act. Priority Flora are plants placed on a reserve list and are not specially protected under the Act, however they should be managed in a similar manner.

5.5.3 PREDICTED IMPACT

No DRF occur within the project area, thus there will be no impact on DRF.

Seven species of Priority Flora were identified within the project area. The distribution of these species in relation to mining leases is indicated in Figure 12. This map also indicates the distribution of these species within some adjacent parts of the Argyle Forest Block (as requested by Mr K. Atkins, Principal Botanist, CALM, pers. comm.), to improve the knowledge of the distribution of local genotypes of these species.

The approximate level of disturbance is quantified in Table 9 below. The maximum level of disturbance would occur to *Synaphae whicherensis*, with 68 ha removed. However, as this species is widely distributed in the area, this represents only 26 % of the total identified population. The Priority Flora species with the lowest distribution is *Acacia semitrullata* (2.38 ha). Thirty-seven percent of this population will be affected by the proposal.

5.5.4 MANAGEMENT

Populations of Priority Flora have been avoided wherever practical in the mine-planning phase. Those populations that will be affected will be identified for collection of seed or cuttings prior to disturbance. This material will then be included in the rehabilitation programme.

Table 9 Disturbance of Priority Flora within the Gwindinup area shown in Figure 12

Species	Areas not disturbed		Areas disturbed		Total areas (ha)
	(ha)	(%)	(ha)	(%)	
<i>Acacia flagelliformis</i>	2.80	82	0.63	18	3.43
<i>Lambertia multiflora</i> ssp. aff. <i>Darlingensis</i>	7.16	100	0	0	7.16
<i>Synaphea whicherensis</i>	188.73	74	67.99	26	256.72
<i>Jacksonia sparsa</i>	51.86	83	10.40	17	62.26
<i>Acacia semitrullata</i>	1.50	63	0.88	37	2.38
<i>Acacia mooreana</i>	26.60	69	4.35	31	15.38
<i>Boronia humifusa</i>	79.09	82	17.36	18	96.45

None of the affected Priority Flora species are expected to be difficult to regenerate (D. Backshall, ESM, pers. comm.). The *Acacia* species are expected to be easy to harvest and regenerate. Heat treatment will probably be used to encourage germination. *Jacksonia sparsa* will also be regenerated by seed. *Synaphea whicherensis* and *Boronia humifusa* will be regenerated via cuttings. *Lambertia multiflora* ssp. aff. *Darlingensis* is not affected by the proposal.

Prior to disturbance of any Priority Flora, an appropriate management strategy will be developed in consultation with CALM.

Commitments

Commitments 3 and 4, for the development of a Rehabilitation Plan (Section 4.4), are relevant.

5.5.5 PREDICTED OUTCOME

The EPA objective for this factor will be achieved. Any disturbance of Priority Flora within the project area will be undertaken in compliance with the *Wildlife Conservation Act 1950*.

5.6 WETLANDS

5.6.1 EPA OBJECTIVE

- ♦ Maintain the integrity, functions and environmental values of wetlands.

5.6.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The relevant assessment standard for this factor is the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*. The purpose of this policy is to protect the environmental values of lakes and wetlands on the Swan Coastal Plain.

5.6.3 PREDICTED IMPACT

Protected wetlands

Wetlands of the Swan Coastal Plain were comprehensively studied in a joint project by the Water Authority of Western Australia and the DEP. Mapping relevant to the project area is included in Hill *et al.* (1996). This mapping information is shown in Figure 11 and confirms that no wetlands protected by the EPP or by CALM, occur within, or near to, the project area. Consequently, no impact to any protected wetlands will occur.

Other wetlands

Approximately 200 ha of sumpland, floodplain and palusplain occurring on the western side of the project area will be affected by the proposal. These areas consist of farmland and bluegum plantations which are of negligible conservation value (Section 3.7.3). As a consequence of the lack of existing native vegetation, and the continued use of these areas for agricultural production, these wetlands are considered to have few attributes that are still important to wetland function. Management objectives relating to these areas should instead be focused on water quality protection (discussed in Section 6.2.4).

Alteration of water regimes

The Gwindinup minesites will use dry mining techniques and will not require active dewatering. Only slow rates of seepage may occur into the mine pit. This water can be directed into the process circuit. Cable Sands' experience with similar mine sites at Yarloop and Bengier has shown negligible effects on groundwater levels surrounding the mining areas. Thus any impacts on wetland vegetation or native vegetation surrounding minesite areas are expected to be negligible.

Abstraction of water from the Yarragadee aquifer will not affect wetlands at Gwindinup as there is negligible hydraulic connection between the aquifer and surface waters. The Yarragadee aquifer is located at a depth of 600-1200 m (as discussed in Section 3.5.3) and is confined by silt and clay layers of low hydraulic conductivity.

5.6.4 MANAGEMENT

Management procedures for groundwater quality (Section 6.1.4) and surface water quality (Section 6.2.4) will be observed to ensure the environmental values of water systems in the area are maintained.

5.6.5 PREDICTED OUTCOME

The EPA objective for this factor will be achieved. No protected wetlands, or other wetlands of conservation value, will be affected by the proposal. The environmental values of other wetlands affected by the proposal will not be significantly reduced.

5.7 FAUNA

5.7.1 EPA OBJECTIVE

- ♦ To maintain the abundance, species diversity and geographical distribution of fauna.

5.7.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this factor is the EPA objective.

5.7.3 PREDICTED IMPACT

Although some fauna will be directly affected by the clearance of native vegetation, large areas of comparable fauna habitat lie within state forest adjacent to the proposed mine area. It is anticipated that a large proportion of the affected fauna will move into these areas. In cases where fauna are located in cryptic locations (eg. burrows), or are relatively immobile, some losses may be unavoidable.

The presence of aquatic invertebrate fauna is likely to be limited by the seasonal flow characteristics of streams occurring within the project area.

The risk of indirect fauna losses due to traffic should also be considered. Cable Sand's previous experience indicates this risk is likely to be low. Access to the mine site would be through existing roads in agricultural land. As a 30 km/h speed limit would be imposed for internal roads, this risk is thought to be minimal.

Overall, it is not expected that the proposal will adversely affect the abundance, species diversity and geographical distribution of fauna in the region. Nevertheless, it is still desirable to manage the mining operation so that fauna losses are minimised.

5.7.4 MANAGEMENT

The primary mechanism for protection of native fauna will be by implementation of Cable Sands' Native Vegetation Protection Strategy (Section 4.2).

Where clearing of native vegetation is necessary, progressive rehabilitation of mined areas, as they become available, will lead to the redevelopment of fauna habitat which will allow fauna to migrate back into these areas as soon as possible. Retention of non-commercial timber for inclusion as habitat during the rehabilitation phase will provide additional niches that will encourage the dispersion of native fauna into rehabilitated areas.

Commitments

Environmental management commitments (Section 4) and commitments for vegetation communities (Section 5.3) are relevant.

5.7.5 PREDICTED OUTCOME

The EPA's objective for fauna will be achieved. The long term abundance, diversity and distribution of native fauna in the area will be protected by careful management of habitat. In the first instance this management includes avoidance, and where disturbance is necessary, habitat reconstruction during the rehabilitation phase.

5.8 SPECIALLY PROTECTED (THREATENED) AND PRIORITY FAUNA

5.8.1 EPA OBJECTIVE

- ♦ To protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950*.

5.8.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

Threatened Fauna are protected by CALM under the provisions of the *Wildlife Conservation Act 1950*. A search of the area to be disturbed for Threatened Fauna must be undertaken by suitably qualified professionals.

5.8.3 PREDICTED IMPACT

No Threatened or Priority Fauna are expected to be directly killed during minesite development. Threatened and Priority Fauna which are expected to occur within the project area (see Section 3.8.6) are all relatively mobile (e.g. the Chuditch, the Long and Short-billed Black Cockatoos, and the Western Brush Wallaby), thus it is anticipated that individual animals will move out of the area as mining activities commence. Large areas of suitable fauna habitat in state forest adjacent to the proposed mine area will provide refuge for these animals.

The only immobile species listed as Threatened or Priority Fauna in the region was the freshwater mussel, *Westralunio carteri*. Searches of the area did not observe this species, or any suitable habitat for this species (Bamford 2000), thus no impact to this species is anticipated.

5.8.4 MANAGEMENT

The primary mechanism for protection of Threatened and Priority Fauna, will be implementation of Cable Sands' Native Vegetation Protection Strategy (see Section 4.2).

Where clearing of native vegetation is necessary, progressive rehabilitation of mined areas, as they become available, will lead to the redevelopment of fauna habitat which will allow fauna to migrate back into these areas as soon as possible.

Criteria developed by CALM for planning of forestry operations, will also be adopted where practical (Abbott and Christensen 1995). Large trees containing suitable hollows may provide nesting sites for Priority Fauna such as the Red-tailed Black Cockatoo and the Brush-tailed Phascogale. Where practical, occasional examples of these trees will be retained within infrastructure areas. Thus, while fauna may move away from the area during operations, these trees will provide refuges that encourage their return on completion of mining. Preservation of occasional habitat trees may also provide benefits to visual amenity, as discussed in Section 6.1.

Cable Sands' existing contribution to the "Western Shield" fox control programme has helped protect Threatened Fauna. This programme is thought to be responsible for the increased prevalence in the project area of species such as the Chuditch, the Brush-tailed Phascogale and the Southern Brown Bandicoot (Bamford 2000).

Commitments

Environmental management commitments (Section 4) and commitments for vegetation communities (Section 5.3) are relevant.

5.8.5 PREDICTED OUTCOME

The EPA's objective for Specially Protected (Threatened) and Priority Fauna will be achieved. These fauna will be protected by careful management of their habitat. In the first instance this management includes avoidance, and where disturbance is necessary, habitat reconstruction during the rehabilitation phase.

6 Pollution Management

6.1 GROUNDWATER QUALITY

6.1.1 EPA OBJECTIVE

- Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA 1993).

6.1.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard is the draft WA Guidelines for Fresh and Marine Waters (EPA 1993).

6.1.3 PREDICTED IMPACTS

Groundwater in the Yarragadee Aquifer is typically used for mining purposes. As discussed earlier (Section 3.5.3), Cable Sands has negotiated with the WRC for an allocation of 2,900 ML per year from this aquifer. This allocation will result in the Yarragadee Aquifer in the Capel-Ludlow Subarea being fully allocated. The allocation was facilitated by a study into Yarragadee Formation groundwater allocations for the mineral sands industry in the Capel area (Dames & Moore 1998), and after extensive consultation with the WRC. Consequently, it is not expected that utilisation of this allocation will affect other users of the aquifer. Monitoring of groundwater levels will provide an early indication of any adverse impacts and will allow appropriate responses by Cable Sands and the WRC to be implemented.

Abstraction of groundwater from the Yarragadee Aquifer will not affect other aquifers as, in the Gwindinup area, it is separated from the Leederville and superficial aquifers by confining layers of low hydraulic conductivity.

Groundwater in the Leederville Aquifer is typically used for agricultural purposes, including crop irrigation, while superficial groundwater in the area is used mainly for livestock water. Groundwater quality in these aquifers will not be affected by the mining operations as thick clay/silt layers, which are of low hydraulic conductivity, provide an effective barrier between the mining operations and the aquifers. Some clayey material suspended in the mining area may enter the superficial sediments, but would be rapidly filtered out. The salinity of process water from the Yarragadee aquifer is generally lower than that of the superficial aquifer (< 500 mg/L versus ca. 1,000 mg/L respectively, WAWA 1995); thus no adverse effect on superficial groundwater salinity is expected.

As the Gwindinup deposits are located low in the landscape, near the base of the Whicher Scarp, they are expected to intercept the superficial aquifer. Cable Sands' experience at the Yarloop, Benger and Waroona minesites indicates that no active mine pit dewatering will be required. Due to the low hydraulic conductivity of the superficial sediments, only minor seepage into the mine pit is anticipated. This water will be incorporated into the process water circuit. As the hydraulic conductivity is low, groundwater drawdown associated with this seepage is typically negligible.

The Happy Valley deposits are located higher in the landscape and are unlikely to intercept the superficial groundwater.

The risk of groundwater contamination by hydrocarbon spillage should be managed. Management procedures are indicated below which aim to control this risk. Similar procedures have been used to manage this risk satisfactorily to date at Cable Sands' Yarloop and Bengier minesites.

Acid Sulfate Soils

Samples from exploratory drilling of the Gwindinup and Happy Valley Deposits were analysed by a NATA (National Accredited Testing Authority) accredited laboratory for total sulphur during 1999. The results from this testing are summarised in Table 10 below. The results indicate that substrates in the Gwindinup and Happy Valley deposits have negligible potential for acid generation. Total sulphur levels are usually below 0.03%, which is recommended as a management trigger level for total oxidisable sulphur in the *Acid Sulfate Soil Manual* (Stone *et al.* 1998). This manual has been developed in the eastern states of Australia, where extensive drainage of land for agriculture has created acid drainage problems. The applicability of this manual to Western Australian conditions has not yet been determined.

Samples exceeding 0.03% total sulphur were as follows:

- Two samples with 0.031% total sulphur. Given the depositional environment, these samples are likely to be associated with laterite rock and are unlikely to be indicative of potential acid sulfate soils.
- One sample with 0.039% total sulphur. This sample was located at 3m depth and is well above the water table. Consequently, it is likely that this material has already been oxidised and has no acid forming potential.
- One sample with 0.042% total sulphur. This sample was located at a depth of 21m and was 12m below the orebody at this point.

Table 10 Total sulphur analysis for the Gwindinup and Happy Valley deposits

Depth (m)	Total Sulphur (%w/w)			No. of samples
	Mean	Minimum	Maximum	
3	0.022	0.013	0.039	8
6	0.021	0.007	0.028	8
9	0.021	0.005	0.031	8
12	0.020	0.013	0.030	8
15	0.019	0.012	0.027	6
18	0.019	0.014	0.024	5
21	0.025	0.015	0.042	3
Total:	0.021	0.005	0.042	46

As discussed in Section 3.3, the specific environmental conditions required for the generation of acid sulfate soils have not occurred along the Whicher and Darling Scarps. As a result of this knowledge, and confirmation by laboratory analysis, the risk of process water becoming acidic is considered to be negligible.

6.1.4 MANAGEMENT

A groundwater monitoring programme will be developed to ensure that the level and quality of groundwater in the vicinity of the proposal can be closely scrutinised. As currently occurs at other Cable Sands' minesites, these results will be presented in the company's Annual Environmental

Report and other statutory reports. The DEP and the WRC will review these reports.

Abstraction will be managed according to a WRC Groundwater Well Licence that will specify conditions of operation. An Operating Strategy will be developed in consultation with the WRC.

Hydrocarbons will be stored in impermeable bunded areas capable of holding 110% of the largest vessel capacity. The barrier used is likely to be either concrete or a synthetic liner.

Ground Water Quality Commitments

5. Cable Sands will develop a groundwater and surface water monitoring programme prior to and during mining.
6. Cable Sands will develop an Operating Strategy for groundwater abstraction prior to and during mining.

6.1.5 PREDICTED OUTCOME

The EPA's objective for groundwater quality will be achieved.

6.2 SURFACE WATER QUALITY

6.2.1 EPA OBJECTIVES

Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance, are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA 1993).

6.2.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard is the draft WA Guidelines for Fresh and Marine Waters (EPA 1993). The environmental values for which these guidelines apply are:

1. Protection of aquatic ecosystems.
2. Agricultural water use.

6.2.3 PREDICTED IMPACTS

Surface waters will not be used for any on-site processing or mining operations. A deep bore into the Yarragadee Aquifer will supply these water requirements. Potential impacts on this water resource are discussed earlier (Section 6.1.3). To facilitate the management of storm water, surface runoff originating from within the mining area may at times be directed into the process water circuit (see following section).

The proposal is located within the Capel River catchment, transposing the upper tributaries of Gynudup Brook (Figure 8). These tributaries are seasonal, only tending to flow during the winter months. These tributaries also currently receive drainage from agricultural land uses.

Potential risks to surface waters in Gynudup Brook as a result of the proposal would be transmitted downstream to the Capel River. Any such impacts would tend to be reduced with distance from the mine site as a result of dilution with other water sources.

The adjacent catchment for the Preston River will not receive runoff from the minesite areas. Consequently, there is negligible risk of polluted surface water from minesite areas entering into their streams.

Potential sources of surface water contamination, which are discussed in the following section, are:

- turbid water developed by disturbance of existing streams;
- turbid water from the processing of mineral sands ore;
- leachates from sewerage systems or other wastes;
- hydrocarbon spillage associated with fuel storage or machinery operation.

These risks occur at Cable Sands' Yarloop and Bengier minesites and have been managed satisfactorily to date. Management procedures, such as those used at Bengier and Yarloop, will be implemented to control these risks.

Acid Sulfate Soils

As discussed in Section 3.3, the specific environmental conditions required for the generation of acid sulfate soils have not occurred along the Whicher and Darling Scarps. As a result of this knowledge, and confirmation by laboratory analysis (Table 10), the risk of process water becoming acidic is considered to be negligible.

6.2.4 MANAGEMENT

Stream disturbance

Surface water flows downstream of the minesite will be maintained during the mining phase by diversion of drainage lines and surface runoff to avoid mine pits, stockpiles and other infrastructure. Bunds used to divert surface runoff around mining areas will incorporate sediment basins that will attenuate flows and reduce sediment loads. These flows will not include minesite runoff (surface runoff within areas disturbed by mining activities) and will not be incorporated into the process water circuit.

Disturbed areas subject to surface water flows will be subject to more intensive planning and rehabilitation. The design of new drainage lines will be carefully planned to reduce any risk of erosion. For example, to avoid concentration of stream flows, drainage densities and stream bed widths should be maintained at pre-mining levels or greater.

Special erosion control measures will be used in areas at risk of erosion. These measures may include using oversize material to rock mulch exposed streamside banks, stabilising streamside banks with brush harvested during clearing operations, and using commercial erosion control products (eg. geotextile) to stabilise banks.

During the rehabilitation phase, riparian strips of native vegetation will be developed in farmland areas (see Figure 15). These strips will provide a buffer that will help reduce current nutrient loads to Gynudup Brook resulting from agricultural land use.

Minesite runoff

Minesite water will be recycled for use in the mining and processing of mineral sands (process water circuit) where possible. This process water circuit is expected to be able to accommodate most winter storms as water storage and fines dams will provide a significant buffering capacity. If offsite discharge of minesite water is required during larger rainfall events, it will be restricted to clear overflow from water storage dams during winter or decanting of settled water from fines dams. These discharges will be routinely handled by a DEP licence, which will typically set water quality limits in terms of pH, electrical conductivity and suspended solids. Any discharges will be subject to appropriate monitoring (usually daily).

Waste disposal

A sewerage system approved by the Capel Shire will be installed. Consequently, the risk of pollution from sewerage will be no greater than from other land uses in the region. Other wastes will be removed from site and disposed of at a DEP approved waste disposal facility.

Hydrocarbon spillage

Hydrocarbons will be stored in bunded areas capable of holding 110% of the largest vessel capacity. An impermeable barrier, such as concrete or a synthetic liner, will be used to contain any spilt hydrocarbons.

Hydrocarbon spillage procedures form a component of Cable Sands' EMS. Staff training reinforces these procedures. Following clean up of a spillage, any contaminated materials will be disposed of at a DEP approved waste disposal facility.

Commitments

Commitment 5 in Section 6.1.4 is directly relevant. Commitments 1 and 2 in Section 4 will also facilitate management and protection of surface water quality.

6.2.5 PREDICTED OUTCOME

The EPA's objective for surface water quality will be achieved. An additional benefit to catchment management in the region will be the development of riparian zones of native vegetation in farmland areas.

6.3 DUST

6.3.1 EPA OBJECTIVES

- ♦ Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem.
- ♦ Use all practicable measures to minimise the discharge of particulate wastes.

6.3.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The proposed National Environmental Protection Measure (NEPM) for particulate of a mean particle diameter of 10 µm or less is 50 µg/m³ for an averaging period of 1 day.

Current operating minesites have a DEP licence limit of 1000 µg/m³ when measured as the difference between levels upwind and downwind of the mining operations.

6.3.3 PREDICTED IMPACT

The area for assessment of this environmental factor is the area surrounding the proposal and includes nearby residences (see Figure 16).

Cable Sand's experience at its Yarloop, Waroona and Bengier mine sites indicates that the major concern with dust generation relates to the transportation of heavy mineral concentrate on internal gravel roads. Another possible cause of dust generation will be the removal of topsoil and overburden. At greater depths in the mine pit, airflow is reduced and soil moisture levels are higher, thus the potential for dust generation is lessened.

Dust generated by muddy vehicles leaving the minesite and tracking mud onto sealed public roads is expected to be minimal and will not result in any significant impact. The road from the minesite entrance to the site offices will also be sealed, thus any mud on vehicle tyres is likely to have been deposited before the vehicles leave the minesite area.

Overall, it is predicted that the consequence of any dust generated by minesite activities would be relatively low due to the low density of residential housing in the immediate area. At Cable Sands' Yarloop, Waroona and Bengier mine sites, occasional dust complaints have been received from neighbours immediately adjacent to mining activities. It has been possible to quickly resolve these issues by modification of mining activities.

6.3.4 MANAGEMENT

Dust generation from traffic on unsealed internal roads will be minimised through a wetting down dust control programme involving the use of a water cart during the summer months.

Dust generation from other sources is reduced by minimising the areas disturbed, restricting dust generating activities on excessively windy days and rehabilitating as soon as practical after mining has passed. Topsoil stockpiles are vegetated, and fines and sealing agents are used on disturbed areas, to reduce the amount of material available as dust. Where possible the establishment of vegetation screens will also assist in reducing dust problems. These steps have proven to be effective in minimising dust at Cable Sands' Yarloop, Waroona and Bengier mine sites.

Previous experience also indicates that if dust complaints are received, Cable Sands will be able to quickly resolve the issue by modification of mining activities. If required an action plan may be developed as part of the companies EMS, to prevent re-occurrence of dust problems.

Commitments

Environmental management commitments 1 and 2 (Section 4.3) are relevant.

6.3.5 PREDICTED OUTCOME

The EPA's objective for dust will be achieved.

6.4 NOISE

6.4.1 EPA OBJECTIVE

- ♦ Ensure that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.

6.4.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The applicable assessment standard is the *Environmental Protection (Noise) Regulations 1997*.

The regulations specify general noise limits within 15m of a noise sensitive premise, but these limits may be adjusted in accordance with influencing factors such as the proximity of industrial and commercial land and major roads (eg. South West Highway).

6.4.3 NOISE SURVEY

A survey of background noise was undertaken between 23 July and 20 September 1999 by Cable

Sands' DME registered Noise Officer. Methodologies and equipment were used which comply with the *Environmental Protection (Noise) Regulations 1997* and relevant Australian Standards. Calibration of noise measuring equipment was also undertaken in compliance with the above standards.

Noise survey sites are indicated in Figure 16. Sites were chosen to provide an indication of background noise levels currently experienced by rural residences in the area. Consequently, no sites were established in areas of state forest. Instead, a range of sites was selected in areas where rural residences occur.

The survey results shown in Table 11 indicate relatively high background noise levels. These results indicate higher background noise levels in the northern half of the project area (Sites 1-3) while noise levels in the southern half of the project area (Sites 4-6) were somewhat lessened.

L₁₀ measurements ranged from a low of 32.4 dB at Sites 3 and 5, to a high of 53 dB at Site 2. Maximum noise levels exceeding 50dB were measured at Sites 1-3, with the highest noise level being 68.3 dB at Site 2.

Noise was identified as emanating from several sources. Intermittent noise sources were primarily attributable to road traffic (particularly from the South Western Highway), agricultural machinery and livestock. These noise sources are responsible for the high levels measured in the northern half of the project area. Tonal noise references were generally attributable to bird, frog and insect noise.

Table 11 Results of baseline study of existing noise (dB)

Data recorded by Cable Sands' DME registered Noise Officer

		Date					
		23-Jul	30-Jul	6-Aug	27-Aug	17-Sep	20-Sep
Measuring period:		8:30-9:15	14:10-16:00	9:30-10:20	10:30-11:15	10:00-10:50	12:00-13:00
Site 1	L ₁₀	48.8	49.4	46.6	48.6	40.5	47.2
	L ₁	48.2	49.1	45	46.2	37	46
	L _{max}	50.8	50.1	48.8	49.5	43.2	47.9
Site 2	L ₁₀	50.8	33	66.6	44.8	41	48.4
	L ₁	42.4	37.8	53	51.4	36	45.6
	L _{max}	54.2	40.8	68.3	45.3	44	50.6
Site 3	L ₁₀	55.6	43	55.6	47.2	38.2	48
	L ₁	48.6	39.8	51.4	42.6	32.4	41.2
	L _{max}	56.6	43.6	56.9	49.1	41	49.3
Site 4	L ₁₀	39.6	39.4	47	45.8	40.8	51.2
	L ₁	37	38	44.2	41.6	36.8	41
	L _{max}	44.1	40.1	50.1	47.4	42.4	54.4
Site 5	L ₁₀	43.8	32.8	42.2	38.8	42	36.6
	L ₁	38.4	32.4	34.6	37.8	40.2	35
	L _{max}	47.3	37.8	44.3	39.3	45.2	38.7
Site 6	L ₁₀	44.8	35.6	42.6	43.4	41.6	40
	L ₁	43.2	38.9	39.2	41.8	38.6	39
	L _{max}	46.1	40.1	45	43.9	43.7	41

Note:

L₁₀ = background noise level occurring 10% of the time

L₁ = background noise level which occurring 1% of the time

L_{max} = maximum background noise level

6.4.4 PREDICTED IMPACTS

The relatively isolated location of the proposed mine limits the potential to inconvenience surrounding land users. Figure 16 reveals that due to the rural land use surrounding the project area, there will be few residences that would be affected by the mining activities. The closest residences to the proposal, which may be occupied during mining operations, are located at distances of 150-500 m.

Table 11 indicates relatively high pre-existing noise levels as a result of traffic noise and farming activities. These pre-existing conditions lessen the net impact of any noise that may arise from minesite operations. Consequently, calculated values below 40dB are not considered relevant as activities external to mining would elevate background noise levels above this value in the immediate area. This situation has been common at Cable Sands' Benger and Yarloop mine sites.

The major potential for noise pollution is through earthmoving machinery during minesite development. Additional noise from mineral processing will be limited due to the predominance of electrically driven plant equipment. Actual noise levels measured under worst case conditions at the Yarloop minesite are given in Table 12 (Cable Sands 1999c). Similar noise generating conditions to Yarloop are expected to occur at Gwindinup. These noise levels were extrapolated to reflect greater distances between noise sources and noise sensitive premises. These calculated levels (500-1000m) are all well below the assigned noise levels.

Assigned noise levels for the closest residence may be exceeded for a short period when a fines dam will be constructed. This dam will be located at a distance of approximately 150-200m from the residence. During normal operation of the mine site, earthmoving machinery will be operating at a distance in excess of 500m, thus the assigned noise levels are not expected to be exceeded.

Table 12 Assigned noise levels and noise level estimates for the Gwindinup mine

	Assigned Noise Levels ¹	Typical worst case operating levels ²				
		150m	300m	500m	750m	1000m
Daytime						
L _{A10}	45	47	41	37	33	31
L _{A1}	55	55	49	45	41	39
L _{Amax}	65	61	55	51	47	45
19-22						
L _{A10}	40	42	36	32	28	26
L _{A1}	50	46	40	36	32	30
L _{Amax}	55	58	52	48	44	42
22-7						
L _{A10}	35	39	33	29	25	23
L _{A1}	45	43	37	33	29	27
L _{Amax}	55	45	39	35	31	29

Note:

L_{A10} = assigned noise level which is not exceeded for more than 10% of the time

L_{A1} = assigned noise level which is not exceeded for more than 1% of the time

L_{Amax} = assigned noise level which is not exceeded at any time

¹ No influencing factors included

² Recorded data from Cable Sands' Yarloop mine site (Cable Sands 1999c)

³ Calculated level = level at 150m -log₁₀(distance/150)*20 (Bies and Hansen 1988)

6.4.5 MANAGEMENT

As is the normal practice with Cable Sands operations, the following procedures will be implemented to reduce any noise impacts:

- ♦ Restriction of night-time earthmoving operations to within the pit where-ever practical.
- ♦ Substitution of flashing lights for reversing beepers at night-time, subject to approval from the Department of Minerals and Energy.
- ♦ Fitting of upgraded acoustic engine and exhaust noise suppression equipment to all Cable Sands' earthmoving machinery working outside daylight hours.
- ♦ Construction of noise reducing bunding, using topsoil stockpiles where appropriate.

Additional actions, to reduce noise associated with rattling of empty trailers on unsealed minesite roads are:

- ♦ limiting speed on internal minesite roads to 30 km/h;
- ♦ mounting HMC containers to trailer chassis by rubber blocks;
- ♦ locking down containers are during transport.

To help facilitate the implementation of the above management actions, Cable Sands' minesite workforce will be educated in noise awareness.

Commitments

Environmental management commitments 1 and 2 (Section 4.3) are relevant.

6.4.6 PREDICTED OUTCOME

The EPA's objective for noise will be achieved by adhering to the management practices and commitments indicated above.

6.5 RADIATION

6.5.1 CABLE SANDS OBJECTIVE

No EPA objective is specified. Cable Sands' objective is to monitor and maintain acceptable radiation levels in rehabilitation areas, consistent with DME standards.

6.5.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

Maintain gamma radiation levels at or below background levels (as determined by a pre-mining survey).

6.5.3 PREDICTED IMPACT

Preliminary gamma radiation surveys indicate that surface radiation levels within the project area are very low, ranging from 0 to 0.13 $\mu\text{G/hr}$ with a median value of 0.03 $\mu\text{G/hr}$. These levels are typical of the Swan Coastal Plain and do not represent a safety hazard. Extensive volumes of overburden that overlie the mineral deposit naturally insulate and reduce natural gamma radiation experienced at ground level.

Primary (or mine) tailings that are returned to the mined out area will have a reduced level of

radioactive content. Experience with similar mining operations indicates a reduction in gamma radiation levels in the post-mining landscape will occur under normal conditions.

Secondary (or mill) tailings that are to be returned to the mine pit (see Section 2.3.4) will be of comparable radioactivity to the mined materials. Return of these tailings to the mine pit will not increase the existing surface radiation levels in the area, thus no special management procedures are required.

Also being returned to the mined out areas will be small volumes of monazite tailings. These tailings will contain radioactive elements (ca. 180ppm Uranium and 2300ppm Thorium, Cable Sands 1999a). Management procedures for the transport and disposal of this material, within mine pits at Gwindinup, are indicated in the following section.

6.5.4 MANAGEMENT

Cable Sands will manage monazite tailings in a manner approved by the DME.

Standard radiation management procedures used for mining, stockpiling and mineral transport at existing minesites are documented in Cable Sands' *Radiation Management Plan* (Cable Sands 1999a), which has been reviewed and approved by DME. These procedures include the following:

- Trucking will utilise full all-weather tarps, sealed tailgates and radiation signposting conforming with the *Code of Practice for the Safe Transport of Radioactive Substances* (Commonwealth of Australia 1990).
- Specialised Dangerous Goods (Radioactives) training is given to drivers transporting monazite tails to the site of disposal.
- Emergency instructions for the management of monazite tails spillage will be contained within each vehicle.

Subject to approval by DME, it is anticipated that Cable Sands will dispose of monazite tails by dilution with the mine tails. The objective will be to ensure there is no restriction to future land use options, by returning surface radiation levels of the rehabilitated minesite to pre-mining levels or less.

Commitments

Environmental management commitments 1 and 2 (Section 4.3) are relevant.

6.5.5 PREDICTED OUTCOME

The proposal will not result in any adverse impacts to the surrounding environment as a result of radiation.

6.6 GREENHOUSE GASES

6.6.1 EPA OBJECTIVES

Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem.

Use all reasonable and practicable measures to minimise the discharge of greenhouse gases.

6.6.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The applicable assessment standard is the interim EPA guidance statement, *Minimising Greenhouse Gas Emissions* (1998).

6.6.3 PREDICTED IMPACT

The impact of greenhouse gases are of a global scale and are not restricted to the local or regional environment (EPA, 1997).

The implementation of the proposal would result in the emission of carbon dioxide, a greenhouse gas, either directly or indirectly as result of the following activities:

- ◆ consumption of electricity generated from the combustion of Collie coal;
- ◆ internal combustion engines in mining equipment and vehicles;
- ◆ clearing and subsequent decomposition of vegetation.

The anticipated emissions of carbon dioxide from the consumption of electricity and combustion of fuels are likely to be as follows:

- ◆ about 5.5 kt/a of carbon dioxide based on electricity consumption of 5 GWh/a; and
- ◆ about 4.9 kt/a of carbon dioxide based on a diesel fuel consumption of 1,700 kL/a.

These emissions are equivalent to emissions from the current operating mine sites. Emissions from these sites will cease when operations move to Gwindinup.

The proposal will result in the clearance of approximately 250.6 ha of native vegetation and the rehabilitation of 201.6 ha of native vegetation. Rehabilitation will provide a sink that will help offset carbon dioxide released as a result of clearing. Commercial timber salvaged from the clearing operations may be used for furniture or building materials, thus providing an additional sink for carbon dioxide. Consequently, the net impact on carbon dioxide emissions, as a result of clearing, is expected to be negligible.

6.6.4 MANAGEMENT

The proposal is not a significant source of greenhouse gases given the small amount of greenhouse gases (10.4 kt/a) that are released. The emissions are less than 0.02 % of the total emissions of these gases from Western Australia in 1990 (60,000 kt/a (DEP, 1997)). Nonetheless, the proponent is committed, through energy efficiency measures, to reduce as far as is practicable greenhouse gas emissions.

All staff at Cable Sands are given regular environmental training as a requirement of the EMS. This training focuses on improving energy efficiency within the workplace by reducing the consumption of electricity and fuel, and by encouraging recycling of materials.

6.6.5 PREDICTED OUTCOME

The EPA's objective for greenhouse gases will be achieved by adhering to the management practices indicated above.

7 Social Surroundings: Impacts and Management

7.1 VISUAL AMENITY

7.1.1 EPA OBJECTIVE

- ♦ Visual amenity of the area adjacent to the project should not be unduly affected by the proposal.

7.1.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this factor is the EPA objective.

7.1.3 PREDICTED IMPACT

Assessment of this factor was undertaken by evaluation of aerial photographs and topographic maps, as well as physical inspections of the area.

The proposed mining operations are located on westerly and north-westerly facing slopes of the Whicher Scarp, thus it will be visible to farmland areas in these directions. The minesites are not expected to interrupt the skyline, and remnant trees will tend to screen or partially screen the mining operations. Consequently, the impact of the mine on the visual amenity of surrounding farm households is not expected to be severe.

The town of Boyanup is located north of the project area and will not be able to view the Happy Valley or Gwindinup South minesites. The Gwindinup North minesite is expected to be obscured from view by the local topography and remnant roadside vegetation. The impact to visual amenity on residents in Boyanup is therefore considered to be negligible.

The South Western Highway follows the valley of the Preston River, which incises into the Whicher Scarp east of the project area. The geomorphology results in the project area not generally being visible from the highway, thus the proposal will have no impact on the visual amenity of its users.

7.1.4 MANAGEMENT

Due to the negligible impacts, no special management for visual amenity is considered necessary. However, certain practices will be implemented as part of normal operating procedures, which will provide benefits to visual amenity in the area.

Vegetation screening, in the form of shelterbelts, will be established in strategic locations. Overburden and topsoil stockpiles will be placed so as to obscure the view of mining operations to users of local roads west of the project area.

Some native trees within the Happy Valley minesite areas will be retained for fauna habitat purposes. These trees will also provide benefits to visual amenity by disrupting the visual continuity of the mining operations.

Commitment

7. Cable Sands will plant shelter belts prior to mining to enhance the visual amenity of areas adjacent to the project.

7.1.5 PREDICTED OUTCOME

The EPA's objective for visual amenity will be achieved, as the visual amenity of the area will not be unduly affected.

7.2 ROAD TRANSPORTATION/TRAFFIC**7.2.1 EPA OBJECTIVES**

- ◆ Ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings.
- ◆ Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.

7.2.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for this factor is the EPA objective.

7.2.3 EVALUATION OF PREFERRED HAULAGE ROUTE

Haulage route options are described in Section 2.6.2 and illustrated in

Figure 5. The final route was chosen on the basis of capital requirements for road upgrades and its impact on transport operating costs, with likely environmental impacts (including noise) also considered.

As a result of the high capital and operating costs that would be incurred, the least favourable route is the Boundary-Stratham Route (Option 2). The Boyanup West Road, Boundary road and an acutely angled intersection between Railway Road and Boyanup West Road would require upgrading. At 39.6 km long this route is 6.2 km longer than the shortest route.

The Gavin's-Capel Route (Option 4) would require the least capital costs for road upgrading, as parts of Gavin's Road are already used for haulage between the Iluka's Yoganup Extended Mine and its refinery in Capel. Despite this benefit, this route is not favoured as it requires the longest haulage distance and would result in an unacceptably high operating cost over the life of the project.

The preferred haulage route on the basis of an economic analysis of capital and operating costs is the Lowrie-Boyanup Route (Option 3), however MRWA have indicated concern over the safety of the Lowrie Road/South West Highway intersection, due to the close proximity of a railway crossing. Consequently, the Boundary-Boyanup Route (Option 1) has been selected as the preferred haulage route.

7.2.4 PREDICTED IMPACT

Boundary Road

Only a few scattered residences are located along the Boundary Road section of the proposed haulage route (the Boundary-Boyanup Route). These residences will experience an average increase in heavy haulage of approximately 6-12 truckloads per day as a result of the proposal. During batch runs this frequency may increase to approximately 20 truckloads per day.

Railway Road

The Railway Road section of the route has historically received heavy traffic travelling between Iluka's Yoganup North Mine and Capel. As the Yoganup North Mine has now ceased operating, there would be no net increase in heavy haulage on this section of the road above the previous level.

South Western Highway/Robertson Drive/Koombana Drive

The South Western Highway, Robertson Drive and Koombana Drive are MRWA approved heavy haulage routes which currently receive heavy traffic from a number of sources, including the mineral sands industry. Additional traffic to these roads arising as a result of the proposal will be relatively small and any additional impacts are considered to be negligible.

7.2.5 MANAGEMENT

Railway Road, Boundary Road and the South Western Highway are gazetted as heavy haulage routes by MRWA. Consequently, these roads are appropriate for the haulage of Cable Sands' HMC and do not require special management.

The South Western Highway and Railway Road are currently in suitable condition for heavy haulage. Upgrading of Boundary Road by Cable Sands will ensure a road surface is provided that will provide an adequate level of service and safety for the increased volume of traffic on the road as a result of the proposal.

During weekends and public holidays roadside residences tend to have a higher rate of occupancy and a consequent increased sensitivity to traffic noise. To reduce traffic noise where practical, HMC haulage is avoided during these periods. Avoidance of haulage during weekends and public holidays also reduces a potential traffic hazard resulting from increased recreational traffic flow. As the North Shore dry separation plant requires a constant supply of HMC, haulage is reduced by implementing a batch run during working days preceding these periods.

Safety awareness training will be provided to truck operators travelling between Gwindinup and Bunbury. This training will be directed at providing an awareness of any school bus drop off points in the Gwindinup area.

Cable Sands HMC haulage is performed by European designed trucks. Cable Sands experience with previous mining operations has shown these type of trucks produce lower noise emissions than comparably sized trucks of American design.

Cable Sand's experience with heavy haulage at its existing minesites has shown that elevated noise levels are usually associated with rattling of empty trailers on the way to the minesite. This is particularly evident on unsealed internal minesite roads where uneven surfaces cause increased vibration levels. Management actions which will be implemented, and which have been effective at existing minesites, are:

- limiting speed on internal minesite roads to 30 km/h;
- fitting rubber blocks where the HMC containers are mounted to the trailer chassis;

- locking down of trailer containers to the trailer chassis during transport.

Issues relating to the transport of monazite tailings were discussed earlier in Section 6.5.

7.2.6 PREDICTED OUTCOME

The EPA's objective for road transportation/traffic will be achieved by adhering to the management practices and commitments indicated above.

7.3 CULTURE AND HERITAGE

7.3.1 EPA OBJECTIVES

- ♦ Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*.
- ♦ Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.
- ♦ Comply with statutory requirements in relation to areas of cultural or historical significance.

7.3.2 RELEVANT ASSESSMENT STANDARD/PROCEDURE

The assessment standard for Aboriginal heritage is the requirements of the *Aboriginal Heritage Act 1972*.

7.3.3 PREDICTED IMPACT

Previous communication with AAD has indicated that the prevalence of sites of significance to Aboriginal people is usually influenced by factors such as availability of water, access to raw materials (eg. quartz or chert), the presence of prominent features and the level of prior disturbance or development of the land.

A search of AAD's Register of Aboriginal Sites indicated a single interim register, Site S01484, Grindstone Site, occurring over the project area. The site is registered as unreliable and occupies a 6.7 km x 6.7 km grid, the eastern portion of which overlies the project area. The possible presence of artefacts in this portion of the project area will be determined when the survey for sites of Aboriginal heritage significance is implemented.

No sites of European heritage significance occur within the proposed mining areas.

7.3.4 MANAGEMENT

Qualified professionals will undertake a survey of the project area for sites of ethnographic or archaeological significance. The survey will be undertaken prior to any physical disturbance occurring during mine site development. As part of this survey, the following work will be undertaken:

- consultation with AAD to ensure the programme for the survey is satisfactory;
- consultation with Aboriginal people that have cultural associations with the area;
- submission of Aboriginal heritage survey reports to AAD.

Notwithstanding the outcome of these searches, Cable Sands believes that it is unlikely that there are any modern Aboriginal uses of the land which are likely to be compromised by the proposal.

Where practical, Aboriginal heritage sites will be avoided. If disturbance of an Aboriginal site is unavoidable, an application to disturb the site will be made to the Aboriginal Cultural Materials Committee (ACMC), under Section 18 of the Act.

If any archaeological material of Aboriginal heritage significance is unearthed by minesite operations, the operations in the immediate vicinity will cease while the site is investigated.

If any sites of European heritage significance are identified during site development, the Heritage Commission, the National Trust and local stakeholders would be consulted prior to disturbance to ensure such sites are evaluated and appropriate management actions developed.

Commitments

8. Cable Sands will commission ethnographic and archaeological surveys of the project area prior to development of project infrastructure.

7.3.5 PREDICTED OUTCOME

The EPA's objective for culture and heritage will be achieved by adhering to the management practices and commitments indicated above.

7.4 PUBLIC CONSULTATION

Cable Sands has undertaken regular communication with local residents and government agencies prior to and during the development of this report. Consultation that has been undertaken includes:

1. Affected landowners - land negotiations and discussion of environmental issues. Examples of issues discussed include:
 - Groundwater supplies for crop production must not be disrupted (agricultural bores are generally located in the superficial aquifers).
 - Surface waters should not be disrupted where they are used for livestock water, or where surface soaks provide summer pasture production.
 - Boundary Road should be upgraded if subject to heavy haulage. The Boundary Road/Lowrie Road intersection is currently a safety hazard and should be better signposted.
 - Noise, dust and lights are issues that should be addressed.
2. Shire of Capel - haulage route options were discussed with the Shire, who indicated a preference for the Lowrie-Boyanup Route (see Section 2.6.2). This route was subsequently considered unsuitable due to safety issues relating to the close proximity of a railway crossing at the Lowrie Road/South Western Highway intersection.
3. WRC - Cable Sands has negotiated with the WRC for an allocation from the Yarragadee Aquifer, within the Capel-Ludlow Subarea. As a result of these negotiations and a study into the availability of this groundwater resource, the WRC has increased the unallocated resource in the Yarragadee Aquifer to accommodate Cable Sands' request. The issue of an exploratory Groundwater Well Licence (77136) to Cable Sands reflects this outcome. Subject to a satisfactory hydrogeological assessment of the exploration well, it is anticipated that a production Groundwater Well Licence for the Gwindinup proposal will be issued.
4. DEP - discussion of vegetation and rehabilitation issues.

-
5. CALM - a number of initial comments on vegetation, fauna, flora and rehabilitation issues were provided, including:
 - The impact on Whicher Valley and Cartis vegetation needs to be minimised.
 - Any clearing in State Forest No.27 should be minimised by careful mine planning.
 - Comprehensive surveys for flora, vegetation and fauna are required.
 - A dieback survey and development of a Dieback Management Plan is necessary.
 - Weed hygiene, topsoil management and rabbit control are important rehabilitation issues.
 - Infrastructure should be located on disturbed areas or cleared farmland where possible.
 - Management of plant site waste, surface water discharges and dieback should be detailed.
 - Completion criteria should be foreshadowed in qualitative and quantitative terms. The objective should be 95% return of baseline floristic composition, with a minimum of 80%.
 6. AAD - communication has clarified AAD's expectation for forthcoming surveys and subsequent actions if any sites are identified (see Section 7.3.4).

8 Environmental Commitments

Cable Sands has committed to manage impacts associated with the proposal so that there will be no net adverse impact to the environment. Commitments relating to the biophysical environment, pollution management and social surroundings are summarised in Table 13 following.

Table 13 Summary of the proponents environmental commitments

FACTOR	ACTION	OBJECTIVE	TIMING	WHOSE ADVICE
Environmental Management	<p>1. Cable Sands will prepare an Environmental Management Programme (EMP) for the proposal. Among other issues, the EMP will include prescriptions for the management of:</p> <ul style="list-style-type: none"> • wind and water erosion • noise • dust • hydrocarbons • fire • dieback • weeds • native flora and fauna 	<p>Establish stable and sustainable landforms consistent with surroundings.</p> <p>Protect DRF and Priority Flora, and consistent with the provisions of the <i>Wildlife Conservation Act 1950</i>.</p> <p>Maintain the abundance, species diversity and geographical distribution of fauna.</p> <p>Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the <i>Wildlife Conservation Act 1950</i>.</p> <p>Ensure that noise and dust impacts emanating from the proposal comply with statutory requirements and acceptable standards.</p>	Prior to development of project infrastructure	CALM
Rehabilitation	<p>2. Cable Sands will prepare a Rehabilitation Plan prior to development of project infrastructure. The plan will include:</p> <ul style="list-style-type: none"> • final landuse(s) • biophysical baseline data • topsoil management plan • pre and post mining contour plans • mining and tailings return schedules • weed and dieback management plans • erosion control plans • a section on infrastructure removal • rehabilitation completion criteria • rehabilitation monitoring. 	<p>Ensure the proposal area and any other area affected by the proposal is rehabilitated to a standard consistent with the intended post mining long-term land use.</p>	Prior to development of project infrastructure	CALM
Vegetation Conservation	<p>3. Cable Sands will provide legal protection for Conservation Areas A and B within M70/899 (Figure 14, Gwindinup Mineral Sands Mine CER, January 2000).</p> <p>4. Cable Sands will fence Conservation Areas A and B to exclude livestock and unauthorised access.</p>	<p>Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.</p>	Prior to mining	CALM

FACTOR	ACTION	OBJECTIVE	TIMING	WHOSE ADVICE
Water Quality Protection	5. Cable Sands will develop a groundwater and surface water monitoring programme. 6. Cable Sands will develop an Operating Strategy for groundwater abstraction.	Maintain or improve the quality of groundwater and surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA 1993).	Prior to and during mining	WRC
Visual Amenity	7. Cable Sands will plant shelter belts to enhance the visual amenity of areas adjacent to the project.	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal.	Prior to mining	
Aboriginal Heritage	8. Cable Sands will commission ethnographic and archaeological surveys of the project area.	Comply with the requirements of the <i>Aboriginal Heritage Act 1972</i> .	Prior to development of project infrastructure	AAD

9 Conclusion

The proposed Gwindinup Mineral Sands Mine will allow Cable Sands to continue to provide benefits to the regional economy, which are currently provided by the Yarloop and Bengier mine sites. As the proposal relies on utilising capital and labour resources from the Yarloop and Bengier mine sites, there will be no net increase in mineral sands mining in the south-west of Western Australia as a result of the proposal.

Conservation of native vegetation has been identified as an important environmental issue that requires careful planning and management. The Native Vegetation Protection Strategy is a key feature of the proposal that addresses this issue. In addition to minimising the requirement to clear native vegetation, the strategy compensates for unavoidable clearance of vegetation by protecting 92 ha of native vegetation within conservation covenants and rehabilitating 201.6 ha of land to native vegetation.

Other environmental issues such as pollution control and social factors can be managed satisfactorily using practices currently implemented at Cable Sands' other mine sites and enforced via the companies' EMS.

References

- Abbott, I. and Christensen, P. 1995. 'Living with Logging, the Survival of Species' in *Landscape*. Department of Conservation and Land Management, Perth.
- Bamford, M.J. 2000. *Proposed Gwindinup Mineral Sands Mine - Fauna Survey, Winter 1999*. Report prepared by Bamford, M.J. & A.R., Consulting Ecologists, for Cable Sands (WA) Pty Ltd.
- Barnesby, B.A., King, P.D. and Proulx-Nixon, M. (in prep.). *Land Resource Map No. 23: Land Resources from Harvey to Capel on the Swan Coastal Plain*. Agriculture WA, Perth.
- Baxter, J.L. 1977. *Heavy Mineral Sand Deposits of Western Australia*. Western Australia Geological Survey, Mineral Resources Bulletin No. 10.
- Baxter, J.L. and Collins, L.B. 1982. *Genesis of Heavy Mineral Strandlines, Southern Perth Basin, Western Australia - Progress Report*. Western Australian Institute of Technology, Perth.
- Belbin, L. 1993. *PATN - Pattern Analysis Package Users Guide*. C.S.I.R.O. Division of Wildlife Ecology, Canberra.
- Bettenay, E. and Hingston, F.J. 1957. *Pedology of the Soils of the Capel-Boyanup Area, WA*. CSIRO Division of Soils, Divisional Report 11/56, Adelaide.
- BHP Titanium Minerals Pty Ltd. 1995. *Beenup Titanium Minerals Project - Proposal to Extend Approved Mining Area*. Report submitted to the EPA.
- Bies, D.A. and Hansen, C.H. 1988. *Engineering Noise Control*. Unwin Hyman, London.
- Cable Sands. 1999a. *Radiation Management Plan*. Report prepared by Cable Sands (WA) Pty Ltd for the Department of Minerals and Energy, Perth.
- Cable Sands. 1999b. *Jangardup Heavy Minerals Mine, Extension: Location 13471 - Mining and Restoration Plan*. Report prepared by Cable Sands (WA) Pty Ltd for the Department of Environmental Protection, Perth.
- Cable Sands. 1999c. *Yarloop Mine Noise Management Plan*. Report prepared by Cable Sands (WA) Pty Ltd for the Department of Environmental Protection, Bunbury.
- CALM 1998. *Declared Rare and Priority Flora List, 15th July 1998*. Department of Conservation and Land Management, Perth.
- Carbon, B.A., Bartle, G.A. and Murray, A.M. 1981. 'Patterns of water stress and transpiration in Jarrah (*Eucalyptus marginata* Donn ex Sm.) forests', in *Australian Forestry Research*. 11: 191-200.
- Casuarina Forest Services. 1993. *Dieback Survey of the Gwindinup Area*. Unpublished report for Cable Sands Pty Ltd, Perth.
- Churchward, H. M. and McArthur, W.M. 1980. 'Darling System, Landforms and Soils' in *The Atlas of the Natural Resources of the Darling Range System, WA*. Department of Conservation and Land Management, Perth.
- Cogger, H.G., Cameron, E.E., Sadlier, R.A. and Egger, P. 1993. *The Action Plan for Australian Reptiles*. Australian Nature Conservation Agency, Canberra.
- Commonwealth of Australia. 1990. *Code of Practice for the Safe Transport of Radioactive Substances*. Australian Government Publishing Service, Canberra.

- Commonwealth of Australia. 1996. *National Strategy for the Conservation of Australia's Biological Diversity*.
- Commonwealth of Australia and WA Government 1998. *Comprehensive Regional Assessment*. Commonwealth and Western Australian Regional Forest Agreement (RFA) Steering Committee.
- Dames and Moore 1998. *Discussion Paper: Yarragadee Formation Groundwater Resource Allocations to the Mineral Sands Industry based in Capel*. A report prepared by Dames and Moore for Westralian Sands Ltd and Cable Sands Pty Ltd, Perth.
- Dell, B., Bartle, J.R. and Tacey, W.H. 1983. 'Root occupation and root channels of Jarrah forest subsoils', in *Australian Journal of Botany*. 31: 615-627.
- DEP. 1997. *Environment Western Australia 1997 Draft State of the Environment Report for Western Australia*. Department of Environmental Protection, Perth.
- EPA 1993. *Draft Western Australian Water Quality Guidelines for Fresh and Marine Water, Bulletin 711*. Environmental Protection Authority, Perth.
- EPA 1995. *Best Practice Environmental Management in Mining, Rehabilitation and Revegetation*. Environmental Protection Agency, Canberra.
- EPA 1997. *Boodarie Resource Processing Estate Port Hedland*. Environmental Protection Authority, Report and Recommendations
- EPA 1998. *Minimising Greenhouse Gas Emissions. Guidance for Assessment of Environmental Factors, Interim No. 12*. Environmental Protection Authority, Perth.
- EPA 1999. *Environmental Protection of Native Vegetation in Western Australia, Preliminary Position Statement No. 2*. Environmental Protection Authority, Perth.
- Environmental Survey and Management Pty Ltd 1999. *Gwindinup Landforms, Vegetation and flora*. A report for Cable Sands Pty Ltd, Perth.
- Environmental Survey and Management Pty Ltd 1998. *Gwindinup Vegetation Assessment*. A report for Cable Sands Pty Ltd, Perth.
- Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. 1994. *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished Report for the Australian Heritage Commission, prepared by the Department of Conservation and Land Management, and the Conservation Council of Western Australia (Inc.).
- GSWA. 1990. *Geology and Mineral Resources of Western Australia*. Geological Survey of Western Australia.
- Hedde, E.M., Loneragan, O.W. and Havel, J.J. 1980. 'Darling System Vegetation Complexes' in *The Atlas of the Natural Resources of the Darling Range System, WA*. Department of Conservation and Land Management, Perth.
- Hill, A.L., Semeniuk, C.A., Semeniuk, V. and Del Marco, A. 1996. *Wetlands of the Swan Coastal Plain, Volume 2b: Wetland Mapping, Classification and Evaluation, Wetland Atlas*. Department of Environmental Protection and the Water Authority of Western Australia, Perth.
- Hingston, F. J., Dimmock, G.M. and Turton, A.G. 1981. 'Nutrient Distribution in a Jarrah (*Eucalyptus marginata* Donn ex Sm.) ecosystem in south-west Western Australia', in *Forest Ecology and Management*. 3: 183-207.
- JANIS. 1997. *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*. Joint ANZECC/MCFFA National Forest Policy Implementation Sub-committee, Canberra.

- McArthur, W.M. and Bettenay, E. 1956. *Soils and Land Use Series No. 16: The Soils and Irrigation Potential of the Capel-Boyanup Area, Western Australia*. CSIRO Division of Soils, Adelaide.
- McArthur, W.M. and Bettenay, E. 1974. *Soil Publication No. 16: The Development and Distribution of the Soils of the Swan Coastal Plain, Western Australia*. CSIRO, Melbourne.
- Mattiske, E.M. and Havel, J.J. 1998. *Vegetation Mapping in the South West of Western Australia*. Department of Conservation and Land Management, Perth.
- Maxwell, S., Burbidge, A.A and Morris, K. 1996. *The 1996 Action Plan for Australian Marsupials and Monotremes*. Wildlife Australia, Canberra.
- Ministry for Planning. 1995. *Urban Bushland Strategy*. Western Australian Government, Perth.
- National Greenhouse Gas Inventory Committee. 1997. *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks*. National Greenhouse Gas Inventory Committee, Canberra.
- Playford, P.E., Cockbain, A.E. and Low, G.H. 1976. *The Geology of the Perth Basin, WA*. Western Australia Geological Survey, Bulletin No.124.
- Ruprecht, J.K. and Schofield, N.J. 1990. 'Seasonal soil water dynamics in the Jarrah forest, Western Australia. I: Results from a hillslope transect with coarse-textured soil profiles', in *Hydrological Processes*. 4: 241-258.
- Safstrom, R. and Craig, G.F. 1996. *Environmental Evaluation of Native Vegetation in the Wheatbelt of Western Australia - Principles and Criteria used to Appraise Land Clearing Proposals*. Report prepared for the Western Australian Department of Environmental Protection.
- Smith, R.A. 1984. *Geology and Hydrogeology of the Boyanup Borehole Line, Perth Basin*. Geological Survey of Western Australia, Bulletin No.124.
- Stone, Y., Ahern, C.R. and Blunden, B. 1998. *Acid Sulfate Soils Manual*. Acid Sulfate Soil Management Advisory Committee, Wollongbar.
- Strahan, R. 1995. *The Mammals of Australia*. Reed Books, Sydney.
- Tille, P.J. 1996. *Land Resources Series No. 14: Wellington-Blackwood Land Resources Survey*, Agriculture WA, Perth.
- WAPC. 1995. *Bunbury-Wellington Region Plan*. Western Australian Planning Commission, Bunbury.
- Ward, S.C. and Koch, J.M. 1996. 'Biomass and nutrient distribution in a 15.5 year old forest growing on a rehabilitated minesite', in *Australian Journal of Ecology*. 21: 309-315.
- WAWA 1995. *Busselton-Capel Groundwater Area Management Plan*. Water Authority of Western Australia, Perth.
- Welch, B.K. 1964. *The Ilmenite Deposits of Geographe Bay*. Australasian Institute of Mining and Metallurgy, Proceeding 211.
- Welker Environmental Consultancy. 1998. *Mining of Yarloop Reserve 31900 - Public Environmental Review*. Report prepared by Welker Environmental Consultancy for Cable Sands (WA) Pty Ltd, Perth.
- WRC. 1998. *Draft Water Quality Protection Guidelines*. Unpublished report prepared by the Waters and Rivers Commission, Perth.

Appendix A

EPA GUIDELINES

Part A: Specific Guidelines for the preparation of the Consultative Environmental Review

1. The proposal

Cable Sands (WA) Pty Ltd (the proponent) intends to mine mineral sands within mining leases M70/895, M70/899, M70/900 and M70/901. The Gwindinup Mineral Sands Mine is intended to replace the production from current operations at Yarloop and Sandalwood when they are exhausted at the end of the year 2001.

The proposed Gwindinup Mineral Sands Mine is located within the Shire of Capel, approximately 35km south south-east of Bunbury and 4km south of the town Boyanup. The proposal location is indicated on the attached plan (see Attachment 3).

The proposal involves:

- mining mineral sand deposits from two mining leases M70/895 (900ha) and M70/899 (570ha) over freehold land; and
- mining mineral sand deposits from mining leases M70/900 (98.4ha) and M70/901 (180ha) over areas of State Forest 27 (see Attachment 4).

The proponent is expected to provide the EPA with a report outlining the likely environmental impacts and proposed means of mitigating the impacts. This report will be made available for a four week review period.

Could you please supply the project officer with an electronic copy of the document for use on Macintosh, Microsoft Word Version 6, and any scanned figures. Where possible, figures should be reproducible in a black and white format.

2. Environmental factors relevant to this proposal

The review document should give an assessment of each of the environmental factors identified for this proposal.

At this stage, the Environmental Protection Authority (EPA) believes the preliminary environmental factors, objectives and work required is as detailed in the table below.

These factors should be addressed within the CER document for the public to consider and make comment to the EPA. The EPA anticipates addressing these factors in its report to the Minister for the Environment.

The EPA expects the proponent to take due care in ensuring all other relevant environmental impacts which may be of interest to the public are addressed and that management is covered in the environmental review.

INTEGRATING PROCESS			
Biodiversity		<p>Maintain biological diversity where that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.</p> <p>Through studies carried out for the following environmental factors, demonstrate that biodiversity will not be compromised by this proposal.</p>	
CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
BIOPHYSICAL			
Flora	Vegetation communities	Maintain species diversity, geographic distribution and productivity of vegetation communities.	<p>Baseline studies by appropriately trained and experienced persons under appropriate seasonal conditions to identify existing vegetation communities and dieback within the project area.</p> <p>Map and describe the vegetation communities and relate these mapped communities to soil/landform types.</p> <p>Assessment of potential impacts (direct and indirect) on vegetation communities (local and regional, terrestrial and aquatic) as a result of mining and associated activities.</p> <p>Proposed measures to mitigate impacts.</p>
	Declared Rare and Priority Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950.	<p>Targeted search by appropriately trained and experienced persons under appropriate seasonal conditions for Declared Rare and Priority Flora likely to occur on the subject land.</p> <p>Analysis of likelihood of occurrence of taxa not flowering at time of survey.</p> <p>Proposed measures to manage impacts.</p>
Fauna	Fauna	Maintain the abundance, species diversity and geographical distribution of fauna.	<p>Baseline studies to identify existing fauna in the project area.</p> <p>Assessment of potential impacts (direct and indirect) on fauna (local and regional, terrestrial and aquatic) as a result of mining and associated activities.</p> <p>Proposed measures to manage impacts.</p>

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
	Specially Protected (Threatened) and Priority Fauna	Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the <i>Wildlife Conservation Act</i> 1950.	Targeted search by appropriately trained persons for Specially Protected (Threatened) and Priority Fauna which may occur in the project area. Analysis of the values of affected land as habitat for endangered fauna. Proposed measures to manage impacts.
Land	Landform	Establish stable, sustainable landform consistent with surroundings.	Assessment of potential impacts of the proposal on existing landforms. Proposed measures to manage impacts, including erosion.
	Rehabilitation	Ensure proposal area, and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long term land use.	Detail of measures proposed to rehabilitate the impacted area, including: <ul style="list-style-type: none"> • removal of infrastructure; • weed control and management; completion criteria (in qualitative and quantitative terms); • how progressive rehabilitation will be implemented; • timetable for rehabilitation; • clean-up of any contaminated areas; • and monitoring of rehabilitation performance criteria.
Wetlands	Wetlands	Maintain the integrity, functions and environmental values of wetlands.	Baseline studies to identify wetlands, including sumpland and palusplain wetlands within the area (a map should be included). Assessment of the impact of dewatering and modifying groundwater levels within the mined area, particularly in relation to possible impacts to the State Forest land and wetlands. Proposed measures to manage impacts.

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
POLLUTION MANAGEMENT			
Air	Particulates / Dust	<p>(i) Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and</p> <p>(ii) Use all reasonable and practicable measures to minimise the discharge of particulate wastes.</p>	<p>Baseline studies to identify existing sources of dust.</p> <p>Assessment of potential increases in dust resulting from the construction and operation of the mine and associated activities.</p> <p>Assessment of potential impacts of increased dust on the surrounding environment and the amenity of surrounding land users from the construction and operation of the mine and associated activities.</p> <p>Proposed measures to manage impacts, including dust from:</p> <ul style="list-style-type: none"> • roadways and access routes; • topsoil (sand) and overburden (clay) stockpiles and bund walls; • dry mining/ extraction process; and • mud/clay tracked onto sealed roads by trucks and vehicles leaving the minesite.
	Greenhouse gases	<p>(i) Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and</p> <p>(ii) Use all reasonable and practicable measures to minimise the discharge of greenhouse gases.</p>	<p>Detail source(s) and amounts of greenhouse gases released or absorbed as a result of mining or rehabilitation activities.</p>
Water	Groundwater quality	<p>Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993).</p>	<p>Detail of water requirements for any on-site processing and mine operations.</p> <p>Details of baseline monitoring of bores, licensing requirements, drainage and fate of water used in any on-site processing and mine operations.</p> <p>Assessment of impact from any change in groundwater quality, including acid sulfate soils, on the surrounding environment.</p> <p>Proposed measures to manage impacts, including over-abstraction.</p>

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
	Surface water quality	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993).	<p>Detail of:</p> <ul style="list-style-type: none"> • water requirements for any on-site processing and mine operations; • drainage and fate of water used in any on-site processing and mine operations; • disposal of plant site waste, particularly sewage; • how surface water discharge will be managed to minimise risk of erosion and risk of dieback spread; and • proposed measures to manage impacts, including monitoring and buffers. <p>Assessment of potential impact on the Preston River, Capel River and Gynudup Brook.</p> <p>Assessment of impact from any change in surface water quality, including from acid sulfate soils, on the surrounding environment.</p>
Non-chemical Emissions	Noise	Ensuring that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.	<p>Baseline studies to identify existing sources of noise.</p> <p>Baseline studies to identify all potentially affected residences within 2km of the mining area. A map should be included showing the precise location of all dwellings and other buildings within 2km of the proposed mining area.</p> <p>Assessment of:</p> <ul style="list-style-type: none"> • potential increases in noise resulting from the construction and operation of the mine and associated activities (including trucking movements, building of dams and bund walls); • transport heavy haulage routes; and • potential impacts of any increased noise on the amenity of surrounding land users. <p>Proposed measures to manage impacts.</p>

CONTENT		SCOPE OF WORK	
Element of the Environment	Environmental Factor	Preliminary Environmental Objective	Work required for the environmental review
SOCIAL SURROUNDINGS			
Aesthetic	Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal.	Assessment of potential impacts on visual amenity of the project area and surrounds from the proposal, particularly in relation to the South West Highway. Proposed measures to manage impacts.
Social	Road transportation/ traffic	(i) ensure that the increase in traffic activities resulting from the project does not adversely impact on the social surroundings; and (ii) Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.	Assessment of transport heavy haulage routes (including routes via South West Highway, Stratham or Capel).
Culture and Heritage	Indigenous and non-indigenous cultures	(i) Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area; and (iii) Comply with statutory requirements in relation to areas of cultural or historical significance.	Identify any Aboriginal cultural and heritage sites/issues of significance through archaeological and ethnographical surveys of the project area and through consultation with local Aboriginal groups and the Department of Aboriginal Affairs. Identify potential impacts on any identified sites. Proposed measures to manage impacts.

3. Availability of the environmental review

3.1 All copies for distribution free of charge

Supplied to DEP:

- Library/Information Centre.....9
- EPA members.....6
- Officers of the DEP (Perth & Bunbury)8

Distributed by the proponent to:

- Government departments • Department of Minerals and Energy.....2

	•	Water and Rivers Commission	2
	•	Department of Conservation and Land Management	2
	•	Aboriginal Affairs Department.....	1
Local government authorities	•	Shire of Capel	2
Libraries	•	J S Battye Library	3
	•	The Environment Centre	2
	•	Shire of Capel Library.....	2
Others	•	Conservation Council of WA.....	1

3.2 Available for public viewing

- Department of Environmental Protection Library, Perth;
- Department of Environmental Protection Library, Bunbury;
- Shire of Capel Library;
- J S Battye Library, Perth; and
- The Environment Centre, Perth.

Appendix B

FLORA

TABLE B1 Flora identified within the Gwindinup Project area by Environmental Survey and Management Pty Ltd (ESM 1999). Conservation status is according to CALM (1998).

FAMILY	SPECIES	CONSERVATION STATUS
ADIANTACEAE	<i>Cheliantes tenuifolia</i> (Burm. F.) Sw	
ZAMIACEAE	<i>Macrozamia reidlei</i> (Fisch. ex Gaud.) C.A. Gardner	
PODOCARPACEAE	<i>Podocarpus drouynianus</i> F. Muel.	
POACEAE	<i>Amphipogon turbinatus</i> R. Brown <i>Danthonia caespitosa</i> Gaud.	
CYPERACEAE	<i>Lepidosperma leptostachyum</i> Benth. <i>Lepidosperma longitudinale</i> <i>Lepidosperma scabrum</i> Lees in Lehm <i>Lepidosperma</i> sp. <i>Mesomelaena stygia</i> ssp. <i>stygia</i> <i>Mesomelaena tetragona</i> (R. Br.) Benth.	
RESTIONACEAE	<i>Anarthria prolifera</i> (R.B.) Benth. <i>Anarthria scabra</i> R. Br. <i>Desmocladius fasciculata</i> (R. Br.) Benth. <i>Hypocalaena exsulca</i> R. Br. <i>Loxocarya cinerea</i> R. Br. <i>Lyginea barbata</i> R. Br. <i>Lyginea imberbis</i> R. Br.	
DASYPONONACEAE	<i>Dasyopogon bromeliifolius</i> R. Br. <i>Dasyopogon hookeri</i> J. Drumm. <i>Lomandra brittanii</i> <i>Lomandra integra</i> <i>Lomandra preissii</i> (Endl.) Ewart <i>Lomandra sericea</i> (Endl.) Ewart. <i>Lomandra sonderi</i> (F. Muel.) Ewart.	
XANTHORRHOEACEAE	<i>Xanthorrhoea gracilis</i> Endl. <i>Xanthorrhoea preissii</i> Endl.	
ANTHERICACEAE	<i>Agrostocrinum scabrum</i> R. Br. <i>Chaemaescilla corymbosa</i> R. Br. (F. Muel.) <i>Johnsonia acaulis</i> Endl. in Lehm <i>Laxmania ramosa</i> ssp. <i>ramosa</i> <i>Thysanotus multiflorus</i> R. Br. <i>Tricoryne elatior</i> R. Br. <i>Tricoryne tenella</i>	
COLCHICACEAE	<i>Burchardia multiflora</i> Lindl.	
HAEMODORACEAE	<i>Anigozanthus manglesii</i> D. Don. <i>Conostylus aurea</i> Lindley. <i>Conostylus serrulata</i> R. Br. <i>Conostylus setosa</i> Lindley. <i>Haemodorum ? spicata</i> R. Br. <i>Phlebocarya ciliata</i> R. Br.	
IRIDACEAE	<i>Patersonia occidentalis</i> R. Br. <i>Patersonia umbrosa</i> Endl. in Lehm.	

FAMILY	SPECIES	CONSERVATION STATUS
	<i>Acacia stenoptera</i> Benth.	
CAESALPINIACEA	<i>Labichea punctata</i> Benth.	
PAPILIONACEAE	<i>Bossiaea eriocarpa</i> Benth. <i>Bossiaea ornata</i> (Lindl.) Benth. <i>Chorizema glycinifolium</i> (Smith) Druce. <i>Chorizema ilicifolium</i> Labill. <i>Davesia decurrens</i> Meisn. <i>Davesia divaricata</i> ssp. <i>divaricata</i> <i>Davesia incrassata</i> Smith. <i>Davesia nudiflora</i> Meisn. in Lehm. <i>Euchilopsis linearis</i> (Benth.) F. Muell. <i>Gompholobium capitatum</i> A. Cunn. <i>Gompholobium conferta</i> DC <i>Gompholobium knightianum</i> Lindl. <i>Gompholobium tomentosum</i> Labill. <i>Hovea chorizemifolia</i> (Sweet) DC <i>Hovea trisperma</i> Benth. <i>Isotropis cuneifolia</i> (Smith) Benth. <i>Jacksonia furcellata</i> (Bonpl.) DC <i>Jacksonia sparsa</i> Chappill. M.S. <i>Jacksonia sternbergiana</i> Huegel <i>Kennedia coccinea</i> Vent. <i>Kennedia prostrata</i> R. Br. <i>Jacksonia densiflora</i> (Benth.) <i>Pultenaea ericifolia</i> Benth. <i>Sphaerolobium medium</i> R. Br. <i>Sphaerolobium vimineum</i> Smith.	PRIORITY 3
RUTACEAE	<i>Boronia defoliata</i> F. Muel. <i>Boronia humifusa</i> Paul G. Wilson <i>Boronia spathulata</i> Lindley. <i>Eriostemon spicatus</i> A. Rich.	PRIORITY 1
TREMANDRACAEA	<i>Platytheca galloides</i> Steetz. <i>Tetratheca hirsuta</i> Lindl.	
STACKHOUSIACEAE	<i>Tripterococcus brunonis</i> Endl.	
EUPHORBIACEAE	<i>Phyllanthus calycinus</i> Labil.	
DILLENIAEAE	<i>Hibbertia acerosa</i> (R. Br.) Benth <i>Hibbertia commutata</i> Steudel. <i>Hibbertia glomerata</i> Benth. <i>Hibbertia huegelii</i> (Endl.) F. Muell. <i>Hibbertia hypercoides</i> Benth. <i>Hibbertia racemosa</i> (Endl.) Glig. <i>Hibbertia vaginata</i> (Benth.) F. Muell.	
THYMELAEACEAE	<i>Pimelea rosea</i> R. Br. <i>Pimelea sulphurea</i> Meissner	
MYRTACEAE	<i>Agonis linearifolia</i> (D.C.) Schauer in Lehm. <i>Calathamnus lateralis</i> Lindley. <i>Calathamnus sanguineus</i> Labill. <i>Calytrix flavescens</i> Cunn. <i>Calytrix fraseri</i> Cunn. <i>Conospermum capitatum</i> ssp. <i>glabratum</i> R. Br. <i>Conospermum flexuosum</i> ssp. <i>Glabratum</i> R. Br.	

FAMILY	SPECIES	CONSERVATION STATUS
	<i>Corymbia calophylla</i> Lindley. <i>Corymbia haemotoxylon</i> Maiden <i>Darwinia aff. vestita</i> <i>Darwinia oederoides</i> (Turcz) Benth. <i>Eucalyptus marginata</i> Donn. ex. Smith. <i>Eremaea pauciflora</i> (Endl.) Druce <i>Hypocalymma angustifolium</i> Endl. <i>Hypocalymma robustum</i> Endl. <i>Kunzea ericifolia</i> (Smith) Heynh. <i>Kunzea recurva</i> Schauer in Lehm <i>Lechenaultia floribunda</i> Benth. in Lehm. <i>Melaleuca trichophylla</i> Lindley <i>Melaleuca</i> sp. <i>Melaleuca thymoides</i> Labill. <i>Pericalymma ellipticum</i> (Endl.) Schauer <i>Verticordia plumosa</i> (Desf.) Druce	
APIACEAE	<i>Daucus glochidiatus</i> (Labill.) Fisher. <i>Actinotus glomeratus</i> Benth. <i>Pentapeltis peltigera</i> (Hook.) Bunge <i>Platysace compressa</i> (Labill.) Norman <i>Platysace tenuissima</i> (Benth.) Norman <i>Glishrocaryon aureum</i> (Lindley) Orch. <i>Xanthosia huegelii</i> (Benth.) in Lehm	
EPACRIDACEAE	<i>Andersonia caerulea</i> R. Br. <i>Astroloma compactum</i> R. Br. <i>Astroloma pallidum</i> R. Br. <i>Conostephium pendulum</i> Benth. <i>Leucopogon australis</i> R. Br. <i>Leucopogon capitellatus</i> DC <i>Leucopogon obovatus</i> (Labill.) R. Br. <i>Leucopogon pendulus</i> R. Br. <i>Leucopogon pulchellus</i> Sonder in lehm. <i>Leucopogon verticellatus</i> R. Br. <i>Lycinema ciliatum</i> R. Br. <i>Sphenotoma capitatum</i> (R. Br.) Lindley <i>Styphelia tenuiflora</i> Lindley	
STYLIDIACEAE	<i>Stylidium amoenum</i> R. Br. <i>Stylidium piliferum</i> R. Br.	
LAMIACEAE	<i>Hemiantra linearis</i> Benth.	
RUBIACEAE	<i>Opercularia apiciflora</i> Labill.	
GOODENIACEAE	<i>Dampiera linearis</i> R. Br. <i>Scaevola striata</i> R. Br.	

Appendix C

FAUNA

TABLE C1 Mammal species expected within the project area

Data from Bamford (2000)

Habitat: Kg - Kingia complexes; Wh - Whicher complexes (including streams within Whicher valleys); Ca - Cartis complex; and FI -farmland (including flooded pasture).

Survey: Where species were recorded, the relevant survey is indicated. A - August 1999, D - December 1999, J - January 2000

Status: indicates the category to which species or sub-species of conservation significance have been allocated. Details on the categories of conservation significance given in Table D4. Int. indicates introduced species.

Species	Habitat	Survey	Conservation Status
Tachyglossidae (echidnas)			
Echidna <i>Tachyglossus aculeatus</i>	Kg,Wh,Ca	A,D	
Dasyuridae			
Mardo <i>Antechinus flavipes</i>	Kg,Wh	A	
Chuditch <i>Dasyurus geoffroii</i>	Kg,Wh	A,D	Schedule 1; Vulnerable
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>	Kg,Wh,Ca	A,D	Priority 3
Gilbert's Dunnart <i>Sminthopsis gilberti</i>	Kg,Wh,Ca	D	
Peramelidae (bandicoots)			
Quenda (Southern Brown Bandicoot) <i>Isodon obesulus</i>	Kg,Wh,Ca	A,D	Priority 4
Phalangeridae (possums)			
Brush-tailed Possum <i>Trichosurus vulpecula</i>	Kg,Wh,Ca	A,D	
Pseudocheiridae (ring-tailed possums)			
Western Ring-tailed Possum <i>Pseudocheirus occidentalis</i>	Wh	D	Schedule 1; Vulnerable
Burramyidae (pygmy possums)			
Western Pygmy Possum <i>Cercartetus concinnus</i>	Kg,Wh	A	
Tarsipedidae (honey possum)			
Honey Possum <i>Tarsipes rostratus</i>	Kg,Wh,Ca	A	
Macropodidae (kangaroos and wallabies)			
Western Grey Kangaroo <i>Macropus fuliginosus</i>	Kg,Wh,Ca,FI	A,D	
Brush or Black-gloved Wallaby <i>Macropus irma</i>	Kg,Wh,Ca	-	Priority 4
Mollosidae (mastiff bats)			
White-striped Bat <i>Nyctinomus australis</i>		D	
<i>Mormopterus planiceps</i>		-	
Vespertilionidae (vesper bats)			
Gould's Wattled Bat <i>Chalinolobus gouldii</i>		-	
Chocolate Wattled Bat <i>Chalinolobus morio</i>		-	
<i>Vespedalus (Eptesicus) regulus</i>		?A	
<i>Falsistrellus mackenziei</i>		-	
Lesser Long-eared Bat <i>Nyctophilus geoffroyi</i>		-	
Gould's Long-eared Bat <i>Nyctophilus gouldii</i>		-	
Greater Long-eared Bat <i>Nyctophilus timoriensis</i>		-	

Species	Habitat	Survey	Conservation Status
Muridae (rats and mice)			
Rakali or Water Rat <i>Hydromys chrysogaster</i>	Wh,FI		
House Mouse <i>Mus musculus</i>	Kg,Wh,Ca,FI	A,D	Int.
Moodit or Southern Bush Rat <i>Rattus fuscipes</i>	Kg,Wh,Ca		
Black Rat <i>Rattus rattus</i>	Wh,FI	A,D	Int.
Leporidae (rabbits and hares)			
Rabbit <i>Oryctolagus cuniculus</i>	Ca,FI	A,D	Int.
Canidae (foxes and dogs)			
European Red Fox <i>Vulpes vulpes</i>	Kg,Wh,Ca,FI	A,D	Int.
Felidae (cats)			
Feral Cat <i>Felis catus</i>	Kg,Wh,Ca,FI		Int.
Suidae (pigs)			
Feral Pig <i>Sus scrofa</i>	Wh	A	Int.
Number of species expected (observed):		29	(17)

TABLE C2 Bird species expected within the project area

Data from Bamford (2000)

Habitat: Kg - Kingia complexes; Wh - Whicher complexes (including streams within Whicher valleys); Ca - Cartis complex; and FI - farmland (including flooded pasture).

Survey: Where species were recorded, the relevant survey is indicated. A - August 1999, D - December 1999, J - January 2000

Status: indicates the category to which species or sub-species of conservation significance have been allocated. Details on the categories of conservation significance given in Table D4. Int. indicates introduced species.

Species	Habitat	Survey	Conservation Status
Casuariidae (cassowaries and emus)			
Emu <i>Dromaius novaehollandiae</i>	Kg,Wh,Ca,FI		A
Phasianidae (pheasants and quails)			
Brown Quail <i>Coturnix ypsilophora</i>			
Stubble Quail <i>Coturnix pectoralis</i>	FI		
Anatidae (ducks, geese and swans)			
Black Swan <i>Cygnus atratus</i>	FI		
Australian Shelduck <i>Tadorna tadornoides</i>	FI	A	
Pacific Black Duck <i>Anas superciliosus</i>	Wh,FI	A	
Grey Teal <i>Anas gibberifrons</i>	FI	A	
Australasian Shoveler <i>Anas rhynchotis</i>	FI		
Hardhead (White-eyed Duck) <i>Aythya australis</i>	FI		
Australian Wood Duck <i>Chenonetta jubata</i>	FI		
Podicepsidae (grebes)			
Hoary-headed Grebe <i>Poliiocephalus poliocephalus</i>	FI		
Australasian Grebe <i>Tachybaptus novaehollandiae</i>	FI	A	
Phalacrocoracidae (cormorants)			
Little Pied Cormorant <i>Phalacrocorax melanoleucos</i>			
Ardeidae (herons and egrets)			
White-faced Heron <i>Egretta novaehollandiae</i>	FI	A,D	
Little Egret <i>Egretta garzetta</i>	FI		
White-necked Heron <i>Ardea pacifica</i>	FI		
Great Egret <i>Egretta alba</i>	FI		
Cattle Egret <i>Ardeola ibis</i>	FI		
Nankeen Night Heron <i>Nycticorax caledonicus</i>	Wh,FI		
Plataleidae (ibis and spoonbills)			
Glossy Ibis <i>Plegadis falcinellus</i>	FI		
Australian White Ibis <i>Threskiornis molucca</i>	FI	A	
Straw-necked Ibis <i>Threskiornis spinicollis</i>	FI	A	
Yellow-billed Spoonbill <i>Platalea flavipes</i>	FI		
Accipitridae (kites, hawks and eagles)			
Square-tailed Kite <i>Lophoictinia isura</i>	Kg,Wh,Ca		Priority 4 (Rare)

Species		Habitat	Survey	Conservation Status
Black-shouldered Kite	<i>Elanus axillaris</i>	FI		
Whistling Kite	<i>Haliastur sphenurus</i>	Kg,Wh,Ca,FI		
Brown Goshawk	<i>Accipiter fasciatus</i>	Kg,Wh,Ca	D	
Collared Sparrowhawk	<i>Accipiter cirrhocephalus</i>	Kg,Wh,Ca		
Wedge-tailed Eagle	<i>Aquila audax</i>	Wh	A,D	
Little Eagle	<i>Hieraaetus morphnoides</i>	Wh	A	
Falconidae (falcons)				
Peregrine Falcon	<i>Falco peregrinus</i>	Kg,Wh,Ca,FI	A,D	(Schedule 4)
Australian Hobby	<i>Falco longipennis</i>	Kg,Wh,Ca		
Brown Falcon	<i>Falco berigora</i>	Wh,Ca,FI	A	
Nankeen Kestrel	<i>Falco cenchroides</i>	FI	A,D	
Turnicidae (button-quails)				
Painted Button-quail	<i>Turnix varia</i>	Kg,Wh	A	
Rallidae (crakes and rails)				
Buff-banded Rail	<i>Rallus philippensis</i>	Wh,FI		
Baillon's Crake	<i>Porzana pusilla</i>	Wh,FI		
Spotless Crake	<i>Porzana tabuensis</i>	Wh,FI		
Dusky Moorhen	<i>Gallinula tenebrosa</i>	FI		
Purple Swamphen	<i>Porphyrio porphyrio</i>	FI	A,D	
Eurasian Coot	<i>Fulica atra</i>	FI		
Scolopacidae (sandpipers)				
Wood Sandpiper	<i>Tringa glareola</i>	FI		
Marsh Sandpiper	<i>Tringa stagnatilis</i>	FI		
Recurvirostridae (stilts and avocets)				
Black-winged Stilt	<i>Himantopus himantopus</i>	FI		
Charadriidae (lapwings and plovers)				
Black-fronted Dotterel	<i>Euseyonis melanops</i>	FI		
Red-kneed Dotterel	<i>Erythronyx cinctus</i>	FI		
Columbidae (pigeons and doves)				
Laughing Turtle-Dove	<i>Streptopelia senegalensis</i>			Int.
Common Bronzewing	<i>Phaps chalcoptera</i>	Wh,Ca	A,D	
Crested Pigeon	<i>Ocyphaps lophotes</i>	FI	A,D	
Cacatuidae (cockatoos)				
Red-tailed Black-Cockatoo (forest sub-species)	<i>Calyptorhynchus banksii naso</i>	Wh	A,D	Priority 4 (Insuff. Known)
Short-billed Black-Cockatoo	<i>Calyptorhynchus latirostris</i>	Kg,Wh,Ca	?A	Schedule 1; Endangered (Vulnerable)
Long-billed Black-Cockatoo	<i>Calyptorhynchus baudinii</i>	FI		Schedule 1; Vulnerable (Insuff. Known)

Species		Habitat	Survey	Conservation Status
Galah	<i>Cacatua roseicapilla</i>	Fl	A	
Psittacidae (lorikeets and parrots)				
Purple-crowned Lorikeet	<i>Glossopsitta porphyrocephala</i>	Kg,Wh,Ca	D	
Regent Parrot	<i>Polytelis anthopeplus</i>	Fl		
Red-capped Parrot	<i>Purpureicephalus spurius</i>	Kg,Wh,Ca		
Western Rosella	<i>Platycercus icterotis</i>	Kg,Wh		
Australian Ringneck	<i>Barnardius zonarius</i>	Kg,Wh,Ca,Fl		
Elegant Parrot	<i>Neophema elegans</i>	Kg,Wh		
Cuculidae (cuckoos)				
Pallid Cuckoo	<i>Cuculus pallidus</i>	Kg,Wh,Ca		
Fan-tailed Cuckoo	<i>Cuculus pyrrhophanus</i>	Kg	A	
Horsfield's Bronze-Cuckoo	<i>Chrysococcyx basalis</i>	Wh,Ca	A,D	
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>	Wh	A,D	
Strigidae (hawk-owls)				
Barking Owl	<i>Ninox connivens connivens</i>	Kg,Wh		Priority 2
Southern Boobook Owl	<i>Ninox novaeseelandiae</i>	Kg,Wh	A,D	
Tytonidae (barn owls)				
Masked Owl	<i>Tyto novaehollandiae novaehollandiae</i>	Kg,Wh		Priority 4 (Rare)
Barn Owl	<i>Tyto alba</i>	Kg,Wh,Ca,Fl		
Podargidae (frogmouths)				
Tawny Frogmouth	<i>Podargus strigoides</i>	Kg,Wh,Ca,Fl	A,D	
Caprimulgidae (nightjars)				
Spotted Nightjar	<i>Eurostopodus argus</i>			
Aegothelidae (owlet-nightjars)				
Australian Owlet-nightjar	<i>Aegotheles cristatus</i>	Kg,Wh	A	
Halcyonidae (forest kingfishers)				
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Kg,Wh	A,D	Int.
Sacred Kingfisher	<i>Todiramphus sanctus</i>	Kg,Wh,Ca,Fl	D	
Meropidae (bee-eaters)				
Rainbow Bee-eater	<i>Merops ornatus</i>	Ca		
Climacteridae (treecreepers)				
Rufous Treecreeper	<i>Climacteris rufus</i>	Kg,Wh		
Maluridae (fairy-wrens)				
Red-winged Fairy-wren	<i>Malurus elegans</i>	Wh		
Splendid Fairy-wren	<i>Malurus splendens</i>	Kg,Wh,Ca	A,D	
Pardalotidae (pardalotes)				
Spotted Pardalote	<i>Pardalotus punctatus</i>	Kg,Wh	A	
Striated Pardalote	<i>Pardalotus striatus</i>	Kg,Wh	A,D	

Species		Habitat	Survey	Conservation Status	
White-browed Scrubwren	<i>Sericornis frontalis</i>	Kg, Wh	A, D	Priority 4	
Weebill	<i>Smicromis brevirostris</i>	Wh	A		
Western Gerygone	<i>Gerygone fusca</i>	Kg, Wh, Ca	A, D		
Inland Thornbill	<i>Acanthiza apicalis</i>	Kg, Wh, Ca	A, D		
Western Thornbill	<i>Acanthiza inornata</i>	Kg, Wh	A, D		
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>	FI	A, D		
Meliphagidae (honeyeaters)					
Red Wattlebird	<i>Anthochaera carunculata</i>	Kg, Wh, Ca	A, D		
Little Wattlebird	<i>Anthochaera chrysoptera</i>	Ca			
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>				
White-naped Honeyeater	<i>Melithreptus lunatus</i>	Kg, Wh	A, D		
Brown Honeyeater	<i>Lichmera indistincta</i>	Kg, Wh, Ca	A, D		
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	Ca	A, D		
White-cheeked Honeyeater	<i>Phylidonyris nigra</i>				
Tawny-crowned Honeyeater	<i>Phylidonyris melanops</i>				
Western Spinebill	<i>Acanthorhynchus superciliosus</i>	Kg, Wh, Ca	A, D		
Petroicidae (Australian robins)					
Scarlet Robin	<i>Petroica multicolor</i>	Wh, Ca	A, D		
Western Yellow Robin	<i>Eopsaltria griseogularis</i>	Kg, Wh	A, D		
White-breasted Robin	<i>Eopsaltria georgiana</i>	Wh	D, J		
Neosittidae (sittellas)					
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Kg, Wh, Ca	A, D		
Pachycephalidae (whistlers)					
Crested Shrike-tit	<i>Falcunculus frontatus</i>	Kg, Wh			
Golden Whistler	<i>Pachycephala pectoralis</i>	Kg, Wh	A, D		
Rufous Whistler	<i>Pachycephala rufiventris</i>	Kg, Wh, Ca	A, D		
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	Wh, Ca	A, D		
Dicruridae (flycatchers)					
Magpie-lark	<i>Grallina cyanoleuca</i>	FI	A, D		
Restless Flycatcher	<i>Myiagra inquieta</i>				
Grey Fantail	<i>Rhipidura fuliginosa</i>	Kg, Wh, Ca	A, D		
Willie Wagtail	<i>Rhipidura leucophrys</i>	FI	A, D		
Campephagidae (cuckoo-shrikes)					
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	Kg, Wh, Ca	A, D		
White-winged Triller	<i>Lalage sueurii</i>	Ca, FI	D		
Artamidae (woodswallows)					
Black-faced Woodswallow	<i>Artamus cinereus</i>	Kg, Wh, Ca, FI	A, D		
Dusky Woodswallow	<i>Artamus cyanopterus</i>	Kg, Wh	D		
Grey Butcherbird	<i>Cracticus torquatus</i>	Kg, Wh, Ca	A, D		

Species		Habitat	Survey	Conservation Status
Australian Magpie	<i>Gymnorhina tibicen</i>	Kh,Wh,Ca,FI	A,D	
Grey Currawong	<i>Strepera versicolor</i>	Kg,Wh	D	
Corvidae (ravens and crows)				
Australian Raven	<i>Corvus coronoides</i>	Kh,Wh,Ca,FI	A,D	
Motacillidae (pipits and true wagtails)				
Richard's Pipit	<i>Anthus novaeseelandiae</i>	FI	A,D	
Passeridae (finches)				
Red-eared Firetail	<i>Stagonopleura oculata</i>	Kg,Wh		
Hirundinidae (swallows)				
Welcome Swallow	<i>Hirundo neoxena</i>	Kh,Wh,Ca,FI	A,D	
Tree Martin	<i>Hirundo nigricans</i>	Kh,Wh,Ca,FI	A,D	
Sylviidae (old world warblers)				
Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>	FI		
Little Grassbird	<i>Megalurus gramineus</i>	FI		
Rufous Songlark	<i>Cincloramphus mathewsi</i>	FI	D	
Zosteropidae (white-eyes)				
Silvereye	<i>Zosterops lateralis</i>	Wh,Ca	Kg,Wh,Ca	
Number of bird species expected (observed):		121	(67)	

TABLE C3 Frog and reptile species expected within the project area

Data from Bamford (2000)

Habitat: Kg - Kingia complexes; Wh - Whicher complexes (including streams within Whicher valleys); Ca - Cartis complex; and FI - farmland (including flooded pasture).

Survey: Where species were recorded, the relevant survey is indicated. A - August 1999, D - December 1999, J - January 2000

Status: indicates the category to which species or sub-species of conservation significance have been allocated. Details on the categories of conservation significance given in Table D4. Int. indicates introduced species.

Species	Habitat	Survey	Conservation Status
FROGS			
Myobatrachidae (ground frogs)			
Quacking Froglet <i>Crinia georgiana</i>	Kg,Wh,Ca,FI	A,D	
Glauert's Froglet <i>Crinia glauerti</i>	Kg,Wh,FI	A,D,J	
Sandplain Froglet <i>Crinia insignifera</i>	Ca,FI	A,D	
Granite Froglet <i>Crinia pseudinsignifera</i>	Kg,Wh		
Green-bellied Froglet <i>Geocrinia leai</i>	Wh		
Moaning Frog <i>Heleioporus eyrei</i>	Wh,Ca	A,D	
Chocolate Burrowing Frog <i>Heleioporus inornatus</i>	Wh,Kg		
Marbled Burrowing Frog <i>Heleioporus psammophilus</i>	Kg	A,D	
Pobblebonk <i>Limnodynastes dorsalis</i>	Wh,Ca,FI	A,J	
Guenther's Toadlet <i>Pseudophryne guentheri</i>	Wh		
Hylidae (tree frogs)			
Slender Tree Frog <i>Litoria adelaidensis</i>	FI	A,D,J	
Motorbike Frog <i>Litoria moorei</i>	Wh,FI		
REPTILES			
Chelidae (side-neck tortoises)			
South-west Long-necked tortoise <i>Chelodina oblonga</i>	FI	D	
Gekkonidae (geckoes)			
Speckled Stone Gecko <i>Diplodactylus polyophthalmus</i>	Kg	D	
Marbled Gecko <i>Phyllodactylus marmoratus</i>	Kg,Wh,Ca		
Barking Gecko <i>Underwoodisaurus milii</i>	Kg		
Pygopodidae (legless-lizards)			
Pretty Worm-Lizard <i>Aprasia pulchella</i>	Kg,Wh,Ca	D	
Sandplain Worm-Lizard <i>Aprasia repens</i>	Wh,Ca		
Burton's Legless-Lizard <i>Lialis burtonis</i>	Kg,Wh,Ca		
Common Scalefoot <i>Pygopus lepidopodus</i>	Kg,Wh,Ca		
Agamidae (dragon lizards)			
Bearded Dragon <i>Pogona minor</i>	Kg,Wh,Ca	A,D	
Varanidae (monitors or goannas)			
Gould's Sand Goanna <i>Varanus gouldii</i>	Kg,Wh,Ca		
Rosenberg's Goanna <i>Varanus rosenbergi</i>	Kg,Wh,Ca		

Species		Habitat	Survey	Conservation Status
Scincidae (skink lizards)				
	<i>Acritoscincus (Bassiana) trilineatum</i>	Wh	A	
Fence Skink	<i>Cryptoblepharus plagiocephalus</i>	Kg,Wh,Ca	A,D	
	<i>Ctenotus australis</i>	Wh		
	<i>Ctenotus impar</i>	Kg,Wh,Ca	A,D	
Red-legged Skink	<i>Ctenotus labillardieri</i>	Kg,Wh	D	
King's Skink	<i>Egernia kingii</i>	Kg,Wh,Ca		
Salmon-bellied Skink	<i>Egernia napoleonis</i>	Kg,Wh,Ca	A,D	
	<i>Glaphyromorphus gracilipes</i>			
	<i>Hemiergis initialis</i>	Kg		
	<i>Hemiergis peronii</i>	Kg,Wh,Ca	A,D	
	<i>Lerista distinguenda</i>	Kg,Wh,Ca	A,D	
	<i>Lerista elegans</i>	Ca		
	<i>Lerista microtis</i>			
Dwarf Skink	<i>Menetia greyii</i>	Kg,Wh,Ca,FI	D	
	<i>Morethia lineocellata</i>	Wh,Ca	A,D	
	<i>Morethia obscura</i>	Kg,Wh	A,D	
Bobtail	<i>Tiliqua rugosa</i>	Kg,Wh,Ca,FI	D	
Typhlopidae (blind snakes)				
	<i>Ramphotyphlops australis</i>	Kg,Wh,Ca	D	
Boidae (pythons)				
South-West Carpet Python	<i>Morelia spilota imbricata</i>	Kg,Wh		Schedule 4; (Vulnerable)
Elapidae (front-fanged snakes)				
Crowned Snake	<i>Drysdalia (Notechis) coronata</i>			
Bardick	<i>Echiopsis (Notechis) curtus</i>			
Tiger Snake	<i>Notechis scutatus</i>	Kg,Wh,Ca,FI	A,J	
Dugite	<i>Pseudonaja affinis</i>	Kg,Wh,Ca,FI		
Jan's Bandy-bandy	<i>Simoselaps bertholdi</i>	Ca		
Gould's Snake	<i>Suta (Rhinoplocephalus) gouldii</i>	Kg,Wh,Ca		
Black-backed Snake	<i>Suta (Rhinoplocephalus) nigriceps</i>	Kg		
Number of frog species expected (recorded):		12	(7)	
Number of reptile species expected (recorded):		36	(10)	

Table C4 Categories used in the recognition of conservation significance.

WA Wildlife Conservation Act.	
Schedule 1.	Fauna which is rare or likely to become extinct
Schedule 2.	Fauna presumed to be extinct
Schedule 3.	Birds protected under an international agreement
Schedule 4.	Other specially protected fauna.
WA Department of Conservation and Land Management (species not listed under the Conservation Act, but for which there is some concern)	
Priority 1.	Taxa with few, poorly known populations on threatened lands.
Priority 2.	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3.	Taxa with several, poorly known populations, some on conservation lands.
Priority 4.	Taxa in need of monitoring.
International Union for the Conservation of Nature and Natural Resources (IUCN)	
Extinct.	Taxa not definitely located in the wild during the past 50 years.
Endangered.	Taxa in danger of extinction and whose survival is unlikely if the causal factors continue to operate.
Vulnerable.	Taxa believed likely to become Endangered in the near future if the causal factors continue to operate.
Rare.	Taxa with small populations that are not considered Endangered or Vulnerable, but which are threatened (if only by virtue of their small population size).
Insufficiently Known.	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Appendix D

ENVIRONMENTAL POLICY

ENVIRONMENTAL *Policy*

GENERAL POLICY

Cable Sands (WA) Pty Ltd is committed to efficient mineral sands extraction and production from exploration, mining and processing operations undertaken in a manner which minimises effects on the environment.

IN FULFILLING THIS COMMITMENT, CABLE SANDS:

- Operates in compliance with an Environmental Manual prepared to AS/NZS ISO 14001 1996.
- Operates in compliance with applicable legislation, regulations and Codes of Practice.
- Commits to pollution prevention.
- Recognises that operations will have a localised and short term impact on the environment and aims to reduce this impact wherever practicable.
- Regularly audits and monitors environmental performance.
- Aims to continually improve environmental management, practices and performances.
- Involves the community in decisions that impacts upon it and will make relevant information about the company's activities publicly available.
- Ensures that all employees, including contractors receive environmental awareness training and are informed of Company environmental responsibilities, policies and commitments.

SCOPE

All aspects of our operations including exploration, mining, production, transport, shipping and rehabilitation are encompassed by our Environmental Policy.



Gary Crockford
General Manager

7/12/98

Date

REVISION 2

CD119



ENVIRONMENTAL
MANAGEMENT
SYSTEM
ISO 14001 NATA CERTIFIED

CABLE SANDS (WA) PTY LTD

