AMC MINERAL SANDS LTD

ENEABBA WEST PROJECT

PUBLIC ENVIRONMENTAL REPORT

MAY 89

A MEMBER OF THE RENISON GOLDFIELDS GROUP OF COMPANIES

ENEABBA WEST MINERAL SANDS PROJECT
PUBLIC ENVIRONMENTAL REPORT

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

The Public Environmental Report (PER) for the proposed Eneabba West Mineral Sands Proposal has been prepared in accordance with Western Australian Government procedures. The report will be available for comment for 8 weeks, beginning on Wednesday, 31 May 1989 and finishing on Tuesday, 25 July 1989.

Comments from government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make a recommendation to Government.

Following receipt of comments from government agencies and the public, the EPA will discuss the issues raised with the proponent, and may ask for further information. The EPA will then prepare its assessment report with recommendations to Government, taking into account issues raised in the public submissions.

The proposal deals with an intention by AMC Mineral Sands Ltd (AMC) to mine heavy mineral sands from the Eneabba West area, about 5km due west of existing AMC operations. The area to be mined is within a current lease held by AMC Mineral Sands Ltd.

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 will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the PER or with 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 environmentally more acceptable.

When making comments on specific proposals in the PER

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- 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 the issues raised are clear. A summary of your submission is helpful. Refer to each point to the appropriate section, chapter or recommendation in the PER. If you discuss sections of the PER keep them distinct and separate, so there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Please indicate whether your submission can be quoted, in part or in full, by the EPA in its Assessment Report.

REMEMBER TO INCLUDE

YOUR NAME / ADDRESS / DATE

THE CLOSING DATE FOR SUBMISSION IS: TUESDAY, 25 JULY 1989.
SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Mr M Waite

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Notification Under Agreement Act

AMC Mineral Sands Ltd, the mineral sands division of Renison Goldfields Consolidated Limited, presently operates two mining plants at Eneabba and processing plants at Narngulu near Geraldton under the Mineral Sands (Eneabba) Agreement Act (1975-1988). The Company is investigating the feasibility of expanding its existing operations by about 40%, by mining a newly identified series of strandlines known as Eneabba West, about five kilometres west of existing operations. Concentrate from the mine would be railed to Narngulu for processing into finished products.

The Government retains ongoing control over the environmental management of operations through provisions of the Agreement Act, including:

1. the "approved proposals" mechanism, whereby operational and environmental proposals require the approval of the Minister for Resources Development,

2. the Company has an obligation for a continuous programme of investigations and research, and

3. a comprehensive reporting mechanism involving further Ministerial approval.

Further, the Minister is advised by the Mineral Sands Agreement Rehabilitation Co-ordinating Committee (MSARCC). This inter-departmental committee has representation from the Departments of Resources Development, Mines, Conservation and Land Management, and Agriculture, as well as the Environmental Protection Authority.

This Public Environmental Report (PER), being part of the feasibility study, is submitted pursuant to Clause 7 of the Mineral Sands (Eneabba) Agreement Act (1975-1988) for the purposes of:

(i) formally submitting to the Minister for Resources Development detailed proposals for approval, and

(ii) assessment under Part IV of the Environmental Protection Act, 1986. The EPA has determined an eight week review period.

1.2 The Proposal

It is proposed to mine more than 200 million tonnes of ore at an average grade of about 3% over 13-14 years, by a 3,000 TPH bucketwheel dredge. Concentrate will be trucked to the Eneabba South concentrator for attritioning and drying and then railed to the Narngulu Processing Plant for separation. Production of the various products will be increased by approximately:

Rutile	40,000 TPA
Zircon	60,000 TPA
Ilmenite	200,000 TPA
Monazite	2,000 TPA

1.3 Land Tenure

The Eneabba West ore body occurs on private land. The land is being incorporated into Mining Lease 267SA under the provisions of the Agreement Act. Access to the site is from the Brand Highway along the gazetted Rocky Springs Road. Flora and Fauna Reserve 29073 occurs to the west of the ore body and Flora and Fauna Reserve 27886 lies to its east.

2. NEED FOR THE PROPOSAL

The project provides the Company and the State an opportunity to further consolidate their share of the world's market for mineral sands. Benefits will flow to the community at local, state and national levels.

Direct permanent employment will increase by 64 jobs, with additional flow-on effects through supplies and services. The State's economy will

benefit by the expenditure of about $100 M capital. State Government revenues will increase by $13 M directly from the project. Annual export earnings will increase by about $90 M.

3. EXISTING ENVIRONMENT

3.1 Eneabba West

The heavy mineral occurs in a series of sub-parallel strandlines lying between RL 38 m and RL 31 m. They are overlain by 15-30 metres of younger windblown sand.

There are no permanent streams in the area, although surface flows occur in winter down the Erindoon Creek catchment towards Lake Erindoon. Where the superficial aquifer is close to the ground surface, large areas of saline soil occur. A major source of salt in the shallow aquifer is a diffuse natural leakage of saline water from a deeper aquifer. A potential source of large supplies of water occurs in the Cattamarra Coal Measures.

The climate is characterised by wet winters and long, hot, dry summers. Annual average rainfall is 530 mm.

A large part of the project area has been cleared for agriculture. The remaining natural vegetation has been degraded by grazing. No rare plants have been found and the vegetation is typical of the Eneabba area.

3.2 Narngulu

The Processing Plant is located within the Narngulu Industrial Estate. The land is flat and of alluvial origin. The main aquifers in the area are the late Jurassic Yarragadee Formation and the mid-Jurassic Kojarena Sandstone. Both of these contain brackish water with about 10,000 mg/l TDS. Ambient dust levels at the site arise from natural windblown sources.

4. CONSIDERATION OF ALTERNATIVES

4.1 Mining Method

The two options for mining included dry mining and dredging. Dredging was selected as it could effectively utilise the high water table and it was considered impractical to dewater the ore body to the depths required.

4.2 Processing Plant Location

Consideration was given to processing the concentrate either at Eneabba or at Narngulu. Neither site had an economic advantage, so Narngulu was selected upon consideration of logistical and social factors.

4.3 Water Supply

The water requirements of the mine will average 1,500 cu m per day, but will peak at 4,500 cu m for short periods in summer. The three sources of water under consideration include the superficial aquifer, the Cattamarra Coal Measures and the deeper Yarragadee Formation to the east of the Brand Highway. The Cattamarra Coal Measures is the preferred supply at this stage based on logistics and costs of construction and reticulation.

4.4 Rehabilitation

After mining, the land will be rehabilitated to a combination of native vegetation and agricultural production. Investigations will be conducted into a number of possible strategies to reverse the spread of salinity by lowering groundwater levels. The use of artificial lakes coupled with fringing native wetland vegetation to increase evapotranspiration will be considered. Other investigations will examine the use of deep rooted plants to increase evapotranspiration, including native vegetation, tree belts, lupins, lucerne and tagasaste.

These investigations will be used to develop rehabilitation strategies in consultation with the landowners and the Department of Agriculture.

5. DESCRIPTION OF OPERATIONS

5.1 Mining

Heavy mineral concentrate will be extracted by a bucketwheel dredge and concentrator floating in the dredge pond. Sand tailings and clay slimes will be returned to the mine path behind the concentrator. The dredge pond will be 15 metres in depth and below the ground surface throughout the mining operation.

Make-up water requirements will be supplied by up to six screened bores drawing from the Cattamarra Coal Measures. Power will be drawn from the SECWA grid system at 33 KV.

Concentrate will be hauled by road train to the Eneabba South concentrator for attritioning and drying. It will then be railed to Narngulu for processing. Access to and from the Brand Highway will be built to MRD and Shire standards with special regard to road safety.

Temporary accommodation for construction workers will be provided by extending the Company's existing single person's quarters at Eneabba. Accommodation for permanent employees will be provided at both Eneabba and Leeman. Sufficient serviced land is available at Leeman to meet the additional requirements.

5.2 Processing

The Narngulu Processing Plant will be expanded to treat the additional concentrate. The separation process will make use of the minerals' properties of magnetic susceptibility, electrical conductivity, specific gravity and particle size. Tailings will be deposited in earth bunkers and progressively rehabilitated, but may be subjected to retreatment prior to plant closure.

Water consumption from the scheme supply is minimised as 95% is recycled. Daily requirements are well within site entitlements. Power consumption from the SECWA grid will increase by 2.2 MW. Finished product will be shipped from the Geraldton wharf. The Company is negotiating with Westrail to replace the current road transport with rail.

In 1988, state-of-the-art equipment was installed in the Processing Plant which significantly improved dust, radiation, heat and noise controls. Similar equipment will be installed in the expanded facilities to maintain high standards of OHS.

5.3 Project Timetable

The feasibility study is scheduled for presentation to the RGC Board for approval in August. Subject to all government and corporate approvals being in place, construction will commence at Eneabba on 1 October to meet contractual arrangements. The dredge will be commissioned in December 1990.

Site construction at Narngulu is scheduled to commence in January 1990, with the plant commissioned by March 1991.

6. ENVIRONMENTAL EFFECTS AND MANAGEMENT

6.1 Mining

Mining at Eneabba West will have short and long term environmental effects. Management strategies have been devised to prevent or minimise deleterious effects.

There will be temporary drawdown of the groundwater level in the vicinity of the dredge pond and this will reduce soil salinity in the short term. This drawdown is not expected to affect nearby native vegetation.

Soil salinity in the area is dependent on the depth of a shallow water table. Groundwater levels will recover soon after mining, as

a result of lateral flow in the superficial aquifer and recharge by rainfall. Strategies will be developed to lower groundwater levels in the longer term to reduce soil salinity and improve productivity of the land. Areas of disturbance will be minimised and mined areas will be rehabilitated quickly to minimise recharge by rainfall.

A series of strategies aimed at lowering the groundwater levels by increasing evapotranspiration will be investigated. One way may be the creation of artificial lakes on the mined areas to maximise evaporation, in association with wetlands vegetation around the margins to increase evapotranspiration. The use of deep rooted plants such as native vegetation, tree belts and agricultural plants such as lupins, lucerne and tagasaste will also be examined.

Following these investigations, rehabilitation strategies will be developed in consultation with the landowners and the Department of Agriculture and submitted for approval under the Agreement Act. The Company will then apply its existing resources and expertise to the rehabilitation of the site. Through the Agreement Act, the progress of mining and rehabilitation will be inspected by the MSARCC and reported on to the Minister.

6.2 Processing

Tailings from the Processing Plant at Narngulu will be deposited in earth bunkers on the site and progressively rehabilitated.

AMC has a comprehensive OHS policy and has implemented systems which require and achieve more stringent standards than those set by legislation. These systems will be extended to activities generated by this proposal. Particular attention is given to dust, noise and radiation controls and safety. These programmes are approved by relevant authorities and the monitoring programmes demonstrate compliance with Government requirements. In particular, the Company is demonstrating compliance with Regulations relating to radiation safety and is committed to ALARA.

6.3 Monitoring

The Company will commence a monitoring programme on the hydrology of the Eneabba West area before, during and after mining on a catchment basis. The programme has been developed by the Company's groundwater consultants and the data will be assessed by a professional hydrologist.

The Company currently conducts comprehensive OHS monitoring for air, noise and radiation safety in accordance with Regulations under the Mines Regulation Act. These programmes are approved by the Department of Mines and will be extended to relevant parts of the Eneabba West project.

Native vegetation will be monitored by a qualified botanist to assess the effect of water table drawdown. The Company's existing rehabilitation monitoring programme, implemented and reported on under the Agreement Act, will be extended to Eneabba West.

7. COMMITMENTS

The Company has a range of obligations under the Agreement Act relating to environmental management, and the Eneabba West project will be covered by these obligations.

In addition, the Company has made a range of commitments relating to road safety, occupational health and safety including radiation safety, hydrology, investigations relating to hydrology and rehabilitation, and monitoring of rehabilitation.

8. CONCLUSIONS

The Eneabba West project will increase production from AMC's operations at Eneabba by about 40%. Significant economic benefits will flow to the community at local, state and national levels.

The proposal involves mining on private land which has been partly cleared for agriculture. The remaining native vegetation has been degraded by grazing and large areas of salinization occur.

In the short term, mining will lower groundwater levels and reduce salinity in the vicinity of the dredge pond. For the longer term, a number of rehabilitation strategies are available to reduce groundwater recharge, lower groundwater levels, reduce salinization and improve agricultural production.

Concentrate will be processed at the Narngulu Processing Plant which will be expanded. Existing OHS programmes will be extended to the expanded facilities to ensure continual compliance with Government requirements.

The proposal will be implemented under the Mineral Sands (Eneabba) Agreement Act (1975-1988), the provisions of which provide the Government with ongoing controls of the environmental management of operations. In addition, AMC is strongly committed to high standards in OHS and environmental management.

1. INTRODUCTION

1.1 Notification Under Agreement Act

Mining for the mineral sands rutile, ilmenite, zircon and monazite commenced at Eneabba, about 300 km north of Perth in the mid-seventies. Initially, three companies commenced operations, viz, Jennings Mining (Australia) Pty Ltd, Allied Eneabba Limited (AEL) and Western Titanium Limited (WTL). In 1977, WTL was merged with a related Company, Associated Minerals Consolidated Limited, now known as AMC Mineral Sands Ltd which operates as the mineral sands division of Renison Goldfields Consolidated Limited (RGC). Jennings Mining ceased operating in 1979 and sold its leases to AMC in 1980. Subsequently, AMC became the sole operator on the Eneabba field when it acquired the operations of AEL in 1986.

Both AMC and AEL operated at Eneabba under State Agreements referred to as the Mineral Sands (Western Titanium) Agreement Act (1975) and the Mineral Sands (Allied Eneabba) Agreement Act (1975) respectively. A result of the merger of the two companies was the rationalisation of the two Agreements into one amended Agreement which is now referred to as the Mineral Sands (Eneabba) Agreement Act (1975-1988). Under the amended Agreement, all of the mineral tenements held by the Company have been consolidated into Mining Lease 267SA. The Agreement contains provisions to add new areas to the Mining Lease if exploration should locate further ore bodies nearby.

The Agreement Act also contains three important provisions relating to environmental management.

1. All operations are conducted under the "approved proposals" mechanism, whereby proposals for operations and environmental management require the approval of the Minister for Resources Development. Any variation to approved proposals, whether of an operational or environmental nature require submission of additional detailed proposals for approval by the Minister.

2. The Company has an ongoing obligation to carry out a continuous programme of investigations and research including monitoring.

3. There is a comprehensive reporting mechanism. Every three years the Company is required to submit a detailed report of progress over the previous three years together with specific detailed proposals for the next three years for approval by the Minister. The Company is also required to submit interim reports of progress on an annual basis.

The Company's activities are supervised by the Mineral Sands Agreement Rehabilitation Co-ordinating Committee (MSARCC) which provides advice to the Minister. This inter-departmental committee has representation from the Departments of Resources Development, Mines, Conservation and Land Management, and Agriculture as well as the Environmental Protection Authority. Through these mechanisms, the Government has ongoing control over operations and environmental management, as well as the flexibility to deal with new issues as they arise.

The consolidation of operations and mineral tenements in the Eneabba district into one operating unit was a significant event for the overall development of the mineral resource. Rationalisation of operations has enabled mining costs to be substantially reduced. Long term planning of the whole field as a single entity has enabled the introduction of lower cost mining methods. This has enabled lower grade ore bodies to be mined economically, which will maximise resource recovery from the field and extend the life of the mine.

Currently, the Company operates two mining plants at Eneabba. The Eneabba North mine employs the traditional dry mining method used at Eneabba, whereby scrapers transport ore to a wet concentrator, which is relocated periodically as the mine advances. The concentrate is then separated at a centrally located processing plant at the Eneabba site, and the final products are railed to Geraldton and Perth for shipping. This operation will be converted to dredging in about four years time to allow the lower grade ore bodies in the ex Jennings areas to be mined economically.

The Eneabba South mine has been recently converted to a dredging operation, whereby a dredge feeds the ore as a slurry to the

concentrator floating in the dredge pond. The concentrate is subjected to attritioning and drying at the old AEL plant prior to being railed to a processing plant in the Narngulu Industrial Estate in Geraldton. Again, the final products are shipped from the Geraldton Port.

Exploration conducted since the rationalisation has identified a major series of strandlines about five kilometres west of current operations. The Company proposes to develop a third mine here, to be known as Eneabba West, for which a feasibility study is being conducted. The feasibility study is scheduled for presentation to the RGC Board in August 1989. If it is decided to proceed with the project, mining is scheduled to commence in January 1991.

This proposal for expansion of AMC's Eneabba operations is subject to the provisions of the Mineral Sands (Eneabba) Agreement Act (1975-1988).

This Public Environmental Report (PER), being part of the feasibility study, is submitted to the Environmental Protection Authority for assessment under Part IV of the Environmental Protection Act, 1986. For this assessment, the EPA has determined an eight week public review period.

1.2 Location

The feasibility study is assessing a proposal to develop a mine and services on strandlines five kilometres to the west of current operations (Figure 1) and south west of Eneabba township. The mine will be located on private land west of the Brand Highway. The land is currently used for agricultural purposes. About half of the land is cleared and sown to pasture, with the remaining native vegetation being grazed to various degrees.

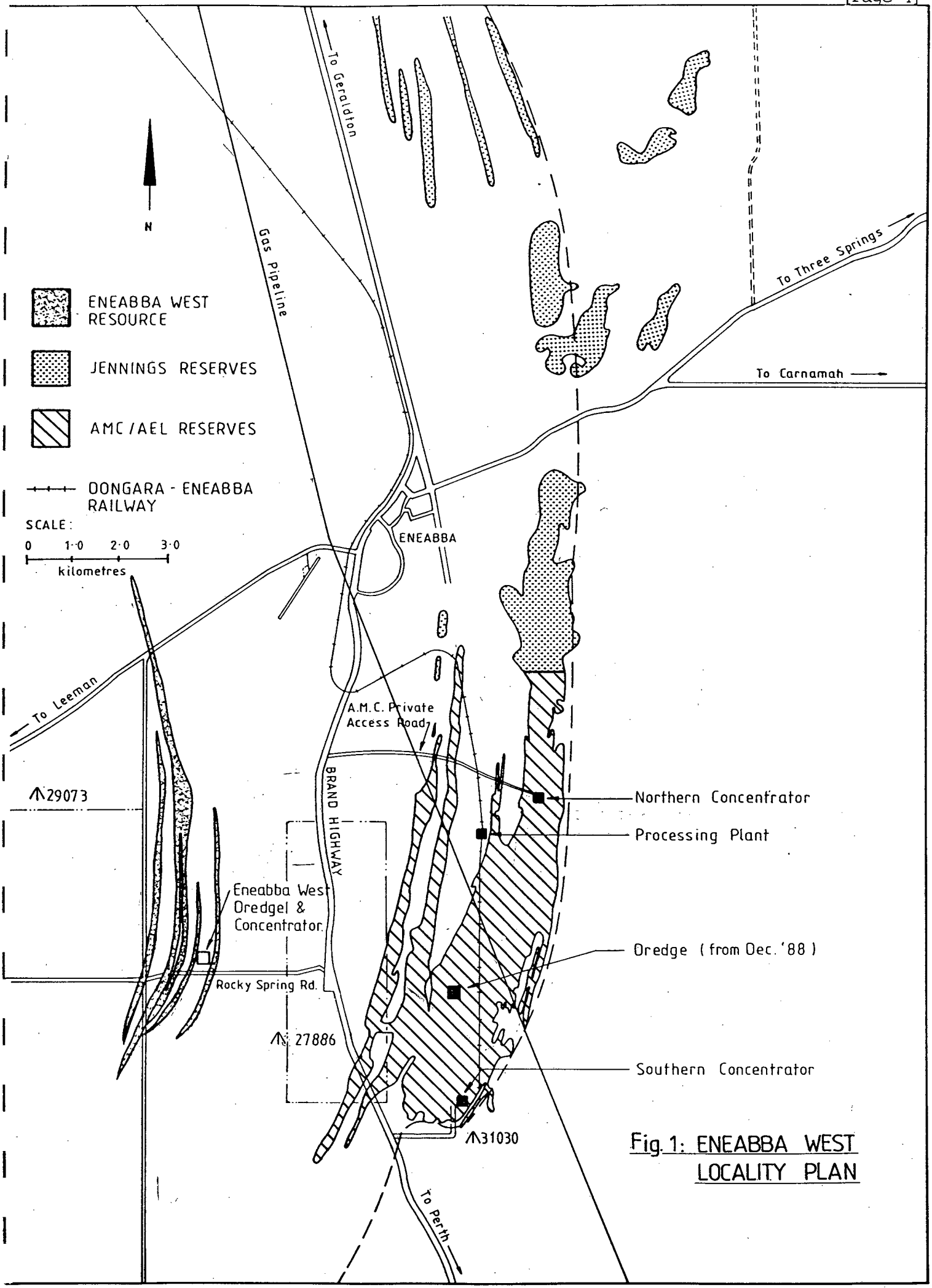


Fig. 1: ENEABBA WEST LOCALITY PLAN

1.3 The Proposal

The proposal involves mining a mineral sands ore body at Eneabba and processing the concentrate at Narngulu.

It is estimated that over 200 million tonnes of ore at an average grade of approximately 3% heavy mineral will be mined over a period of 13-14 years. This will be achieved by the construction of a 3,000 TPH dredge and concentrator. Concentrate will be trucked from the minesite to the Eneabba South concentrator, which will be upgraded, for attritioning and drying. The dried concentrate will then be transported by rail to the Narngulu Processing Plant (Figure 2). At Narngulu, an additional circuit will be built within the existing plant to treat the new material. Production of the various products will be increased by approximately:

Rutile	40,000 TPA
Zircon	60,000 TPA
Ilmenite	200,000 TPA
Monazite	2,000 TPA

Product will then be shipped from existing port facilities. Therefore, this proposal represents an increase of production from the Eneabba minesite of about 40%.

The proposal is illustrated in schematic form in Figure 3.

1.4 Land Tenure

The Eneabba West ore body occurs on private land. Part of the area is contained within Mining Lease 267SA. The remaining area is covered by an Exploration Licence and Exploration Licence Applications. Under the Agreement Act, the Company may apply to the Minister for mining tenements granted under the Mining Act to be included in the Mining Lease which is subject to the Agreement (ie ML 267SA). Such land would be subject to the same terms, covenants and conditions as apply to the Mining Lease, plus such additional

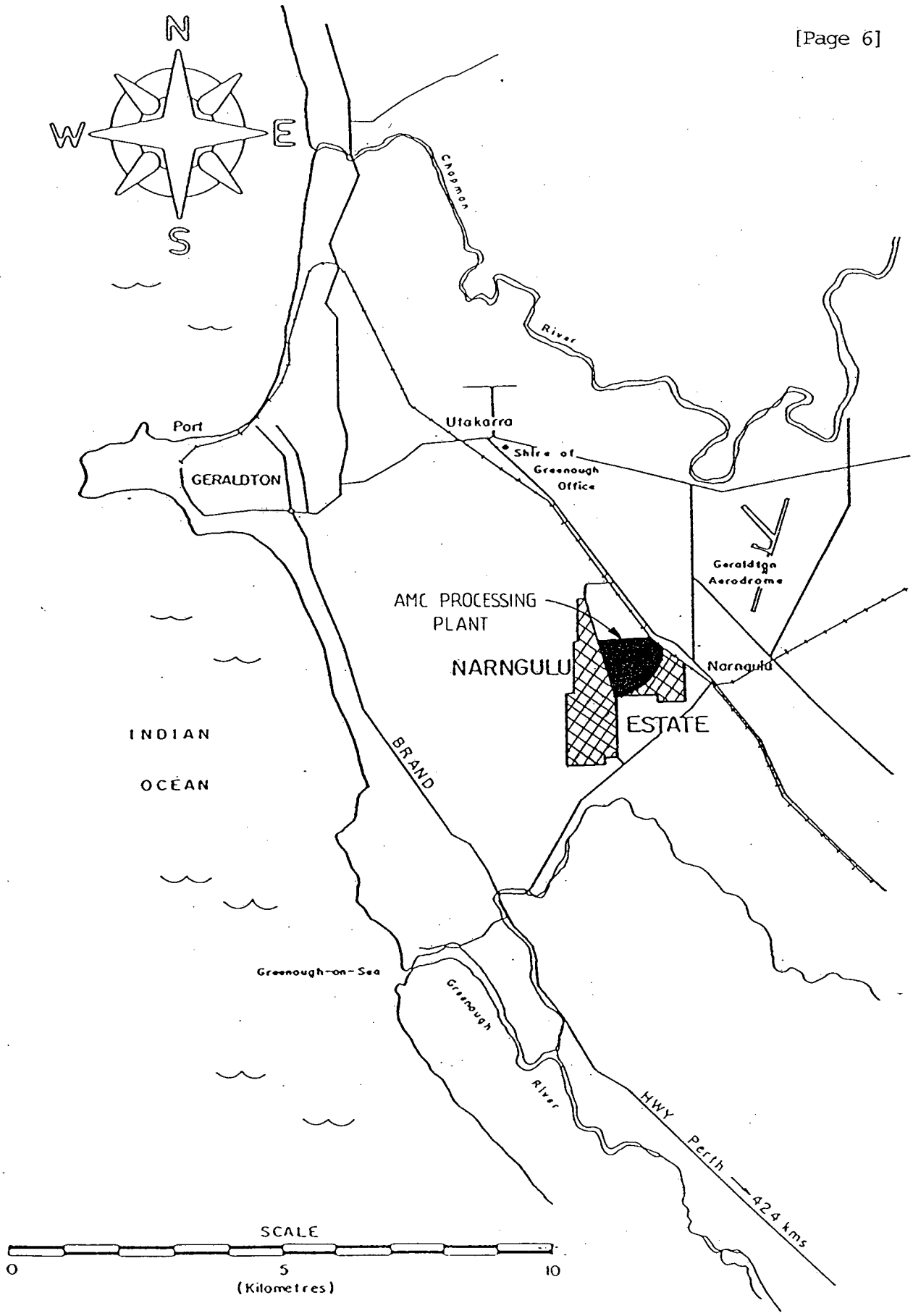


Fig. 2 LOCATION OF NARNGULU PROCESSING PLANT

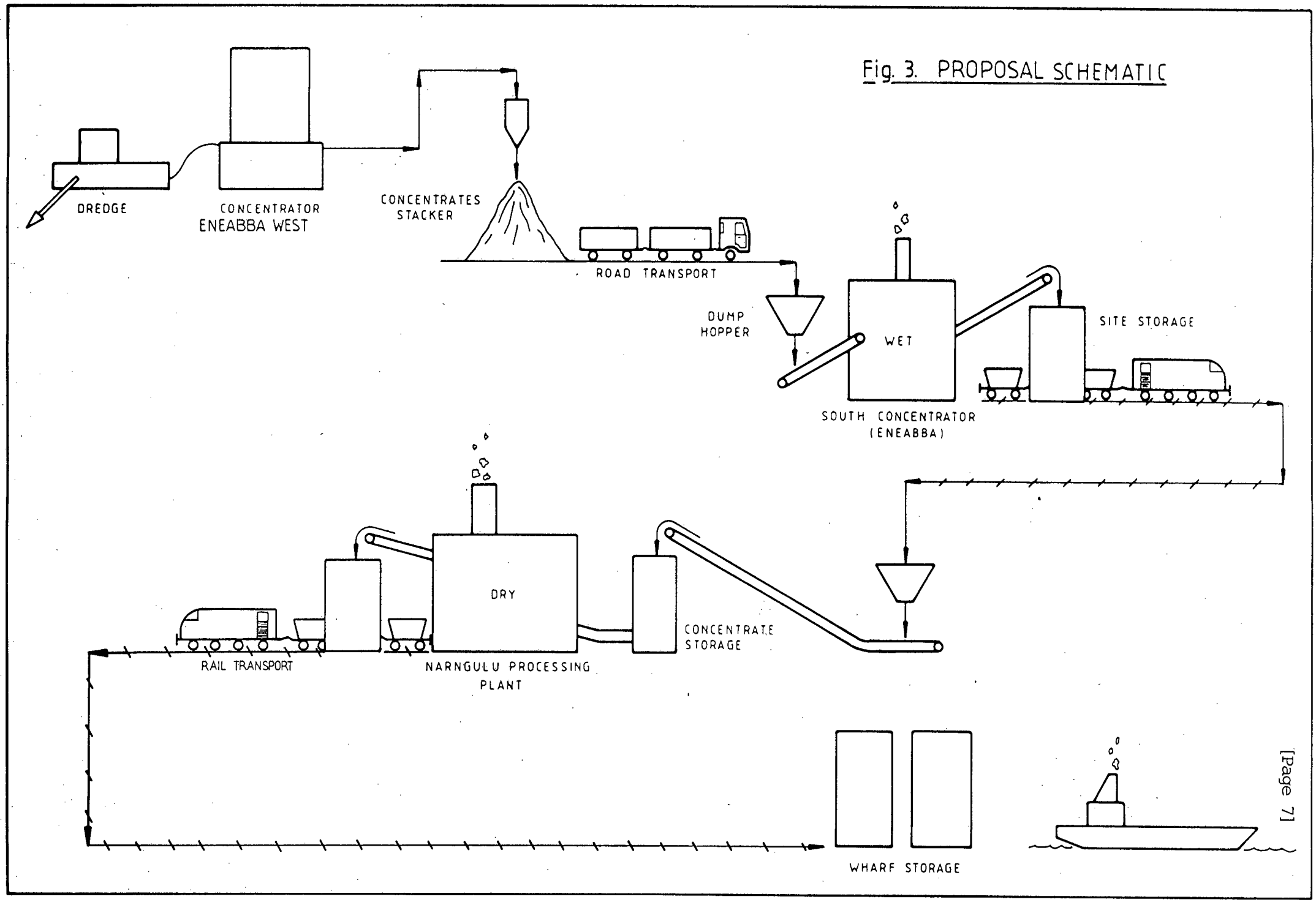


Fig. 3. PROPOSAL SCHEMATIC
DREDGE
CONCENTRATOR
ENEABBA WEST
CONCENTRATES
STACKER
ROAD TRANSPORT
DUMP
HOPPER
WET
SITE STORAGE
SOUTH CONCENTRATOR
(ENEABBA)
DRY
CONCENTRATE
STORAGE
RAIL TRANSPORT
NARNGULU PROCESSING
PLANT
WHARF STORAGE

conditions as the Minister for Mines determines. Upon conclusion of compensation agreements, which are currently being negotiated with landowners, application will be made to include these supplementary areas in ML 267SA.

Access to the minesite will be gained by constructing a sealed roadway from the Brand Highway along the Rocky Springs Road. This gazetted road passes through, and is excised from, Flora and Fauna Reserve 27886.

Flora and Fauna Reserve 29073 occurs to the west of the northern part of the ore body, separated by Erindoon Road.

The various tenures at Eneabba West are shown on Figure 4.

The Company's processing plant at Narngulu is located within the Narngulu Industrial Estate on Lot 2 owned by the Company (Figure 2).

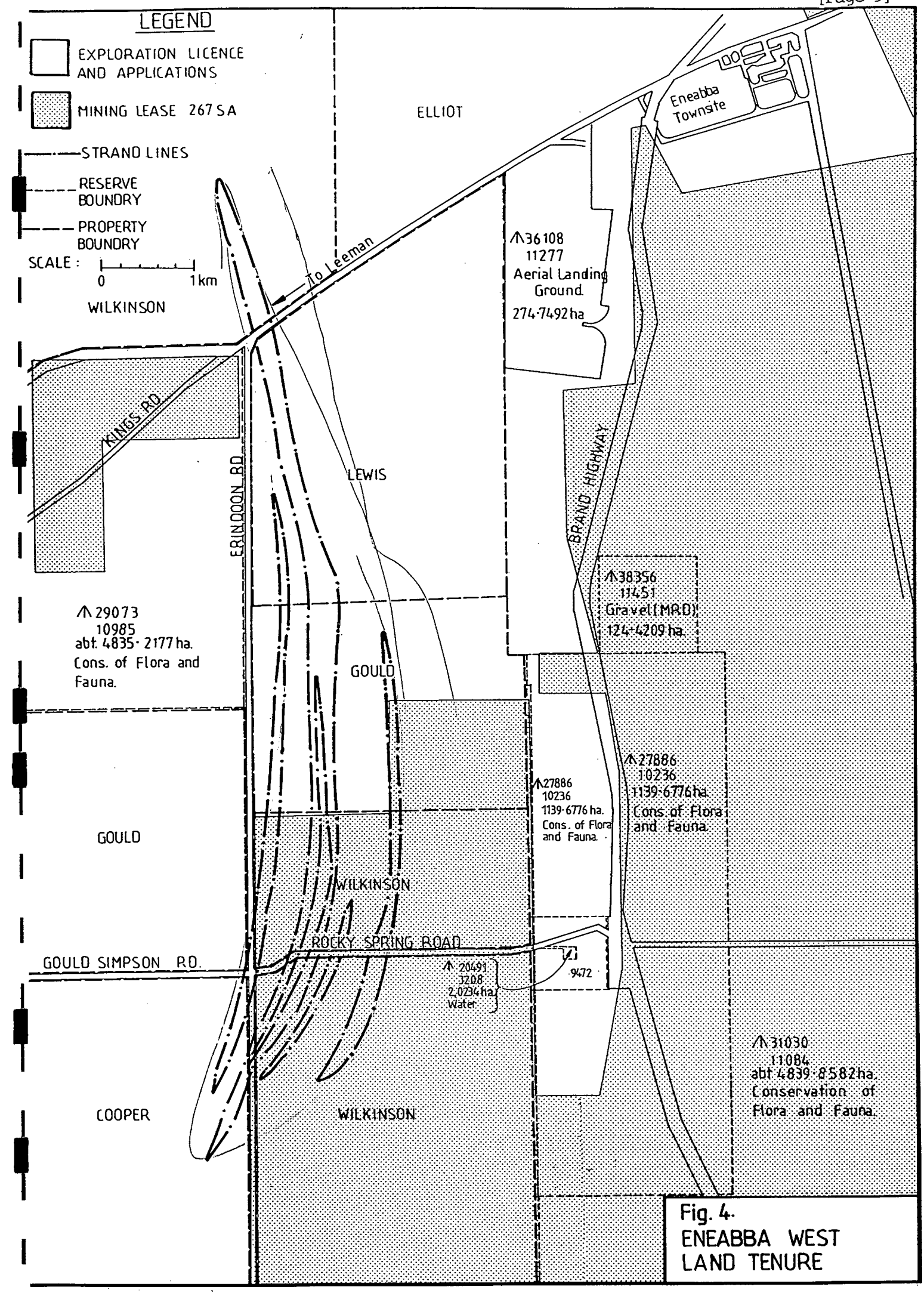


Fig. 4.
ENEABBA WEST
LAND TENURE

2. NEED FOR THE PROPOSAL

The need for the proposal arises from the strong market demand for mineral sands product in the marketplace. Proving up the Eneabba West ore body provides the opportunity for the Company and the State of Western Australia to consolidate their share of the world's market under these buoyant conditions. In so doing, benefits will flow to the community at the local, state and national levels.

At the local level, employment will be enhanced. The project will generate permanent employment for 36 persons at Eneabba and 28 persons at Narngulu. During the design and construction stages, short term employment will peak at 45 persons at Perth, 200 persons at Eneabba and 120 persons at Narngulu. Upon commissioning, additional flow-on benefits will arise through additional requirements for services.

The State's economy will benefit substantially from the capital expenditure of about $100 million, 90% of which will be spent in Australia. On an ongoing basis, increased operating expenses will flow through the economy in the form of salaries and wages and payment for supplies and services . Specifically, the State Government will receive increased payments from the Company of about $13 M, an increase of about 37%, in the form of royalties and payroll tax, as well as payments for power, transport and wharfage.

On a national level, the project will boost export earnings. For example, in the first year of full production, export revenue of the order of $90 M (1989 dollars) will be generated.

Hence, this proposal represents a significant project for the mineral sands industry in Western Australia.

3. EXISTING ENVIRONMENT

3.1 Eneabba West

3.1.1 Geology

The Eneabba heavy mineral deposits are located along a buried ancient scarp cut by wave action on exposed Mesozoic sediments as the shoreline retreated following a transgression during the Pleistocene period, some 1 million to 350,000 years ago.

At the time of maximum transgression, a wave cut platform was established along an irregular shoreline some 120 m above and 20-40 km inland from the present day shoreline. Heavy mineral concentrations were produced during severe erosive storms which preferentially removed the lighter (siliceous and calcareous) sediments from the normal beach profiles, thus concentrating very low proportions of heavy minerals into high grade bands (locally to 70%).

Periods of quiescence between storms allowed normal rebuilding of the beach profile with material introduced by rivers which drained crystalline rocks and Mesozoic sediments to the east, as well as with material cut directly from the Mesozoic sandstones, siltstones and clay below. Multiple storm cycles produced a series of lenticular concentrations termed "strands" along the ancient beach fronts and, as the sea level gradually fell, many of these were left above the level of future storm activity.

The storm concentrations of heavy mineral appear to have been developed most efficiently towards the southern ends of bays before the beaches terminated at a headland. One such headland at Eneabba controlled deposition of numerous strands between RL 112 m and RL 82 m, which have been mined extensively.

The Eneabba West ore body is a sequence of five strands deposited between RL 38 m and RL 31 m some five kilometres west of Eneabba. These are sub-parallel and extend for varying distances, the biggest being recognisable in drilling over a strike length of some 17 km.

Since deposition, the Eneabba West strands have been covered with between 15 and 30 metres of younger windblown and stream-deposited sediments, often quite clayey and usually showing only traces of heavy mineral. Patchy cementation, usually ferruginous but occasionally calcareous, has been introduced by groundwater movement throughout the sequence, but most commonly in the zone of fluctuating water table.

The five Eneabba West strands are potentially economic over varying strike lengths, with the longest strand apparently viable over some 13 km. The feasibility study is assessing a dredge path to mine all the viable area. This path contains over 200 million tonnes at an average heavy mineral grade of about 3%, containing economic quantities of rutile, zircon, ilmenite and monazite.

3.1.2 Climate

Eneabba experiences a dry mediterranean climate, with an annual average rainfall of about 530 mm. Winter rains usually commence in late May, and rainfall exceeds evaporation in the months of June, July and August only. Rainfall peaks in June with a monthly average of 129 mm.

Mean monthly minimum temperatures range from 9.0°C in August to 19.6°C in February. Mean monthly maximum temperatures range from 19.4°C in July to 35.8°C in February. However, temperatures exceeding 40°C are common during the summer months. On these occasions, surface soil temperatures can reach 65°C.

During the summer months, strong winds are experienced from the easterly quadrant in the morning, often swinging to the south west in the afternoon.

3.1.3 Hydrology

The Eneabba West area is on the Eneabba Plain which slopes gently to the west and north. Most of the surface sediments on the Plain consist of one or two metres of aeolian sand, but in lower areas underlying silty and clayey material is exposed. This extends to a depth of about 20 m where clays of older sediments are encountered.

The Company engaged groundwater consultants Rockwater Pty Ltd to investigate the hydrology of the site in relation to operational and environmental matters. The consultants have reported on the existing hydrogeology, sources of water, effects of mining and proposals for ongoing monitoring (Rockwater, 1989). A summary of their findings are included in this report.

There are no permanent streams in the area, but during winter water drains to Lake Erindoon through a network of minor streams and floodways with swampy heads to the west of Brand Highway. A large proportion of the total catchment has been cleared for agriculture. The catchment is very much larger than the area to be mined, and extends well to the south and west of the ore body. Two drains have been constructed to enhance inflow to the Lake from which there is no surface outflow. The Lake is saline and the salinity is apparently increasing. The Lake is an important local recreational facility.

An aquifer in the shallow sediments (Quaternary or Late Tertiary) is recharged by winter rainfall. Groundwater flows generally to the south and west towards Erindoon Creek, its tributaries and swamps in local depressions. On average,

there is little net recharge to the shallow aquifer because of the losses by evapotranspiration. Where the water table is close to the ground surface, there are large areas of saline soil in agricultural land along Erindoon Creek, and smaller areas in uncleared land (Figure 5).

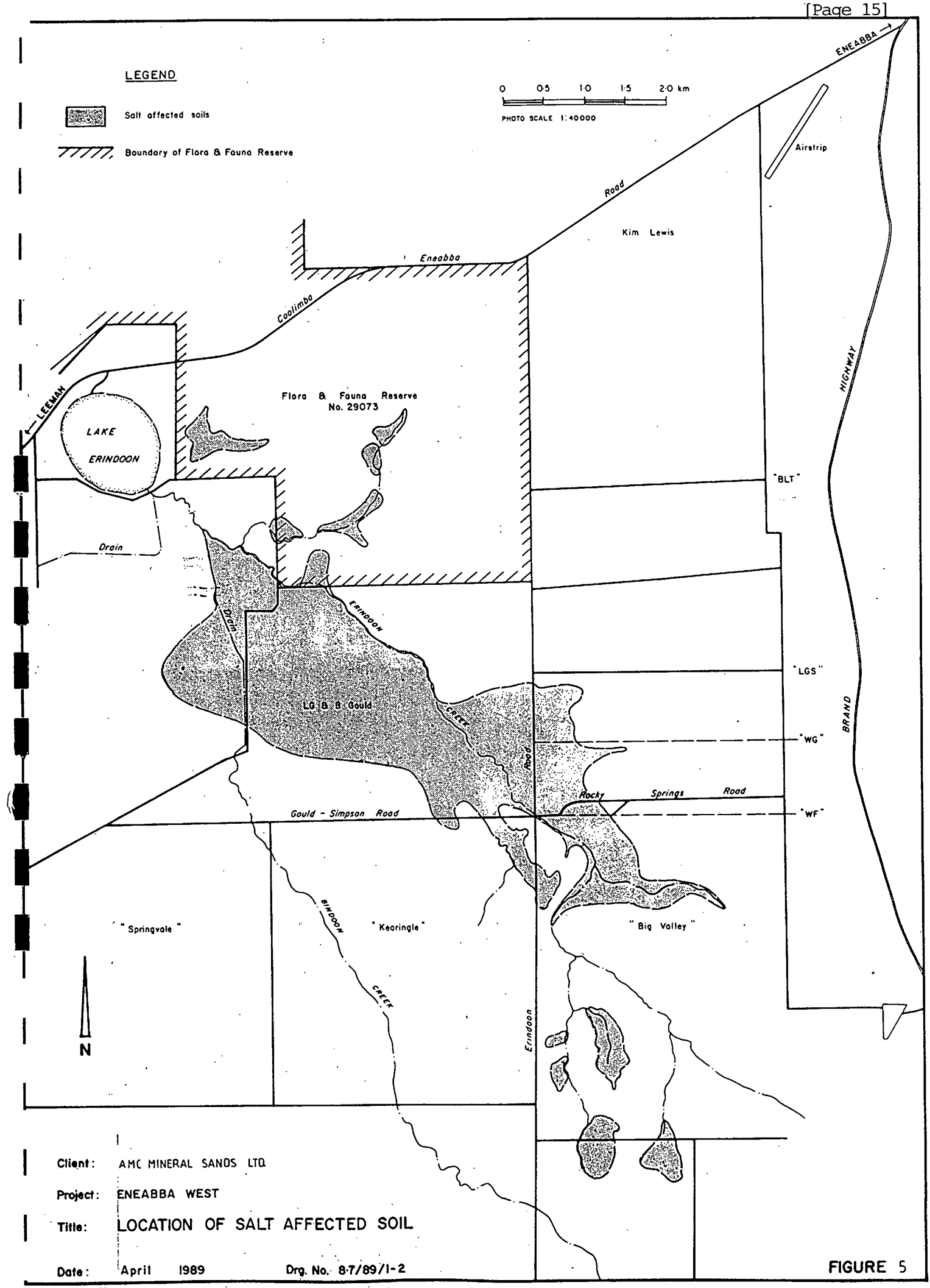
The major source of salt in the shallow aquifer is a diffuse natural leakage of saline water from an aquifer in the deeper sediments.

In this area, significant aquifers are known in the Cattamarra Coal Measures and the Eneabba member of the lower Jurassic Cockleshell Gully Formation. This formation is a potential source of large supplies of fresh to brackish water. Regional information suggests that there are deeper sandstones beneath the area, but these have not been confirmed locally.

Earth tanks and bores have been installed for water supplies in the area. Some earth tanks and a pool in Erindoon Creek contain water which is not suitable for stock, because of high salinity. Bores in both the shallow (less than 20 m) and deeper sediments provide water which is suitable for stock, and spears in one area are used for a domestic supply.

3.1.4 Vegetation

A botanical survey was conducted by consulting botanist J Elkington in September 1988 on the areas overlying the strandlines. A large part of the survey area has been cleared for agriculture, whilst most of the remaining native vegetation has been degraded by grazing. Progressive clearing of the native vegetation for agricultural purposes on the dunal rises appears to have contributed to salinization of soils in adjacent depressions, particularly on the southern parts of the ore body. Soils affected by salinization are indicated either by bare surface areas or by colonies of the salt tolerant Halosarcia sp.



Client: AMC MINERAL SANDS LTD.

Project: ENEABBA WEST

Title: LOCATION OF SALT AFFECTED SOIL

Date: April 1989 Drg. No. 8·7/89/1-2

FIGURE 5

ROCKWATER PTY LTD

During the survey, areas of native heath and pastures were mapped (Figure 6). Descriptions of the vegetation are summarised below from the Elkington's Report.

Native Heath

Uncleared native heath is mostly surrounded by pastures, and in many cases, remains on land considered unsuitable for clearing by the Department of Agriculture because of surface water or salinization. The heath is generally in a degraded condition because of grazing by livestock.

The native vegetation surveyed at Eneabba West is typical of that found in the Eneabba area. It extends into the Flora and Fauna Reserves nearby.

Within each vegetation type, the species present were identified and classified according to their abundance, using the subjective categories of common, frequent, occasional, scarce and rare. The term "rare" used in this assessment implies that a species was noted only once or twice in a vegetation type. It does not imply restricted distribution or gazetted rarity. A search conducted by the botanist, in consultation with the Department of Conservation and Land Management, did not locate any gazetted rare species.

The following vegetation types were defined within the native heath:

Banksia heath
Mixed low heath
Wetland heath

Banksia Heath. This vegetation was identified in 7 locations occurring on sandy rises and deep dune sands. The number of species represented ranged from 34 in a location adjacent to a water trough where grazing was evident, to 103 in a large area of heath.

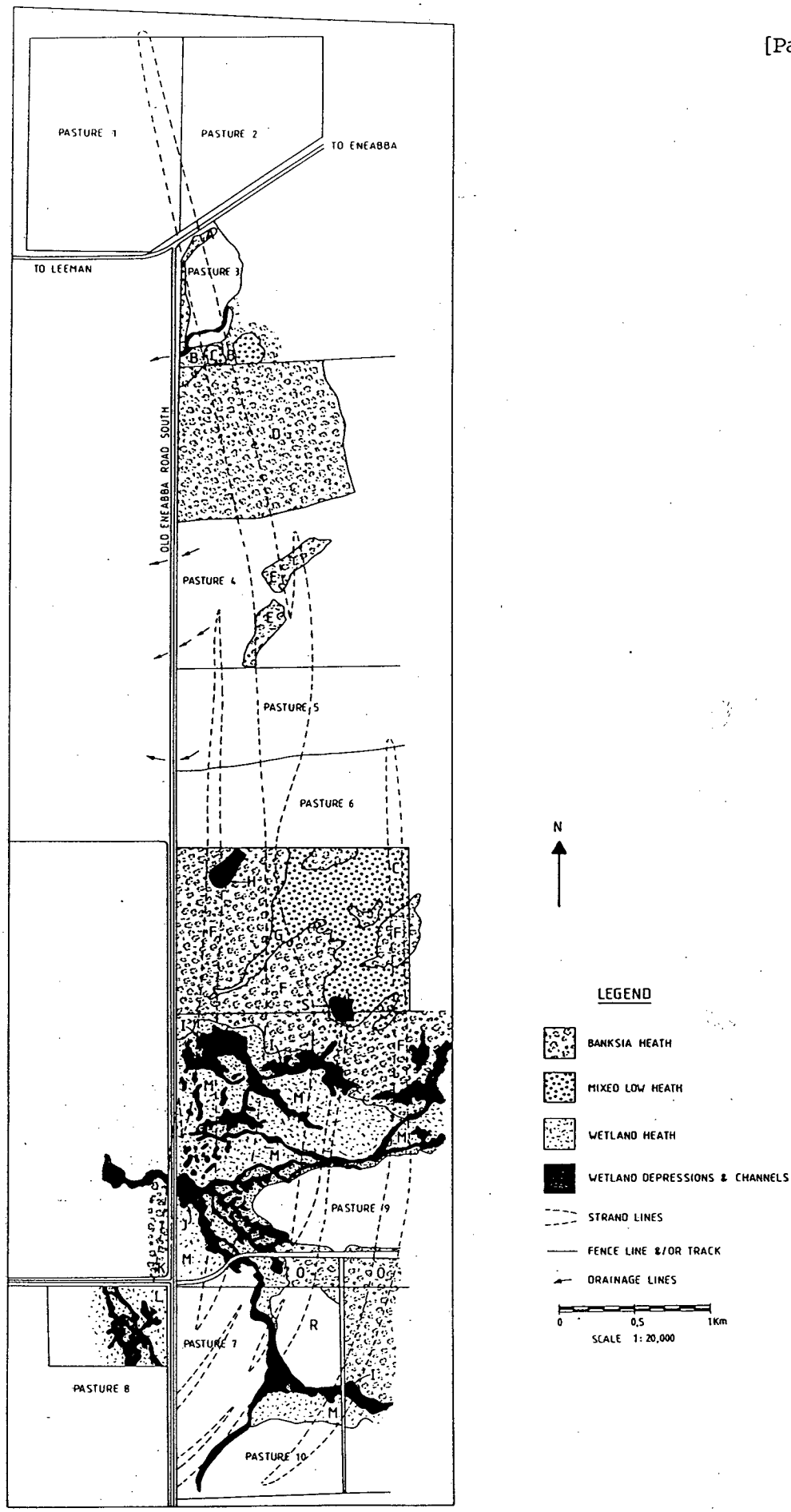


FIGURE 6. VEGETATION PLAN ENEABBA WEST.

The canopy is dominated by Banksia attenuata, B. candolleana, B. hookeriana and B. menziesii, with Xylomelum angustifolium and Nuytsia floribunda occurring as occasional emergents.

Beaufortia elegans, Hibbertia furfuracea and Phymatocarpus porphyrocephalus are the most common shrubs. The ground layer is dominated by perrenial monocots including Restio sphacellatus, Schoenus curvifolius, and a large number of Drosera spp where grazing is limited.

Mixed low heath. This vegetation was identified on four areas, usually downslope from dunal rises. Where it remained, this heath is in good condition with a variety of shrub species present. Astroloma xerophyllum, Hibbertia crassifolia, and Dryandra spp are frequent, with a ground layer not unlike that of Banksia heath. Banksia spp are found infrequently, except where drainage channels occur containing small specimens of Banksia leptophylla.

Wetland heath. A significant part of the native vegetation consists of wetland heath. It generally has a dense foliage cover dominated by Banksia leptophylla occurring with Melaleuca aff sclerophylla, Calytrix empetroides and Beaufortia elegans. The ground layer has few species, which is consistent with other wetlands identified in the Eneabba region. The area is traversed by a series of drainage lines each containing their own particular suite of species. These include Calothamnus villosus, Kunzea recurva, Leptocarpus tenax, Melaleuca hamulosa and M. raphiophylla. Water often remains in depressions along these drainage lines. These depresssions are small, less than 30 metres across. They do not exhibit zoned transitional vegetation as found in other wetlands of the region. Several of these depressions had open bare patches where shrubs and rushes are absent or sparse, although annuals, such as Stylidium obtusatum and Polypompholyx multifida occurred.

Agricultural Land

The pastures were assessed subjectively based on information received from the Three Springs Office of the Department of Agriculture.

For the Eneabba region a good pasture should consist of 50% legumes and 50% grasses with a good cover up to 50 centimetres high.

For the areas sampled, the pastures ranged from poor to good. Poor pastures were identified in several locations with blue lupins and the weedy species Hypochaeris glabra and Podotheca gnaphalioides dominating. Much of this land appeared to have been cleared recently.

Some pastures are of variable quality depending on where they were sampled. The ridges often supported deep rooted blue lupins with few other species, indicating free draining sands. Other areas had good swards of clover, serradella and capeweed. These shallower rooted plants often occur close to drainage lines. Good pastures were identified in three localities and contained closed swards of up to 50% clover. Rye grass and Hypochaeris sp were common here, with other grasses also present.

Areas of salinization brought about by clearing were also identified. These areas occur along drainage lines in swales, particularly in the vicinity of the Rocky Springs and Erindoon Roads. Bare patches of soil with salt tolerant Halosarcia sp were indicative of salt affected land.

3.1.5 Soils

Soils were examined at four sites representative of the topography and vegetation of the Eneabba West area, by AMC scientists. At each location, soil profiles were described, and samples collected for nutrient analysis.

The results indicated that soils underlying the pastures and native vegetation were similar. Generally, soils are podsolized sands with a shallow topsoil over deep sands. Topsoil depth was often ill defined, ranging from 0 to 13 cm. Some staining and minor laterisation of topsoils occurred within the drainage lines.

The fertility of the soils at all sites was low. Nitrate nitrogen ranged from 4 ppm in pastures to 7 ppm in wetland heath sites. Available phosphorous levels ranged from 5 to 9 ppm, with the higher values recorded under pastures. Soil pH values ranged from 5.6 to 6.6. High salt levels were found only in the wet heath topsoil sample. Below the soil surface at this site, salt levels were close to normal. This suggests deposition of salt in the drainage channel, and further concentration by evaporation.

3.1.6 Fauna

In view of the degradation of the remaining native vegetation on the ore body, it was considered that faunal studies would not be appropriate. Indeed, it would be expected that native fauna would be found preferentially in the undisturbed habitats within Flora and Fauna Reserve 29073 on the western side of Erindoon Road, or in Flora and Fauna Reserve 27886 to the east.

Observations by local landholders indicate that the areas of wetland heath are havens for vermin such as rabbits and foxes.

3.1.7 Land Use

The properties on which the ore body occurs are all private land currently being utilised as pastures for sheep and wool production. The pastures are not highly productive because of low soil fertility, and vary from poor on the deep sand ridges to areas of good pasture in the dune swales.

Remnant tracts of native vegetation remain in areas adjacent to these pastures on land that was deemed unsuitable for clearing because of soil type, surface water or potential for salinization. Grazing into the native vegetation occurs where it is accessible and open cover. Some of this native vegetation consists of regrowth of areas that were cleared for pasture establishment.

Recent applications have been made to the Department of Agriculture to clear native vegetation for pastures. These applications are considered in relation to the shallow surface waters particularly in the wetland heath where there is a potential for increased salinization. Some salinization is already evident within pastures.

3.1.8 Radiation

Under the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987), the Company is required to carry out pre-operational monitoring of radiation on the site. This will be conducted in the latter half of 1989 along the lines recommended in the Guideline issued by the Department of Mines in October 1987. Results will be reported to the Department of Mines as required under the Code.

3.2 Narngulu

3.2.1 Geology

The Narngulu Processing Plant site is located on the coastal belt immediately west of the Geraldton fault, a fault trending north-west through Narngulu with a downthrow to the west of approximately 250 m. The fault cannot be seen from the surface and, therefore, cannot be positioned accurately.

The formations underlying the site have been ascertained from geological interpretations by Groundwater Resource

Consultants Pty Ltd of three bores drilled during the construction of the existing processing plant and from driller's logs of bores established at other areas on the site.

The basement, believed to be sub-surface westward extension of the Northampton block comprising middle proterozoic granulite, granite and migmatite, was not intersected by any boreholes in the vicinity of the site.

The surficial deposits (recent and Quaternary sediment) are principally clay, with some sand and limestone of alluvial origin arising from the northerly migration of the Greenough River from a previous course south of Narngulu to its present location.

3.2.2 Hydrology

The groundwater supply potential of the Narngulu Processing Plant site has been investigated previously when 17 exploratory bores were drilled. These investigations, undertaken from 1973-1975, indicated that no significant quantities of non-saline water exist in the Narngulu area.

The main aquifers in the area are the late Jurassic Yarragadee Formation and the mid-Jurassic Kojarena Sandstone. Both of these contain brackish water of salinity about 10,000 mg/l total dissolved solids (TDS). Three production bores established on the site concentrated on the mid-Jurassic Yarragadee Formation proved to be of insufficient thickness and porosity to be a useful aquifer. These bores, of which only one remains in service as a supplemental supply, were installed to supply water at a rate of 1.1 ml/d.

Potable groundwater, of quality less than 1,000 mg/l TDS, can occur in isolated pockets of sand or limestone, generally at a depth of less than 20 m. These pockets have limited

recharge capacity from infiltration of surface waters, and past experience indicates that these rapidly become saline if exploited at pumping rates above 0.02 ml/d.

Information on regional groundwater flow is sparse, but it is believed that flow is probably to the south, towards the ancestral Greenough River, as indicated by the surface topography, and hence to the ocean. Data from a former hydrogeological study indicate that the groundwater movement would be at a rate of about 50 m/a.

A bore census conducted as part of this study in July/August 1984 located details of 62 groundwater points within a 5 km radius of Narngulu. These included the three existing bores already described, some bores abandoned as long ago as 1898 because of high salinities, and other points which are simply soakage supplies. Salinity records indicate generally brackish waters, in the range of 3,000-5,000 mg/l of chloride, used principally for domestic stock watering purposes and irrigation of saltine turf.

3.2.3 Radiation

The Processing Plant is extensively monitored as part of the continuing radiation safety activities carried out by the Company. Full compliance with the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987) is demonstrated through annual and quarterly reports to the Department of Mines.

3.2.4 Air Quality

Measurements of ambient dust levels and sulphur dioxide concentrations were carried out on the lease boundary during 1986/87 and reported to the EPA. It was concluded that the highest 24 hourly dust concentrations, of around 660 micrograms per cubic metre, were mainly due to wind blown dust, a natural phenomenon in the area. No sulphur dioxide

levels above the minimum detectable level were measured. Because of the nature of activities, it is not expected that the proposal will lead to significant changes in ambient air quality.

4. CONSIDERATION OF ALTERNATIVES

4.1 Mining Method

Current operations at Eneabba involve two different mining methods. These are dry mining, using earth moving equipment to transport ore from a dry pit to a stationary concentrator, and dredging whereby a dredge and concentrator float in a pond excavated on the mine path. Both methods were considered for the new operation.

At Eneabba West, the base of the ore body lies some 20 metres below ground water level. Ground surface lies at groundwater level in parts and rises to 15 metres above water level in other parts.

Dry mining was discarded because of the impracticability of dewatering the ore body to the depths required. Conversely, dredging could effectively utilise the high water table. Further, being a lower cost mining method, dredging is more economic for the relatively low grades of the ore body.

4.2 Processing Plant Location

Concentrate from the Eneabba North mine is treated at a Processing Plant located at the minesite. Conversely, concentrate from the Eneabba South mine is railed to the Narngulu Processing Plant near Geraldton, following attritioning and drying at the Eneabba South concentrator.

The treatment of the Eneabba West concentrate will require additional circuitry to handle the increased tonnage arising from this operation. A cost study was carried out to examine the economics of locating the additional processing facilities at either Eneabba or Narngulu. The results revealed that neither site had an economic advantage over the other. Thus, the decision involved the consideration of logistical and social factors. On that basis, Narngulu was selected for the following reasons:

1. The workforce is more stable at Narngulu with a labour turnover almost one quarter that of Eneabba.

2. Easier and cheaper access to service contractors and casual labour at Narngulu.

3. Site management at Narngulu is dedicated to processing.

4. Housing accommodation is more readily available in Geraldton for the Narngulu site. At Eneabba, additional housing would be required.

5. At Eneabba it would be more difficult to handle a construction workforce of 250-300 personnel with the simultaneous construction of dredge, concentrator, housing and processing plant.

6. The State Government is encouraging development in the Geraldton region.

4.3 Water Supply

Rockwater (1989) estimate that a water supply averaging about 1500 cu m per day (range 500-2,000 cu m per day) is required to make up for losses by evaporation from the dredge pond and tailings areas. However, requirements could peak at up to 4,500 cu m per day for short periods in summer. Three sources of water are under consideration: the shallow sediments (less than about 20 m), the Cattamarra Coal Measures in the Cockleshell Gully Formation at about 140 m depth, and the deeper Yarragadee Formation east of the fault line.

Previous test pumping has shown that up to six bores in the Cattamarra Coal Measures will provide for the peak water requirement. This is the preferred supply at this stage of investigations. The costs of construction and reticulation probably would be much greater to provide the necessary supply from the shallow or deeper sediments. Test pumping has shown that about 30 bores would be required to meet the peak demand for water from the shallow sediments. Drawing from the deep aquifer would involve pumping from east of the Brand Highway.

Rockwater (1989) advise that the use of water from the Cattamarra Coal Measures will introduce additional salt to the shallow sediments. However, this will be very small (about 2%) in comparison with the quantity of salt already in these sediments.

4.4 Rehabilitation

The basic options for rehabilitating the land after mining are native vegetation or agricultural production. As the site is all private land, the landowners would be interested in maximising the potential for agricultural production. However, the Department of Agriculture considers parts of the land to be unsuitable for agriculture, mainly because of the high water table and associated salinization.

The spread of soil salinity can be reversed by lowering the water table to below the rooting depth of plants. One possible way of achieving this reduction involves the construction of artificial lakes in the mine tailings. The base of these lakes should be one or two metres below the present summer water table, and they should not be lined. Groundwater would be lost from the lakes by evaporation. The land surface around these lakes would be graded and would provide conditions suitable for wetlands vegetation to increase evapotranspiration. The design of the lakes, their size and the numbers required to lower the water level by a significant amount will be investigated.

An important strategy to minimise groundwater recharge and to lower groundwater levels is to establish deep rooted vegetation to increase evapotranspiration. Native vegetation is particularly suitable for this purpose and will be established on areas unsuitable for agricultural production. On agricultural land, a range of further options are available. Lupins, being deeper rooted than clover-based pastures, use more water. Lucerne and tagasaste also have potential to lower water tables significantly, and their use will be investigated. There is also scope for planting belts of trees.

Rehabilitation strategies will be developed progressively in consultation with the landowners and officers of the Department of Agriculture following the appropriate investigations. They will be submitted to the Minister for approval under the reporting provisions of the Agreement Act.

5. DESCRIPTION OF OPERATIONS

5.1 Mining

5.1.1 Mining Method

The proposed dredge operation involves the construction of a bucket wheel dredge which will float in a pond averaging 15 metres in depth. The position of the dredge will be controlled by spuds and winches.

The rotation of the wheel will allow the buckets to cut the ore in a vertically upward direction. The design of the wheel and buckets will direct ore into the dredge pump suction. The pump will deliver the water/sand/clay mixture through a floating delivery line to a floating concentrator located towards the rear of the pond.

The concentrator will be manoeuvered by the use of winches which will be attached by steel ropes to movable anchors located on the bank.

On board the concentrator, the slurry will be screened through a trommel to remove oversize material which will be returned to the dredge pond. Clay slimes will be removed via planned overflows from the primary feed bin and returned to the dredge pond where they will settle to the pond bottom. The heavy mineral concentrates will be separated from the sand slurry by gravity separation using banks of spirals. The concentrate will then be pumped ashore to a centrally located stockpile and dewatered by a cyclone. Cyclone overflows will be returned to the dredge pond.

Meanwhile, submersible pumps will withdraw settled clay slimes from the pond bottom. Clay slimes and sand tailings will be combined and pumped to the rear of the dredge pond. Transverse levees will be built from concentrator tailings to keep the clay and sand in the area of deposition and prevent migration to the front of the pond.

An area of 20 hectares would be cleared for the construction of the dredge and concentrator.

The concentrator will be constructed as a floating unit requiring an area of 2.5 hectares to be excavated to a depth of 3 m below ground level. The dredge will be constructed on a two hectare area of dry ground situated beside the concentrator site. Following construction both areas will be flooded to a level which will enable the concentrator to float above the dredge construction pad.

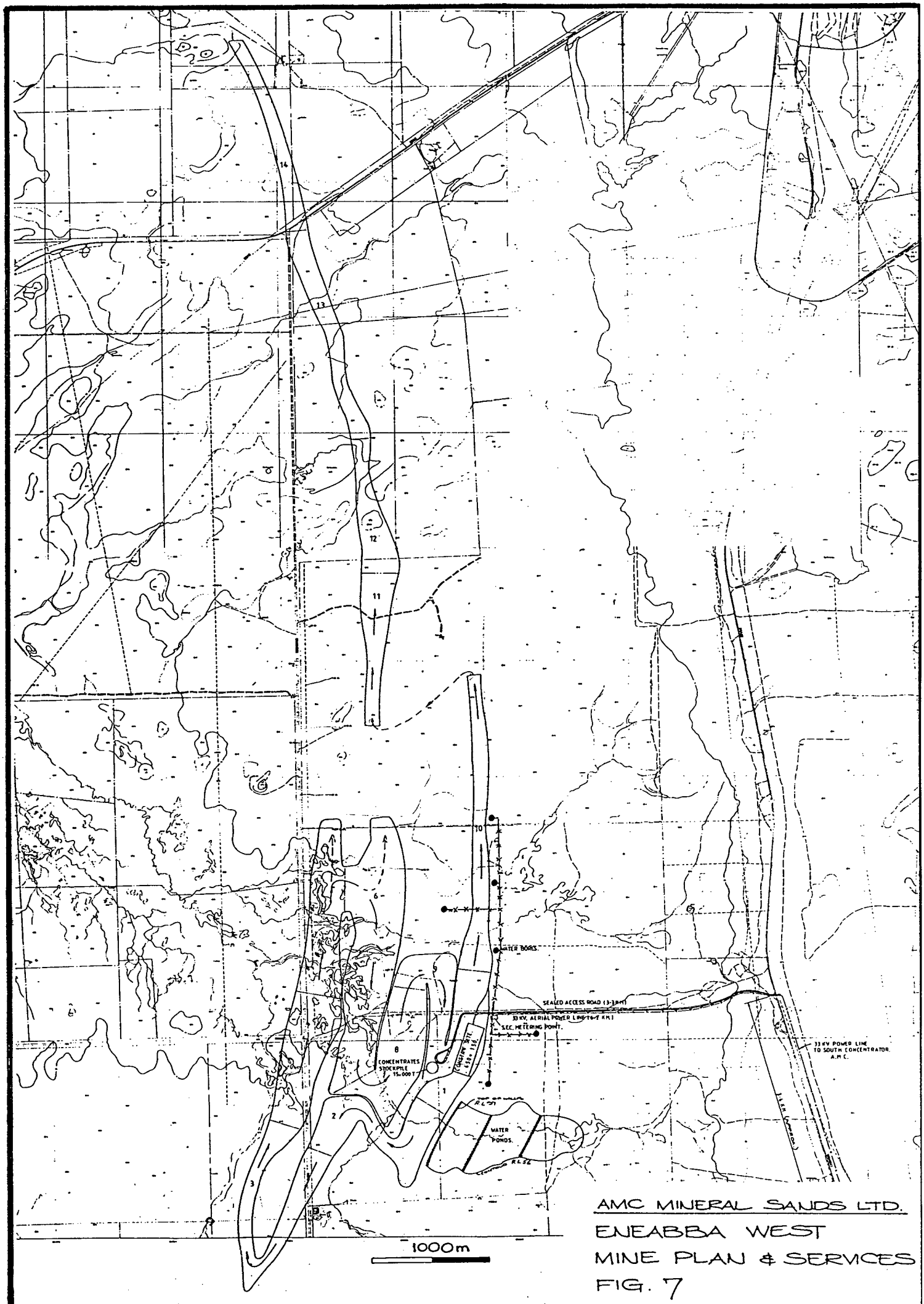
Material excavated will be used to build levee walls around the excavated areas to enable the water level to be increased following construction.

The water supply bores will be constructed beside the mine path and their output, together with the surface water from the 1990 winter rains, will be used to fill an initial water supply dam. The dam will be formed by constructing a levee wall across a drainage area lying to the east of the dredge path (Figure 7). The wall will be six metres high and will allow the retention of one million cubic metres of water.

At the commencement of operations, the dredge and concentrator will be floating above the construction pad. As the dredge pond is excavated to full size, tailings from the operation will be pumped to the water storage dam. Water will be pumped from the dam to the dredge pond to maintain the pond water level.

After mining commences, the dredge and concentrator will only be able to reach the planned mining base by a controlled reduction of the pond water level. The water level will be reduced by expanding the pond volume, retaining water in tailings and evaporation.

The water dam will be filled with tailings during the first four months of mining. Beyond that time the dredge pond will



AMC MINERAL SANDS LTD.

ENEABBA WEST

MINE PLAN & SERVICES

FIG. 7

have sufficient volume to allow the normal continuous operation of placing tailings in the dredge pond to the rear of the concentrator.

5.1.2 Mine Plan

The planned dredge path (Figure 7) will follow the parallel strandlines lying approximately north-south, with short east-west turning points. The average operating width will be 400 metres whilst the length of the dredge pond and associated tailings disposal areas will vary according to the varying configuration of the dredge pond. The pond depth will be about 15 metres. Although the ore body is 20 metres below the ground water level, hydrological studies have shown that the loss of water through evaporation, as well as that retained in tailings, will be sufficient to enable the dredge pond to be held at a level some 5 metres below groundwater level. The natural ground will therefore always be higher than the pond water level.

The mine life is estimated at 13 to 14 calendar years.

5.1.3 Water Supply

Make-up water for the dredging operation will be approximately equal to evaporation losses minus groundwater inflows to the dredge pond. Hydrological studies by Rockwater (1989) estimate that make-up water requirements are likely to average about 1,500 cu m per day.

Pond make-up water will be supplied by up to six screened bores drawing from the Cattamarra Coal Measures approximately 140 metres below the surface. The Company will apply to the Water Authority for a licence to install and operate the bores.

5.1.4 Power Supply

Power will be drawn from the SECWA grid system at 33 KV. A new line will be constructed running from the Eneabba substation north along the Brand Highway, a distance of 3 km, then along Rocky Spring Road to the lease boundary, a total distance of approximately 10 km.

A Company owned 33 KV aerial distribution system will be installed to supply the mining plant and water bore pumps. A mobile 33/11 KV transformer will feed the dredge and concentrator via a trailing cable.

A total supply estimated at 11.5 MVA is required for the Eneabba West dredge and concentrator.

Existing power installations have sufficient capacity to supply the additional requirement at the Eneabba South concentrator.

5.1.5 Transport

The Company has held a series of discussions with the Main Roads Department and the Shire of Carnamah regarding roadworks. All roadworks will be constructed at Company expense to MRD and Shire standards with special regards to road safety.

The main access to the Eneabba West minesite for services and concentrate haulage will be from the Brand Highway via the gazetted Rocky Springs Road. The access road will be constructed to highway standard and will be surfaced with hot mix. At the "T" intersection with the Brand Highway, a "STOP" sign will be erected on the Rocky Spring Road. The Brand Highway will be widened from this point to allow the construction of overtaking lanes up to a distance of 800 metres to provide for safe acceleration and deceleration of vehicles entering and leaving the access road.

Further south, the access road to the Eneabba South concentrator on the east side of the Brand Highway will be similarly constructed.

Both junctions with the Brand Highway will be located to ensure that vehicles entering the highway have clear visibility for a distance of 400 metres in both directions. Additional access to the minesite for employees residing in Leeman may be gained via Erindoon Road from the Leeman - Eneabba Road. Traffic from this source will be minor and will relate to changes of shift.

At the minesite, the concentrate stockpile will have a capacity of 15,000 tonne to allow further dewatering of the concentrate after cycloning prior to loading for transport to the Eneabba South Concentrator. Concentrate will be loaded into road trains using rubber tyred front end loaders. It is proposed that road haulage will be carried out by a contractor, with a road train of 50 tonne capacity departing every 40 minutes on a continuous 24 hours per day, seven days per week basis.

Following attritioning and drying at the Eneabba South Concentrator, concentrate will then be transported to the Narngulu Processing Plant by the existing dedicated rail system.

5.1.6 Manpower and Housing

On-site assembly of a dredge and concentrator, together with other related works, requires the provision of temporary accommodation and messing in the Eneabba area for a peak workforce of some 200 persons, which will be managed by AMC. The camp will be required for a period of approximately 12 months from January 1990.

It is proposed to site the camp in the township of Eneabba, utilising the existing facilities at Banksia House, the Company's single persons quarters. Additional temporary accommodation will be in the form of airconditioned, 6 single room transportable bunk houses, with associated ablution and laundry blocks.

Bunk houses will be arranged in clusters in a landscaped area, separated from the existing quarters by the car park, and with covered breezeways linking the various facilities.

Additional temporary catering and recreational facilities will be provided in line with the increased labour force.

Temporary married accommodation can be adequately catered for by commercial caravan parks in the vicinity.

The existing commercial and recreational facilities in the town will cater also for the needs of the construction workforce.

Upon commissioning of the dredge and concentrator, additional permanent employment will be generated for 36 persons. Accommodation for these additional employees will be provided at both Eneabba and the nearby coastal town of Leeman. At Eneabba, the existing permanent Banksia House facilities will be expanded to house another 10 single persons.

Accommodation for extra married employees and their families will be provided by the construction of 26 homes at Leeman. These will be a combination of two bedroom units and three bedroom houses. These will be constructed within an existing sub-division developed by Western Titanium Limited in 1976. The sub-division has all roadworks, drainage, water, deep sewerage and power installed. AMC presently owns eight housing lots in the sub-division and will purchase an additional eight lots from the Department of Land Administration, which owns the balance of the sub-division. Two units will be erected on each building lot.

The Shire of Coorow are being kept fully informed of the Company's proposals.

All accommodation will be built to Shire building and health standards.

5.2 Processing

5.2.1 Processing Method

The heavy mineral concentrate from Eneabba West will be separated into saleable products by new plant to be erected within the environs of the existing Processing Plant at Narngulu (Figure 8). The expanded plant will integrate services such as air, water and power supply, and tailings disposal systems. Operation of all circuits will be managed by the same workforce using a common central control room.

The plant will operate 24 hours per day, 365 days per year and treat approximately 400,000 tonnes per annum of concentrate, producing about:

40,000 tpa rutile
60,000 tpa zircon
200,000 tpa ilmenite
2,000 tpa monazite

Concentrate will be railed from Eneabba and unloaded via an existing facility. A transfer conveyor will direct the material into two new 3,500 tonne feed bins located adjacent to the existing bins.

Separation and purification of the valuable heavy minerals will make use of their properties of magnetic susceptibility, electrical conductivity, specific gravity and particle size. A schematic flowsheet is shown in Figure 9.

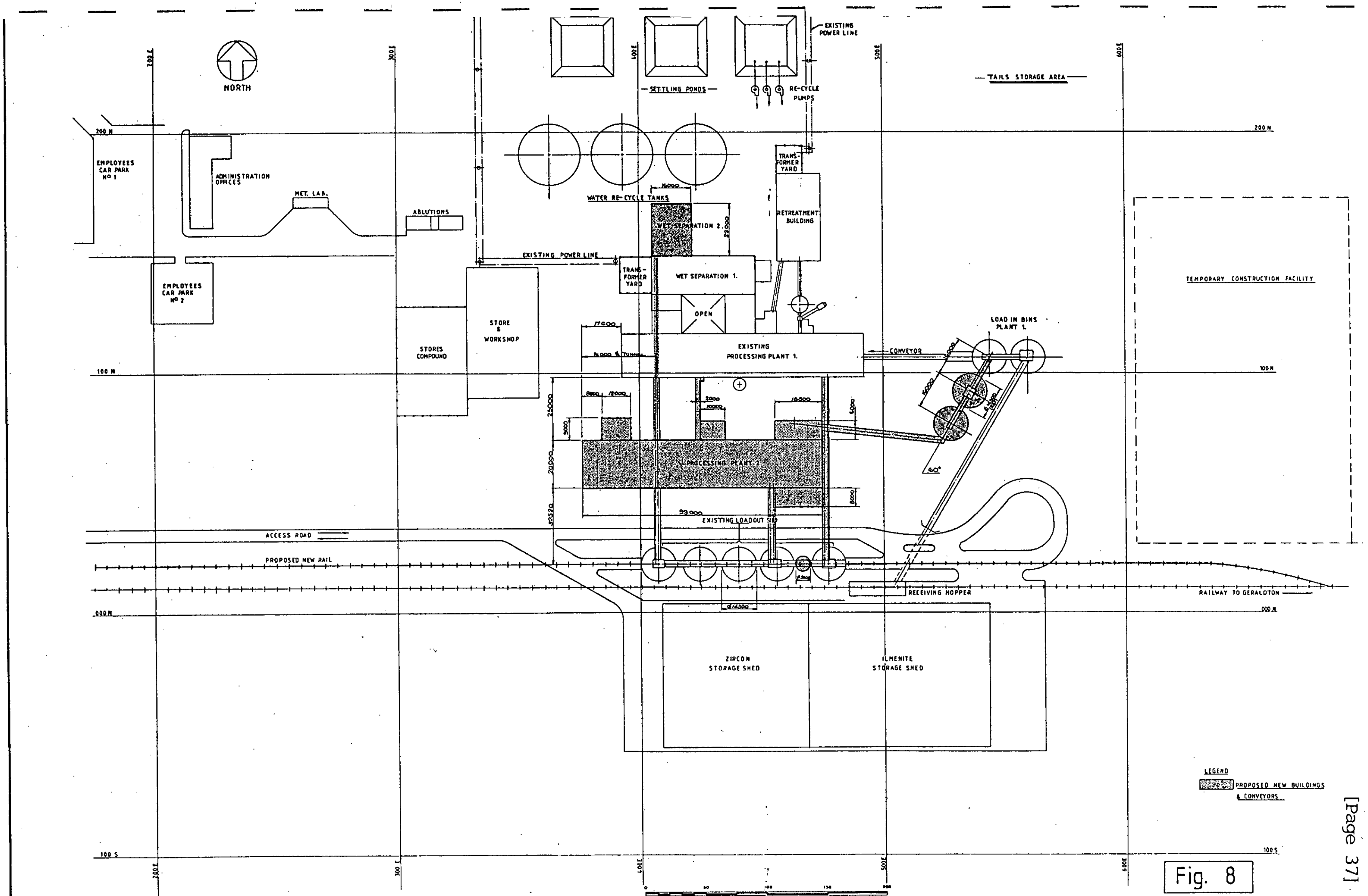


Fig. 8

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			NARNGULU PROCESSING PLANT SITE PLAN
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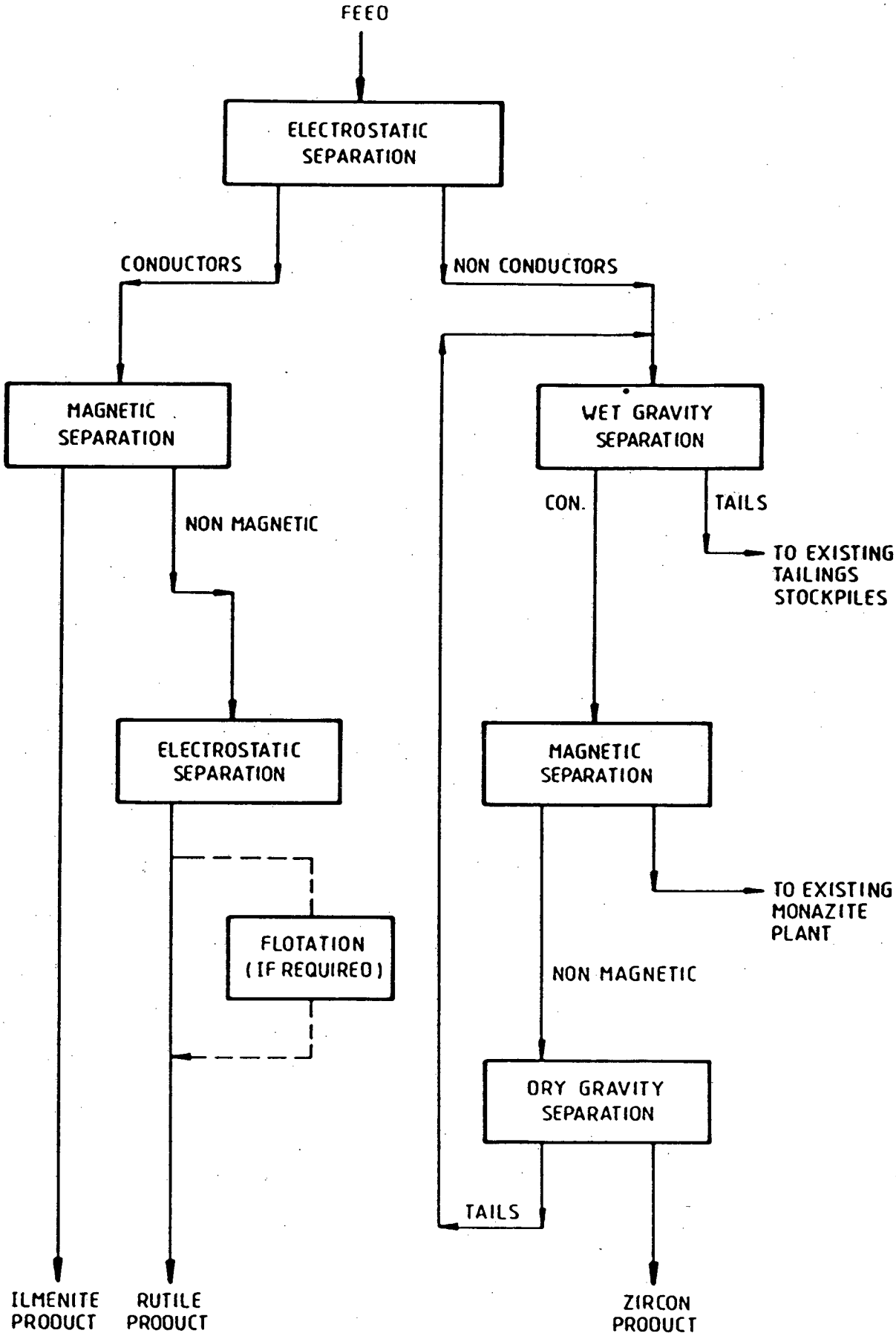
A 2-1-89 DRAWING REVISED & DIMENSIONS ADDED



PROCESSING PLANT FLOWSHEET

FIG. 9

The initial separation will be electrical, utilising high tension rolls and electrostatic plates to produce a conductor product containing mainly ilmenite and rutile, and a non-conductor containing zircon and monazite. As high temperatures are required for efficient separation, the material will be preheated and heaters will be used to maintain temperatures.

An ilmenite product will be recovered from conductors using high intensity crossbelt and induced roll magnets. The non-magnetic product will be further cleaned by high tension and magnetic separation to become a rutile product.

Minor amounts of pyrite are present directly below the ore body and could, on occasions, contaminate the rutile product. A flotation circuit with reagents will be installed, if and when necessary, for use as required to remove the pyrite.

The non-conductors from the initial electrostatic separation will go through a wet gravity circuit to reject the low specific gravity tailings minerals, which cannot be processed to a saleable product at this time. The concentrate from this stage will undergo further high tension cleaning and magnetic and gravity separation to produce a zircon product and a monazite concentrate. The latter will be cleaned to product grade in the monazite section of the existing plant using size, wet and dry gravity separation and dry magnetic separation.

Product will be stored in the existing product bins which will be increased in number from five to six. This product will be transferred to the wharf for export.

5.2.2 Tailings Disposal

Tailings from the expanded processing plant will be generated at the rate of about 150,000 TPA (80,000 m^3 per annum).

The tailings will consist of silica, "trash" minerals and small quantities of valuable heavy minerals. They will be disposed of in earth bunkers on site in such a way as to enable future retreatment to extract all recoverable valuable heavy mineral. Detailed records of tailings analysis and placement will be kept to facilitate this retreatment.

There is ample area available on site to permit storage of tailings well beyond the life of mine.

Most of the process water from the flotation circuit will be recycled. The small quantities of tailings and process water discharged by this circuit will be transported by road tankers to the Company's adjacent synthetic rutile plant and disposed of in lined dams. The quantities of material handled will vary according to the intermittent use of the flotation circuit.

5.2.3 Water

A total water usage of up to 5,000m^3 per day will be required for the combined operations of which about 95% will be recirculated. The make-up of 300m^3 per day will come from the scheme supply. This will increase the fresh water usage from 450m^3 per day to 750m^3 per day, which is well within the current entitlement of the site at 1,315m^3 per day.

5.2.4 Power

Power consumption at the site will increase by 2.2 MW as a result of the additional processing to a total site consumption of 4.1 MW. The Company has advised SECWA of this increase. Investigations into the capacity of the existing system to supply this power are in progress.

5.2.5 Transport

The Eneabba West Project will generate over 400,000 tonnes heavy mineral concentrate per annum. Together with the Eneabba South concentrate, which is currently processed at Narngulu, total railings from Eneabba will exceed one million tonnes per annum. The concentrate will be railed in trains of 2,000 tonnes capacity. Negotiations are in place with Westrail as to the most effective way of handling this requirement.

Currently, between 400,000 and 500,000 tonnes per annum of finished product are road hauled to the Geraldton Wharf for export. The Eneabba West Project will generate about 300,000 tonnes per annum of additional product, including rutile, zircon and ilmenite, for shipping. As an alternative, negotiations are taking place with Westrail regarding rail transport, which is our preferred option to reduce traffic. It is expected a decision on the method of product transport will be made shortly.

In addition, monazite production will increase by about 2,000 tonnes per annum. Existing methods of transport will be used for this product. These involve packing the product in 2 tonne bags, placing the bags in containers and transporting them by rail to Fremantle for export.

5.2.6 Manpower

By integrating this plant with existing facilities some economies have been achieved. Total manpower at Narngulu will increase by an additional 28 people, and it is expected that these people can be accommodated in Geraldton.

5.2.7 Occupational Health and Safety

In 1988, the existing Narngulu Processing Plant underwent significant modifications to improve metallurgical

efficiency. The opportunity was taken at the same time to install new equipment to improve dust, radiation and noise control following major investigations by AMC over the previous three years. This work included the installation of fully enclosed separating equipment, and the containment and extraction of any dust generated. This had the added benefit of reducing heat and noise exposure significantly. Monitoring results in these areas show significant improvements in ambient dust levels.

It is proposed to install similar equipment in the new plant constructed to treat the Eneabba West concentrate. A description of the existing occupational health and safety practices that will be applied to the new plant is given in Section 6. 2. 2.

5. 3 Project Timetable

The feasibility study presently being prepared is scheduled for presentation to the RGC Board for approval at its August meeting.

Construction contracts are being negotiated with an acceptance date of 1 October 1989. Thus all government and corporate approvals and licences must be in place by that date.

Site construction is programmed to commence at Eneabba on 1 October 1989 and the dredge and concentrator are scheduled for commissioning in December 1990.

Site construction at Narngulu is scheduled to commence during January 1990, with the plant commissioned by March 1991.

6. ENVIRONMENTAL EFFECTS AND MANAGEMENT

6.1 Mining

6.1.1 Hydrology

Rockwater (1989) report that their investigations indicate that excavating the dredge pond into the superficial deposits, and subsequently filling this excavation with tailings and slimes could have both short term and long term environmental effects in the Eneabba West area. Management strategies have been devised to prevent or minimise the development of deleterious effects.

The water level in the pond generally will be 3 to 5 m below the present average groundwater level. This will lower the water level in the superficial aquifer by up to 1 m at a distance of 1 km. The drawdown will be less than the seasonal fluctuation of water levels at distances of more than about 1,500 m.

As the dredge pond moves along mineral strands, the water level at a particular point will firstly fall to a minimum, and then recover by groundwater flow and recharge from rainfall. Both the extent of the drawdown and the period of disturbance will decrease with distance from the dredge path. At a distance of 200 m from the edge of the path of the dredge moving at a steady 1 km per year, the groundwater level will be lowered by more than 1 m for about 2 years, and by more than 2 m for about 1 year.

These temporary drawdowns are expected to have little or no effect on sources of water on neighbouring farms, except where dams rely on groundwater seepage. Alternative supplies will be provided, where necessary, over the period of drawdown.

Soil salinity is dependent on the depth of a shallow water table. The period of water table drawdown will result in salt being leached downwards by rainfall. Those areas currently effected by soil salinity will experience some reduction of salinity within about 500 m of the dredge path. This effect will be a benefit arising from the project.

The small and temporary drawdown of groundwater levels near the dredge path should not affect the Banksia heath and mixed low heath vegetation associations which are not dependent on the presence of a shallow water table.

Areas of wetland heath and wetland depression vegetation should not be affected by mining beyond a distance of about 100 m from the edge of the path of the dredge pond. It is probable that vegetation within the 100 m strip would survive the temporary lowering of the water table without significant effect. This will be confirmed by observations in the early stages of mining.

From about Year 11 onwards, the dredge will be mining to the east of Flora and Fauna Reserve 29073. For the most part, the dredge path will be 300 to 600 m east of the eastern boundary of the Reserve, although for part of the last year of mine life, the dredge comes closer to the boundary. However, at no time does the dredge path come within 300 to 400 metres of wetland vegetation in the Reserve. By that time, drawdown effects, if any, will be well established and, if necessary, strategies developed to minimise the effects of water level changes.

Groundwater levels will recover soon after mining, as a result of lateral flow in the superficial aquifer and recharge by rainfall. There will be an increase of groundwater recharge before tailings and other disturbed lands are adequately revegetated. A long period of high recharge would cause some increase in the area of saline soil and consequently damage to plants. This will be prevented by

keeping the area of disturbance for operational purposes to a minimum and by ensuring that mined areas are rehabilitated quickly. In keeping with normal company practice, all mined areas will be rehabilitated the winter following the completion of tailings disposal. In this way, evapotranspiration will be maximised and groundwater recharge minimised.

Outside of the agricultural areas, native vegetation will be planted as much as possible. Alternative agricultural crops and tree belts will be investigated to improve production and to reduce the rate of groundwater recharge on farmland. The use of artificial lakes to maximise water loss by evaporation, and to provide watering points for fauna and stock will be investigated.

The flows of water and salt to Lake Erindoon will be very slightly reduced during the mining operation by the lowering of water levels in the vicinity of the dredge pond. At any time, this area will be small in comparison with the whole catchment of the Lake, and consequently the effect of the Lake will be small.

Pumping water from the Cattamarra Coal Measures into the dredge pond will slightly increase the salt content of the surface sediments, and possibly increase slightly the long term inflow of salt to Lake Erindoon. This will be prevented by the strategies to lower groundwater levels using vegetation and possibly artificial lakes to maximise evapotranspiration.

6.1.2 Rehabilitation

The Company is committed to achieving a high standard of rehabilitation at its minesites. This is illustrated at the existing Eneabba operations, where the Company currently conducts a large, sophisticated rehabilitation programme concentrating on the re-establishment of native ecosystems.

Approximately 90-100 ha are treated each year. The existing resources of manpower and equipment will be applied to the rehabilitation of the Eneabba West operation and have the capacity to handle the extra area. The rehabilitation programme is supported by an extensive programme of research and investigations.

Rehabilitation costs are treated as a normal mining expense. The estimated costs are charged against the mine on a monthly basis relative to areas disturbed. The funds are credited to a rehabilitation provision account and, as rehabilitation proceeds, actual costs are debited to the provision account. This account is reviewed regularly to ensure that it holds sufficient funds to cover the rehabilitation of areas occupied by the mining operation. In this way, funds are available to complete rehabilitation at the end of mine life.

Existing rehabilitation methods will be applied to areas rehabilitated to native vegetation at Eneabba West. The initial step will involve re-establishment of the landform by the placement of tailings on the mine path, and contouring the surface. Topsoil which has been stripped ahead of mining and stored will then be respread. The soil surface will be stabilized by planting a low density cover crop and by spreading mulch harvested from areas to be mined. A seed mix, composed of species collected locally for the particular vegetation association being established, will be sown to augment seed contained in the topsoil and mulch. Selected species may be planted out as nursery stock in the second year to supplement other establishment procedures.

Rehabilitation for agricultural use will also involve re-establishment of the landform and replacement of topsoil. The land would then be planted to the selected agricultural crops using conventional techniques.

The water dam built to store water for the commissioning stage (Figure 7) will be progressively filled with tailings as the dredge establishes the permanent dredge pond. Thus, the final land surface behind the dam wall will be up to five metres above the original valley floor and, hence, above the ground water table. Tailings will also be stacked against the downstream side of the dam wall such that the final land surface will have a gentle gradient. The effect of increasing the ground level will be to increase the area of arable land and it will be planted to a suitable agricultural crop.

Raising the ground level in this way will also significantly reduce the catchment area of this particular valley. Some surface flow could still be expected and the finished surface will be shaped to provide for this flow. Consideration will be given to planting belts of trees to intercept surface flows at the head of the valley and seepage flow at the toe of the tailings.

The Agreement Act contains the necessary provisions for the Government to control the environmental aspects of mining. In keeping with current practice, specific mine plans and rehabilitation plans will be submitted for the Minister's approval on a triennial basis through the reporting procedures of the Act. The progress of mining and rehabilitation will be the subject of regular inspections by the MSARCC, and the Company will be required to report progress on an annual and more detailed triennial basis.

6.1.3 Road Safety

All roads will be constructed to MRD or Shire standards as appropriate with special regards to road safety.

At the 'T' intersection of Rocky Spring Road and Brand Highway, "STOP" signs will be installed. The carriageway of Brand Highway will be widened to include an overtaking lane

on the south bound lane to enable the entering vehicles to accelerate to highway speed. An overtaking lane will also be installed on the north bound lane to allow vehicles leaving the highway to decelerate.

Similar "stop" signs and overtaking lanes will be installed at the junction of Brand Highway and the access road to Eneabba South concentrator.

Both junctions with Brand Highway will be located to ensure that vehicles entering the highway have clear visibility for a distance of 400 metres in both directions.

Road train wagons will be securely tarped to ensure no spillage of mineral from the wagon during travelling.

6. 1. 4 Community Impact

Leeman is a small community situated on the coast 150 km south of Geraldton and 350 km from Perth, within the Coorow Shire. It has a permanent population of approximately 500 which increases to over 600 during the cray fishing season in summer.

The employment is made up of 40% mining, 40% fishing and 20% other. The town is serviced by a light industrial area. The current stores and retail outlets have capacity to cater for additional population, however, most families do major shopping once a month in Geraldton.

The average age of the town's population is in the low thirties and great importance is placed on sporting facilities which include football, cricket, tennis, netball, basketball, badminton and lawn bowls. Existing sporting facilities will not be adversely affected by the proposed increase.

Additional housing in Leeman will introduce more families into the town and additional children will need to be accommodated at the Leeman Primary School.

Existing land sub-division with constructed roads, power and water are adequate for the proposed housing.

AMC has an ongoing commitment to assist the development of the town's facilities as circumstances warrant.

6.2 Processing

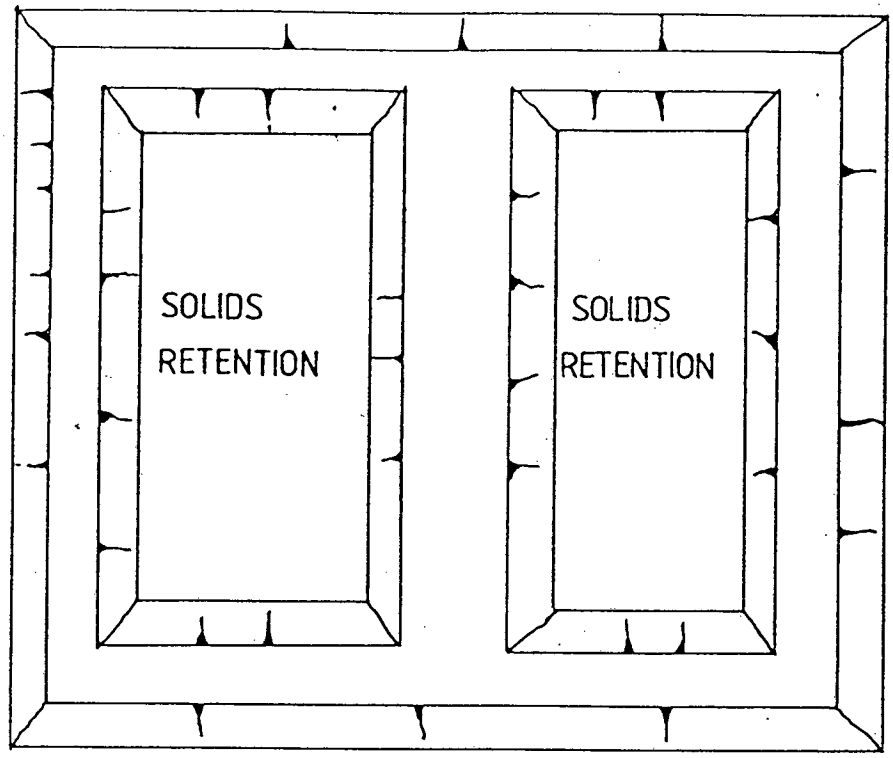
6.2.1 Tailings Management

Combined tailings from the existing and proposed processing plants will be disposed of in earth bunkers excavated to a depth of two metres below the natural ground level. Portion of the material excavated will be used to form compacted and stabilized bund walls to a height of two metres around the perimeters of the excavated bunkers (Figure 10).

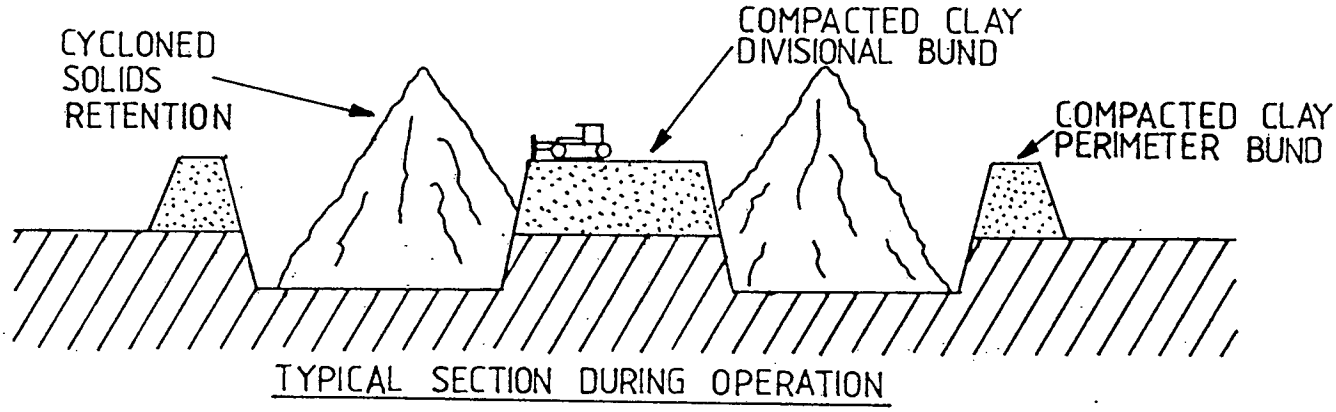
The overburden excavated from the bunkers will be stockpiled and stabilized for future reclamation. The clay soil on the site extends to a depth of eight metres.

The tailings, which do not contain any soluble particulates, are to be pumped to a skid mounted hydrocyclone situated on a bund wall between the excavated bunkers. The underflow from the hydrocyclone will be naturally drained of residual water and then stacked into the excavated bunkers to a depth of three metres. As the stockpiles are formed the tailings will be contoured and progressively covered with 300 mm of reclaimed topsoil and then stabilized.

All water used to pump tailings to the stockpile area will be about neutral pH and free of dissolved solids. Thus, it will not be detrimental to the groundwater in the area.



PLAN



TYPICAL SECTION DURING OPERATION

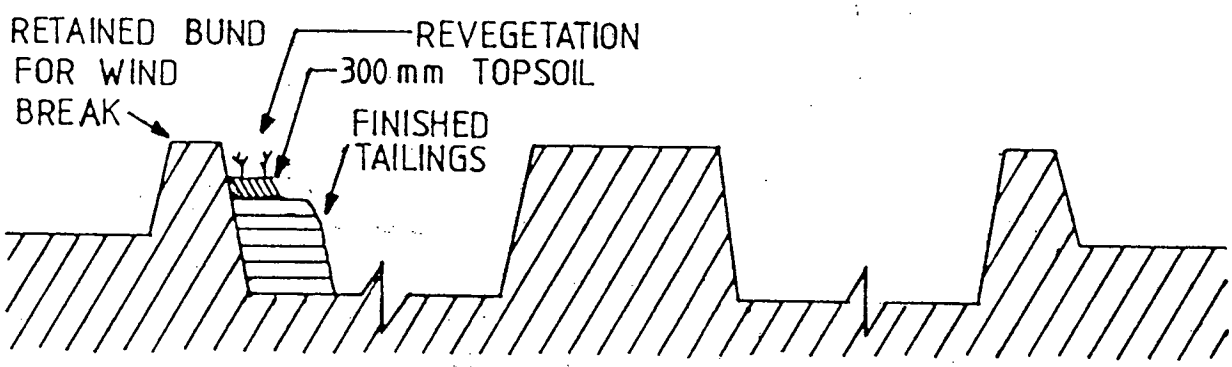


Fig. 10 NARNGULU PROCESSING PLANT
TAILINGS DISPOSAL

It is anticipated that the combined tailings will occupy a total surface area 564 metres x 564 metres. Additional storage area for a further 10 years operation is available on the site if required.

Prior to the cessation of operations of the processing plant at Narngulu, the topsoil would be removed from the tailings bunkers and the tailings reprocessed until all recoverable valuable heavy minerals have been extracted. The barren tailings would then be buried in the bunkers and covered with topsoil and revegetated in accordance with Part VI Clauses 30-33 of "The Code of Practice on Radiation Protection in the Mining and Processing of Mineral Sands (1982).

6.2.2 Occupational Health and Safety

AMC has a comprehensive occupational health and safety (OHS) policy and has implemented systems which require and achieve more stringent standards than those set by legislation. The Company has anticipated the legislative changes which will become part of the Mines Regulation Act and Regulations by implementing the relevant parts of the Occupational Health and Safety and Welfare Act. These actions are in addition to maintaining continuing compliance with the health and safety aspects of the Mines Regulation Act and Regulations in their present form. Whilst this is a complex subject, the following topics are addressed briefly to indicate the Company's commitment to OHS. The Company reports to the appropriate authorities in accordance with the Regulations.

It is Company policy to extend its OHS systems to all operations including any changes in activities and plant extensions.

Dust

Results of routine air monitoring in the existing processing plant show that there is a high level of compliance with the

limits specified as "standards of purity" in the Regulations of the Mines Regulation Act. In particular the large majority of workplaces are in full compliance with the total dust "standard of purity" of 10 mg/m³. The site Ventilation Officer carries out a comprehensive dust monitoring programme approved by the Mines Department. Where workplace dust levels are measured to be close to, or above, "standards of purity", engineering work is initiated to reduce levels at source or improve ventilation.

A range of approved and appropriate respiratory protective devices is available for use in any area, and a training programme is in place to encourage the correct use of such equipment.

Noise

A full noise survey of the site has been conducted by the Noise Officer and all hearing conservation actions taken. In various locations, action has been taken to reduce noise levels at their source, attenuate noise on its transmission path and to utilise hearing protection. All areas and equipment that require action are suitably signposted and employees receive regular hearing conservation instruction, as originally required by the Noise Abatement (Hearing Conservation in Workplaces) Regulations.

Hazardous Materials

The operations on the existing site involve the use of certain chemicals which may be regarded as hazardous materials. These include acids, alkalis, flammables, solvents and items such as rods which emit fumes during welding. Controls are placed on the purchase, use, storage, transport, handling and disposal of all these materials by way of standard procedures and material safety data sheets.

Safety

An effective safety programme is in operation and has maintained an admirable safety performance over the past few years. The effect of this programme can be gauged from the data of lost time injury frequency rate for both the Narngulu Minerals and Eneabba sites shown in Figure 11.

Radiation Safety

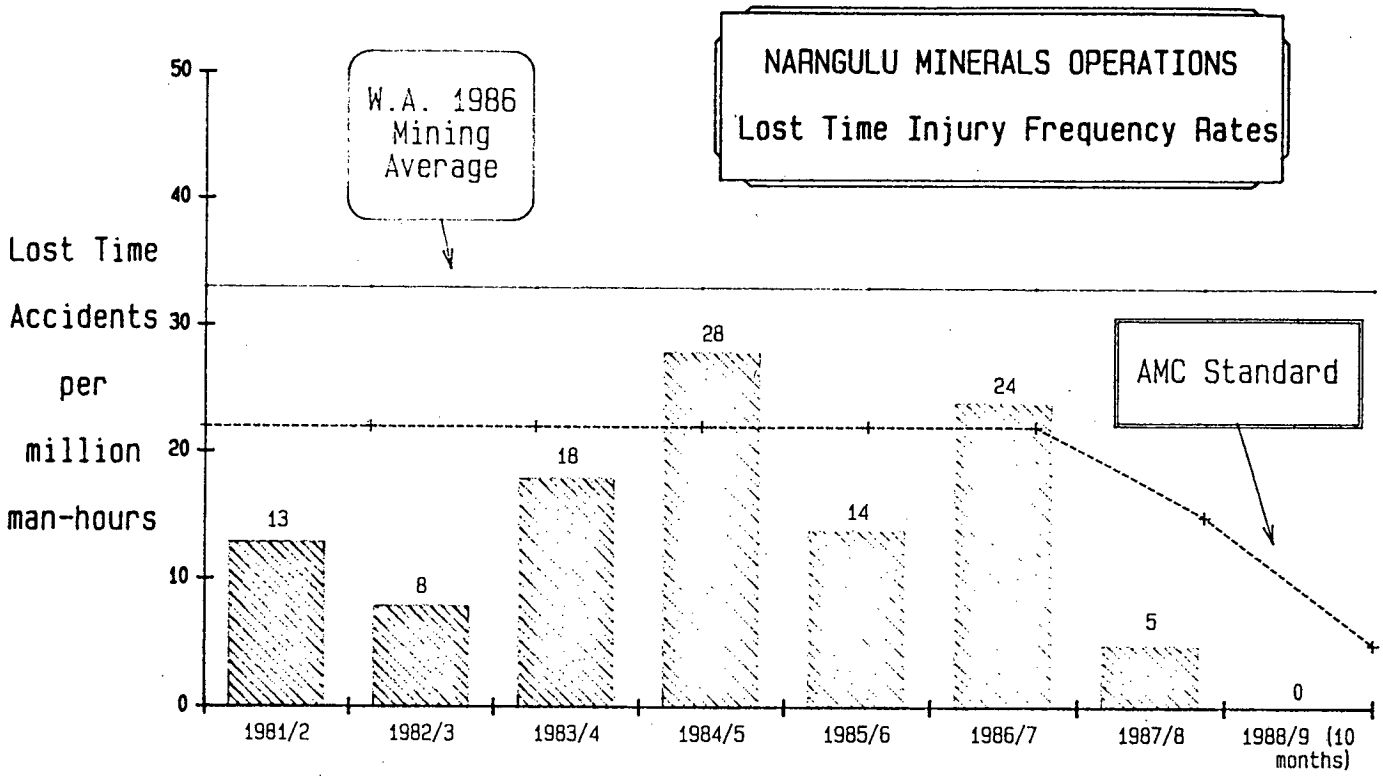
A comprehensive monitoring programme, approved by the Mines Department, has demonstrated significant compliance with the Code of Practice on Radiation Protection in the Mining and Processing of Mineral Sands (1982) and the recently gazetted Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987). A comprehensive programme of dust reduction to lower internal radiation doses to workers is in progress. As noted above, actions taken to date demonstrate an ability to achieve lower dust levels in compliance with all statutory limits and the ALARA principle.

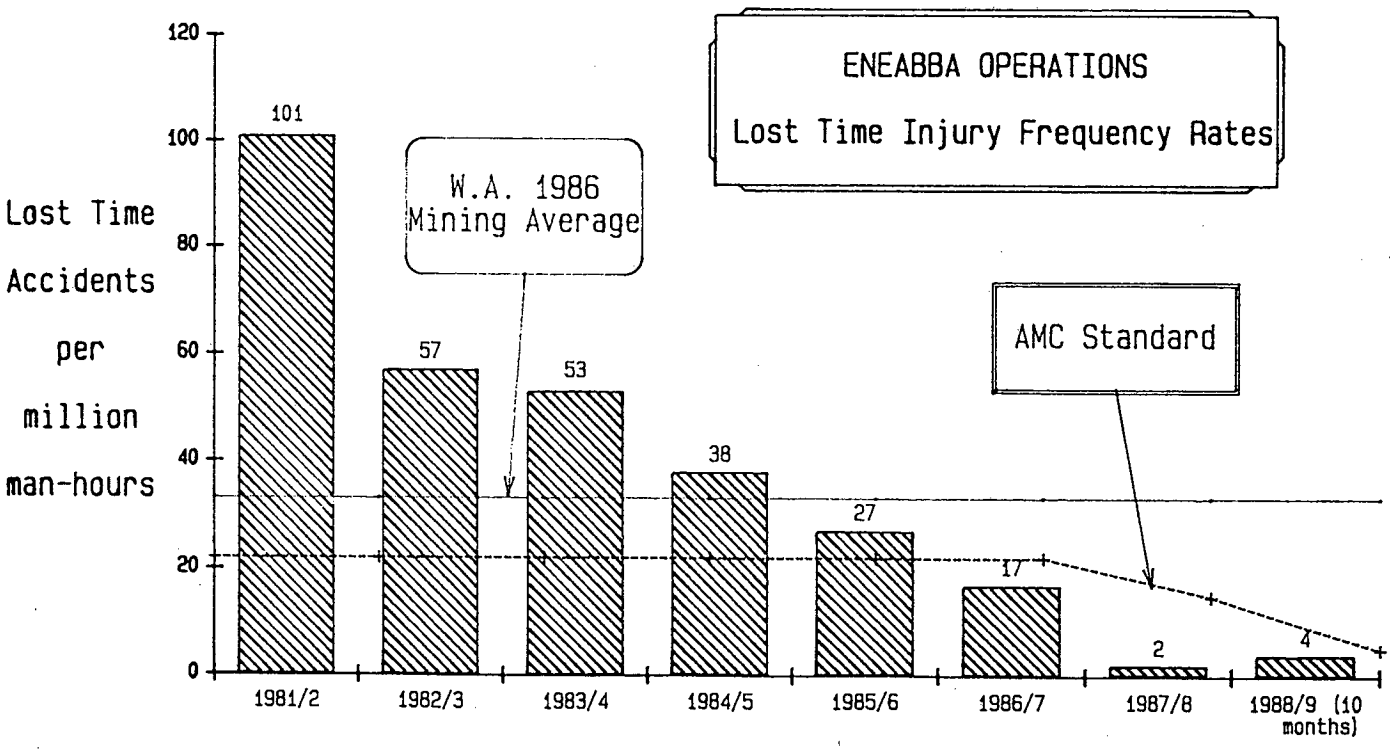
6.3 Monitoring

6.3.1 Hydrology

The Eneabba West ore body occurs within the headwaters of the catchment of Erindoon Creek and Lake Erindoon. Significant areas of salinization currently exist, and salinization appears to be increasing. There have been no previous measurements of soil salinity in the Eneabba West area, and very little data is available on groundwater levels, salinity and aquifer properties. Therefore, the Company considers it important to monitor the hydrology of the catchment to obtain a log of data for reference purposes. The monitoring programme was developed during discussions with AMC's groundwater consultants (Rockwater, 1989).

Figure 11. Safety Performance. LTI Frequency Rates.





A survey of all farm bores in the area was undertaken during preliminary hydrology investigations. The groundwater level and electrical conductivity will be monitored in all suitable farm bores within 5 km of areas to be mined. This will include bores in both the superficial sediments and deeper aquifer.

Water levels and electrical conductivities will also be monitored in the dredge pond, all production bores in the Eneabba West area, and two lines each of 10 piezometer sites running about 1.5 km each side of Erindoon Road (Figure 12). At each piezometer site there will be two piezometers, one open at the bottom and the other near the top of the aquifer in the superficial sediments. About half of these piezometers have been installed during drilling operations.

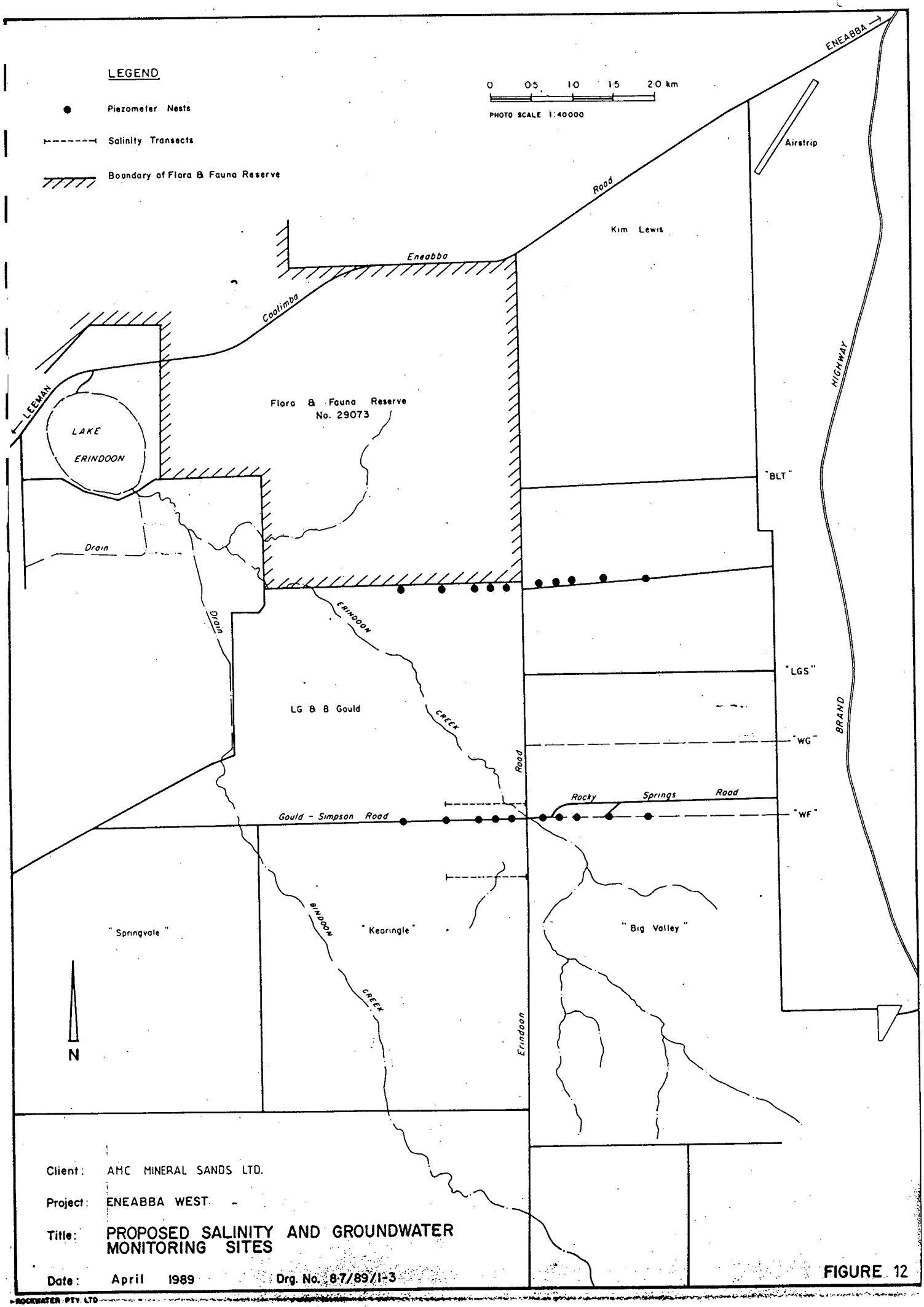
The monitoring programme will commence soon after Board approval is given to proceed with the project and well before mining commences. Initially, measurements will be made every month, but intervals of three months should be adequate once trends are established.

Once each year, a water sample from each bore and piezometer and the dredge pond will be analysed to determine the concentrations of all major ions.

Every three months a water sample will be taken from Lake Erindoon and analysed for major ions.

Surface soil salinity will be monitored by measuring the electrical conductivity of the soil at intervals along two transects each running about 1 km through presently saline land to the west of Erindoon Road (Figure 12). These measurements will be repeated every three months.

The hydrological monitoring data will be collated and analysed each year, and a report prepared by a professional hydrologist.


LEGEND
Piezometer Nests
Salinity Transects
Boundary of Flora & Fauna Reserve
0 0·5 1·0 1·5 2·0 km
PHOTO SCALE 1:40000
ENEABBA
Airstrip
Road
Kim Lewis
Eneabba
Coolimba
LEEMAN
LAKE ERINDOON
Flora & Fauna Reserve No. 29073
HIGHWAY
"BLT"
Drain
Drain
ERINDOON CREEK
"LGS"
LG & B Gould
"WG"
Road
Rocky Springs Road
Gould - Simpson Road
"WF"
BRAND
"Springvale"
BINDOON CREEK
"Kearingle"
"Big Valley"
Erindoon
N
Client: AMC MINERAL SANDS LTD.
Project: ENEABBA WEST
Title: PROPOSED SALINITY AND GROUNDWATER MONITORING SITES
Date: April 1989
Drg. No. 87/89/1-3
FIGURE 12
ROCKWATER PTY. LTD.

6.3.2 Occupational Health and Safety

Comprehensive OHS monitoring, consistent with existing hazards, is in place at all sites. This monitoring will be extended, where relevant, to include the mining and concentration plants at Eneabba West, and the increased processing facilities at Narngulu.

Air Monitoring

Personal and environmental air sampling is conducted using both active and passive samplers depending upon the contaminant sought. Where appropriate guidelines exist these are utilised, but air monitoring is primarily conducted in accordance with the requirements of Regulations under the Mines Regulation Act. Monitoring programmes are prepared by the site Ventilation Officer and approved by officials of the Mines Department. Sampling and analysis procedures employed are also approved by the Mines Department.

Noise

Monitoring for noise in existing operations has been under the Noise Abatement (Hearing Conservation in Workplaces) Regulations 1983. Future monitoring will be conducted under the yet-to-be proclaimed amendments to the Mines Regulation Act and Regulations. In the interim, the relevant section of the Occupational Health, Safety and Welfare Regulations 1988 is being used. It is planned that the existing procedures for monitoring will need only minor amendment to ensure compliance with the new regulations, and these amended monitoring procedures will be extended to cover the new operations, as required.

Radiation Safety

Monitoring is an integral part of the radiation safety programme at all sites. Parameters monitored include gamma

radiation, airborne alpha activity and radionuclides in water. The radiation monitoring programme is in compliance with the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987), and is approved by the Mines Department.

Safety Monitoring and Auditing

The existing monitoring and reporting of lost time accidents, under the Mines Department "Axtat" system, will be extended to cover all new operations. In addition, AMC maintains detailed information on all lost time, medically referred, first aid and non-treatable injuries together with data on days lost due to injuries and days on light duties.

The recently implemented Chamber of Mines self audit system for health, safety and the environment has also been trialled at AMC and is used in cross-site safety auditing.

Other non-statutory procedures are in use to maintain a high standard of OHS on all sites. These procedures will also be extended to the new areas of work.

6.3.3 Rehabilitation

As recommended by Rockwater (1989), native vegetation will be monitored by a qualified botanist along drill lines WF, WG and LGS (Figure 12) before and after mining. This will determine the extent of damage caused by drawdown of the water table, if any, to various vegetation associations at different distances from the dredge path. This information will be used to determine the need to develop strategies to minimise drawdown effects.

Those areas designated for rehabilitation to native vegetation will be monitored on a regular basis after establishment. The Company currently has an intensive programme to monitor the establishment and development of

native vegetation for its existing mining operations at Eneabba. An electronic botanical data management system has been developed to handle the large quantities of data generated by this programme, currently involving about 10,000 quadrats per annum. This programme will be extended to the Eneabba West operation.

The Company is committed to minimising the area open to operations. Details of areas disturbed, areas rehabilitated and area open will be submitted annually to the Minister and the MSARCC in keeping with current practice.

7. COMMITMENTS

In addition to the Environmental Protection Act (1986), the Company has obligations under the Mineral Sands (Eneabba) Agreement Act (1975-1988) for environmental management, including:

1. submission of detailed proposals for approval by the Minister,

2. conduct of a continuous programme of investigations and research including monitoring, and

3. submission of Triennial Reports for approval by the Minister, together with interim reports of progress.

Through these processes, the Company will be submitting specific plans for mining and environmental management for Ministerial approval on an ongoing basis.

The Company is committed to achieving a high standard of environmental management and rehabilitation. Towards this end, the Company is committed to the following:

* construction of access to and from the Brand Highway to MRD and Shire standards with special regards to road safety.

* application of a comprehensive occupational health and safety policy and systems to achieve more stringent standards than those set by legislation.

* application of the ALARA principle.

* pre-operational monitoring of radiation on the minesite and reporting of results to the Department of Mines as required under the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive ores (1987).

* extension of OHS monitoring, where relevant, to new mining and processing facilities constructed under this proposal including:

. personal and environmental air sampling in accordance with requirements of Regulations under the Mines Regulation Act,

. monitoring for noise under the yet-to-be proclaimed amendments to the Mines Regulation Act and Regulations,

. monitoring for radiation in compliance with the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987),

. monitoring and reporting of lost time accidents under the Department of Mines "Axtat" system.

* monitoring the hydrology of the Erindoon Creek catchment including:

. groundwater levels and electrical conductivity in suitable farm bores within a five kilometre radius of the minesite, as well as in the dredge pond, production bores and two lines of piezometers,

. analysis of major ions in water sampled from each bore and piezometer and the dredge pond on an annual basis,

(B)

. analysis of major ions in water samples from Lake Erindoon on a quarterly basis,

. monitoring of surface soil salinity along two transects through saline land, on a quarterly basis.

* investigation of the feasibility of lowering groundwater levels by construction of artificial lakes in the mine tailings to increase evapotranspiration.

* investigation of the use of deep rooted species such as native species, lupins, lucerne, tagasaste and tree belts to lower groundwater levels by increasing evapotranspiration.

* development of suitable rehabilitation strategies in consultation with the landowners and the Department of Agriculture following the appropriate investigations, and submission of these strategies for approval under the Agreement Act.

* monitoring the effect of water table drawdown on standing native vegetation along three drill lines to determine the need to develop strategies to minimise drawdown effects.

* monitoring of the establishment and development of rehabilitated native vegetation using the existing electronic botanical data management system.

* minimising the area open to operations and reporting details of areas disturbed, areas rehabilitated and area open through the reporting procedures of the Agreement Act.

8. CONCLUSIONS

The Eneabba West proposal will increase AMC's production of mineral sands products from the Eneabba field by about 40%, and will have a life of 13-14 years. It will yield substantial economic benefits at the local, state and national levels. The project will generate a further 64 permanent jobs directly, plus additional flow-on effects through increased requirements for services and supplies. Direct revenues to the State Government from the project will increase by about $13 M, and annual export revenue of the order of $90 M will be generated.

The proposal involves mining a series of strandlines which occur on private land. A large part of the land has been cleared for agricultural use, whilst the remaining native vegetation has been degraded by grazing. No rare plant species have been found on the site. The ground water table is close to the surface in the southern half of the ore body, and there are large areas of saline soil.

Mining operations will have short and long term environmental effects. Soil salinity in the area is dependent on the depth of a shallow water table. In the short term, drawdown effects on the superficial groundwater aquifer will result in a reduction of soil salinity in the vicinity of the dredge path. This temporary drawdown is not expected to affect areas of native vegetation, although wetland vegetation will be monitored specifically to confirm this.

Groundwater levels will recover soon after mining as a result of lateral flow in the superficial aquifer and recharge by rainfall. Recharge will be minimised by keeping areas of disturbance for operations to a minimum, and by ensuring mined areas are rehabilitated quickly.

For the longer term, a number of rehabilitation strategies are available to reduce groundwater recharge, lower groundwater levels, reduce salinization and improve production. These include the use of artificial lakes to increase evaporation, as well as deep rooted native vegetation, tree belts and agricultural crops such as lupins, lucerne and tagasaste. Following appropriate investigations, specific rehabilitation plans will be developed progressively in consultation with the landowners and the Department of Agriculture and submitted for approval.

Concentrate from the operation will be railed to an existing processing plant at Narngulu, which will be expanded, for separation into final products. During an upgrade of the metallurgical efficiency of this plant in 1988, new equipment was installed to improve dust, radiation and noise controls. Monitoring has shown a significant reduction in ambient dust levels, and compliance with the Code of Practice in Mining and Processing of Mineral Sands (1982) and the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987). Similar equipment will be installed in the expanded plant to maintain equivalent levels of protection to the workforce.

The project will be carried out under the Mineral Sands (Eneabba) Agreement Act (1975-1988). This Act contains a range of provisions for the Government to maintain ongoing control over the environmental management of the operation. At existing operations at Eneabba conducted under the Act, the Company has demonstrated a strong commitment to a high level of performance in OHS and environmental management. This commitment and expertise will be extended to the Eneabba West project.

9. REFERENCES

Elkington, J. (1988). Botanical Survey of the Eneabba West Area. 22 pp.

Rockwater, (1989). Eneabba West Project Site Hydrogeology, and Effects of Proposed Mining. 28 pp.

Note: Copies of these reports are available on request.

APPENDIX 1

GUIDELINES* FOR THE PUBLIC ENVIRONMENTAL REPORT (PER) ON THE PROPOSAL BY ASSOCIATED MINERALS CONSOLIDATED FOR A HEAVY MINERAL SAND MINE AT ENEABBA WEST

The PER should facilitate public review of the key environmental issues by expressing the main body of the text in terms understandable to the general public, and placing technical detail in appendices.

SUMMARY

The PER should contain a brief summary of:

- salient features of the proposal
- alternative sites and technologies considered
- description of the receiving environment and analysis of potential impacts and their significance
- environmental monitoring and management programmes, safeguards and commitments
- conclusions

1. INTRODUCTION

The PER should include an explanation of the following:

- identification of the proponent and responsible authorities
- background and objectives of the proposal
- brief details of the scope and timing of the proposal
- environmental interaction with other developments (present and future)
- relevant statutory requirements and approvals
- brief description of the environmental impact assessment process and the scope, purpose and structure of the PER

2. NEED FOR THE PROPOSAL

This section presents an opportunity for the proponent to describe in a general way the broad costs and benefits of the project to the Company and community. These should be described at local, State and National levels.

3. EVALUATION OF ALTERNATIVES

A description should be given of how the project has developed and the degree to which development alternatives, including the 'no development' option, have been examined.

Each site considered should be described sufficiently to provide an appreciation of its salient characteristics. The criteria used to evaluate sites should be described and the relative advantages and disadvantages of each site given, including environmental considerations.

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* These guidelines may be amended if a joint State - Commonwealth environmental assessment is necessary by virtue of the Commonwealth's Environment Protection (Impact of Proposals) Act applying to the project through, for example, the requirement for export approval.

The criteria used in the evaluation of alternative technologies to achieve the objectives of the proposal should be given. Where options in process or technology exist these should be explained and compared in terms of the selection criteria. Environmental consequences of the alternative technology options available should be discussed.

When alternatives are rejected, the factors which led to their rejection should be clearly identified.

The aim of this section is to lead the reader through the thought processes which led to the desired proposal, and to outline the factors which control its present form.

4. PROPOSED LOCATION

The proposed location is to be described including:

- cadastral, land use planning and zoning information
- adjacent land uses, including:
  - the location of any nearby residences
  - recreational land use
  - reserves
  - historical, archaeological or ethnographic sites
- topography
- natural drainage and downstream destinations
- flora and fauna
- meteorology, especially the prevailing winds
- location of existing structures, and structures to be built on the site
- provision of services, including power, gas, telephone, road and rail access, water and drainage

5. DESCRIPTION OF THE PROPOSAL

In this section the processes involved in the operation of the proposed mine site should be explained. The physical elements of the plant upgrade should also be described along with their functions. The inputs, outputs and by-products of each process should be explained. Materials handling procedures should be described and an indication of gross quantities given. Transport arrangements should also be described.

6. EXISTING ENVIRONMENT

This section should provide an overall description of the environment and an appraisal of the physical and ecological systems likely to be affected by all aspects of the proposal, but should concentrate on the significant aspects of the environment subject to potential impact from the development. Only the habitats, resources and potential resources which could be influenced by the project should be described. Excessive descriptions which are irrelevant to the impact of the proposal tend to detract from the document.

Impacts during construction and commissioning should be addressed separately from impacts of the mine and plant once fully operational. Impacts should be quantified where possible, and criteria for making assessments of their significance should be outlined. Compliance with relevant standards and statutes should be demonstrated.

The following potential environmental impacts should be included:

- effects on geomorphology, land stability and landscape
- effects on drainage and water quality (surface and ground)
- effects on biota
- effects of emissions (air and noise)
- management of solid and liquid wastes and stormwater
- impact on adjacent land uses including any conservation and recreation aspects
- effects on access and transport systems
- effects on existing services including power, water, gas and telephone
- effects on existing community facilities
- impacts of construction and operational workforces
- effects on existing contingency planning, safety and emergency services
- visual impact

It should be noted that air and noise emissions are likely to be key issues and therefore should be addressed in considerable detail.

Predicted noise emissions should indicate the likely presence of special characteristics (eg tonal components) which may affect the level of annoyance generated by the noise.

"Worst case" scenarios should be described, with the rate of occurrence of these conditions being indicated.

The discussion of air and noise emissions should make specific reference to the way in which seasonal wind patterns are likely to modify the impacts of those emissions.

7. ENVIRONMENTAL IMPACTS

The proposal will impact on some aspects of the environment, and it is necessary to discuss the individual impacts and then synthesize these so as to show the overall effect on the total environment. This is necessary for two reasons: firstly to allow the reader of the document to draw conclusions on whether the proposed is environmentally acceptable, and secondly, to show that operative management, ameliorative and monitoring programmes can be devised to manage potential impacts.

Consideration should be given to both the long term and short term effects of the project development and operation at the various locations where the project and associated activities may significantly impact on the environment.

A thorough evaluation of the hydrological, geomrphological and botanical impacts of the proposal should be provided. Discuss effects of project and associated population on the existing environment, including any archaeological, enthnographic and heritage aspects and the existing local population.

This section should show the overall effect on the total ecosystem and surroundings of the area. It will be necessary to address the impacts on the individual environmental components before a final overall synthesis can be made. In all cases where an assessment is made the criteria employed to assess impacts should be clearly stated. Wherever possible effects should be

quantified and uncertainties highlighted. The synthesis should also include an assessment of the significance and timing of the various impacts identified. For example:

- it may be useful to examine mine site impacts separately from plant upgrade impacts;

- construction impacts separately from operational and decommissioning impacts; and

- some of the infrastructure elements (such as the power supply) will have little or no ongoing interaction with the environment once they are established.

A brief and general land capability analysis of the affected land after mining for the range of uses considered should be provided.

There should be a radiation assessment of the project and a description of how the relevant statutory requirements are to be met.

8. ENVIRONMENTAL MANAGEMENT

An environmental management programme should be described on the basis of (and cross-referenced to) the synthesis of environmental impacts previously outlined. The objectives, the scope and details of the programme should be described. Assignment of responsibility for environmental management structure should also be stated and commitments given.

It will be essential to discuss the proposed management programme in relation to current practice elsewhere in WA and Australia for various aspects of the proposal.

Discuss the mechanism proposed to ensure that environmental management commitments are met through fluctuating economic conditions.

Specific commitments should be given to all components and procedures of the environmental management programme.

The PER should include an indication of the likely life of the project and preliminary plans for decommissioning the plant and rehabilitating the mine site.

Emphasis should be given as to how the environmental management programme will be adapted in response to results from the monitoring programme.

9. MONITORING

The systems for the treatment and control of air, noise and water pollution will require monitoring to ensure that they are operating efficiently and the receiving environment will require monitoring to ensure that environmental impacts are constrained to an acceptable level.

The specification of a monitoring programme should be given and responsibility for the operation of that system should be assigned. Emphasis should be placed on how the environmental management programme and plant operations will be adapted where necessary in the light of monitoring or auditing results.

Procedures should be outlined for reporting the results of the monitoring of environmental impacts to the appropriate authorities.

10. COMMITMENTS

A list of commitments made by the proponent in the PER should be given.

11. CONCLUSION

Conclusions of the overall impact of the proposal (including the role of ameliorative measures) should be stated together with an assessment of the environmental acceptability of the project.

12. REFERENCE (BIBLIOGRAPHY/ABBREVIATIONS

12.1 GLOSSARY

Provide definitions of technical terms used. Also define and explain units of measurement which may not normally be understood by the interested layman.

12.2 GUIDELINES

Guidelines which have been approved by the EPA should be reproduced in the document.

11.3 APPENDICES

These may be produced as separate volumes or incorporated in the back of the document.