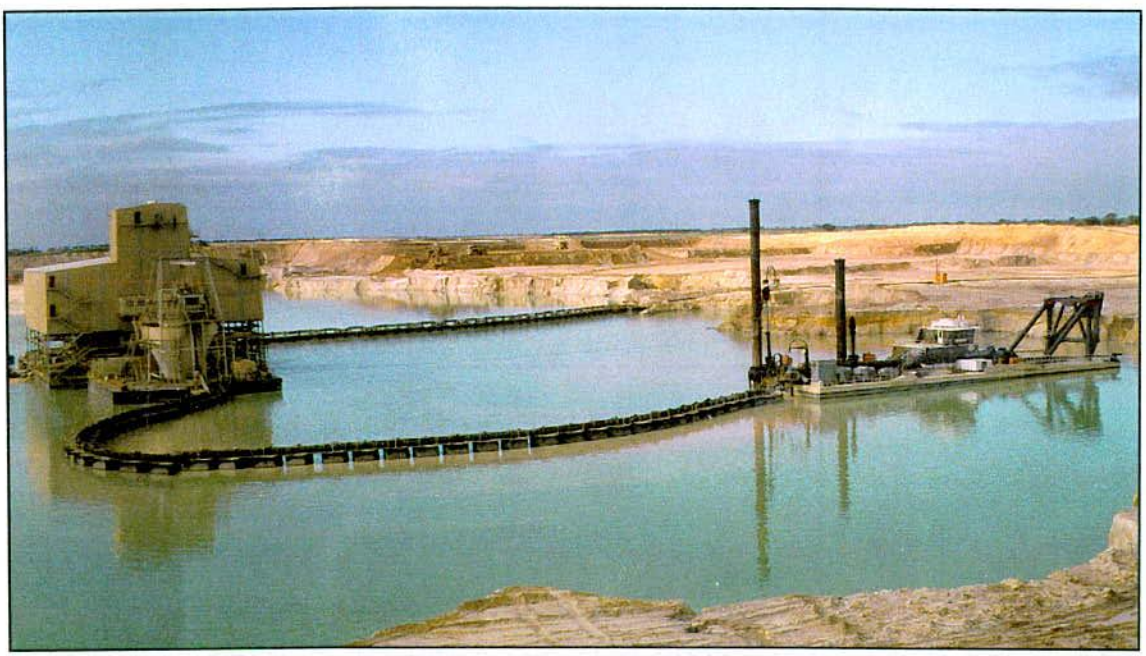
TIWEST PTY LTD

COOLJARLOO MINE



Mining of Titanium Minerals Orebodies 27 200 and 28 000

Public Environmental Review

October 1999

COOLJARLOO MINE

MINING OF TITANIUM MINERALS – OREBODIES 27 200 AND 28 000

PUBLIC ENVIRONMENTAL REVIEW
(EPA ASSESSMENT NUMBER 1272)

TIWEST PTY LTD
OCTOBER 1999

INVITATION TO COMMENT

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

Tiwest Joint Venture intends to mine mineral sands of Orebody 27 200 (M268SA) and Orebody 28 000 (ML 70/1010 and M268SA) subject to exploration results at Cooljarloo Mine, Dandaragan.

In accordance with the Environmental Protection Act 1986, a Public Environmental Review (PER) has been prepared which describes the proposal and its likely effects on the environment.

The PER is available for public review for 8 weeks from 8 November 1999 to 3 January 2000.

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

Why write a submission?

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

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

Why not join a group?

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

Developing a submission

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

When making comments on specific proposals in the plan:

- clearly state your point of view;
- indicate the source of information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

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

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendations;
- if you discuss different sections of the document, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name
- address
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is 3 January 2000.

Submissions should be addressed to:

Chairman
Environmental Protection Authority
PO Box K822
PERTH WA 6842
Attention: Mr Ben von Perger

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

BACKGROUND

Tiwest Pty Ltd (Tiwest) is the operations manager for the Tiwest Joint Venture, which is an integrated titanium minerals mining and processing project established pursuant to the *Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988*. The project is based on titanium mineral deposits at Cooljarloo, 170km north of Perth.

Tiwest has mined titanium minerals at the Cooljarloo Mine since 1989. Initial environmental approvals were received in 1988, following assessment of an Environmental Review and Management Programme which outlined the extent of mineral resources known at the time. Tiwest has since confirmed an additional resource, the 27 200 orebody within the current mining lease M268SA and identified the potential for a further resource, the 28 000 orebody predominantly under land immediately adjacent to M268SA. Confirmation of the 28 000 orebody is dependent on the grant of a mining tenement (ML 70/1010) which is subject to the provisions of the *Native Title Act 1993*.

A proposal to mine the 27 200 orebody was referred to the Environmental Protection Authority in April 1999, which determined that formal environmental impact assessment of the proposal be conducted at the level of a Public Environmental Review (PER). Tiwest subsequently elected to include the mining of any viable 28 000 orebody within the scope of the PER.

THE PROPOSAL

The proposal described in this PER is the extension of existing mining operations at Cooljarloo to the 27 200 orebody and any viable 28 000 orebody. Tiwest proposes to commence mining the 27 200 orebody in June 2002 and expects to have completed mining by April 2004. The optimum time to mine any viable 28 000 orebody is when mining operations are adjacent to the major 27 000 South deposit, between June 2000 and June 2002. The location of the additional orebodies in relation to the mineral resources defined in 1988 is detailed in the figure found overleaf.

Approval to mine the 27 200 orebody will extend the current mine life at Cooljarloo by 20 months to around 17 years. Based on the information currently available, approval to mine the 28 000 orebody would extend mine life by around two months. Tiwest proposes to dredge mine the 27 200 orebody. The 28 000 orebody may be dredge or dry mined, depending on the location of mineralisation relative to local groundwater levels.

Implementation of this proposal will not result in an increase in mining rate or expansion of infrastructure beyond those defined in current environmental approvals. The characteristics of the proposal are detailed in the following table, together with data for the main 27 000 South orebody for comparison.

ENVIRONMENTAL IMPACTS AND MANAGEMENT

Tiwest's Environmental Management System

Tiwest has an established environmental management system at Cooljarloo, based on objectives, procedures and responsibilities defined in the following core documentation:–

- Cooljarloo Environmental Policy
- Cooljarloo Environmental Management Programme
- Environmental Procedures Manual
- Environmental Responsibilities and Obligations Manual
- Environmental Reports, internal and external
- Cooljarloo Environmental Handbook

The Cooljarloo Environmental Management Programme (EMP) is reviewed annually and updated documents submitted to the Departments of Environmental Protection, Minerals & Energy, Conservation & Land Management and the Water & Rivers Commission. The current EMP was approved by the DEP for the purposes of Tiwest's environmental licence in August 1998.

The existing environmental management system would be routinely employed in mining the 27 200 and 28 000 orebodies. Although the specific details of some environmental procedures may change to include the new areas, mining the additional orebodies will not necessitate changes to the standards or objectives currently applied at Cooljarloo.

Consideration of the environmental impacts of the proposal is addressed under the following environmental factors.

Vegetation

A primary environmental impact associated with this proposal is the disturbance of up to 220 ha of native vegetation. This represents 4.3% of the native vegetation in conservation reserves within 1 km of the boundary of mining lease M268SA, and 0.44% of the native vegetation in conservation reserves within 25 km of the 27 200 and 28 000 orebodies. The vegetation associations are typical of the native vegetation that occurs over the Bassendean Dune system.

The extent of disturbance to native vegetation, particularly vegetation not overlying mineral resources, is limited through appropriate mine planning. Disturbed areas will be revegetated using local provenance native seed, topsoil and mulched vegetation appropriate to the final landform.

Mining the 27 200 and 28 000 orebodies will not result in a reduction in the diversity or the geographic range of native vegetation species. Reductions in species abundance and vegetation productivity associated with clearing up to 220 ha of native vegetation will be temporary, and reversed over time with the maturing of areas under rehabilitation.

Dieback

No *phytophthora* infestations have been identified on mining lease M268SA south of Cooljarloo Road, or tenement ML70/1010, in the vicinity of the 27 200 and 28 000 orebodies. The *phytophthora* species that poses the greatest threat to native vegetation, *Phytophthora cinnamomi* has not been identified on mining lease M268SA.

Tiwest implements a dieback management plan to prevent the introduction of *Phytophthora cinnamomi* to the mining lease. Access to the mining tenement is restricted, and all vehicles entering operational areas must pass through an automated, chlorinated washdown facility. A mobile washdown facility is utilised where the use of the fixed facilities is not practicable.

There will be no increase in the risk of dieback impact on native vegetation as a consequence of mining the 27 200 and 28 000 orebodies.

Declared Rare Flora and Priority Species

Four populations of the declared Rare Flora (DRF) species *Andersonia gracilis* and one population of the DRF species *Anigozanthus viridis* spp. *terraspectans* have been identified on the mining tenements south of Cooljarloo Road. (Mattiske Consulting Pty. Ltd., 1998; Landcare Services Pty. Ltd., 1999).

No DRF have been identified in the vicinity of the 27 200 orebody. A population of 9 plants of *Andersonia gracilis* exists in an area of potential disturbance associated with the 28 000 orebody. This population represents less than 0.03% of the *Andersonia gracilis* in currently known populations.

The population of *Anigozanthus viridis* spp. *terraspectans* comprising 10 plants is located towards the southern boundary of mining lease M268SA and will not be disturbed.

Two populations, comprising 130 plants of *Andersonia gracilis* will be disturbed in mining the main 27 000 South orebody. Tiwest has conducted specific surveys for *Andersonia gracilis* off mining lease M268SA to assess the status of the species in the local area and therefore the impact of removing these. Significant populations exist in damplands on private land, roadside reserves, the Wongonderrah Nature Reserve and vacant Crown Land adjacent to mining lease M268SA.

The table overleaf indicates the current status, and cumulative impacts on DRF of mining at Cooljarloo. There will be no significant impact on total populations of DRF as a consequence of mining the 27 200 and 28 000 orebodies.

Fourteen Priority species of flora have been identified in vegetation surveys of M268SA and ML 70/1010. Surveys will be undertaken to quantify the abundance of Priority species in adjacent conservation reserves.

One undescribed species, *Darwinia* sp. Cooljarloo (G Cockerton 2852) was identified in the area of ML 70/1010. It is unlikely that the species warrants priority status at present although

it has limited representation within collections at the WA Herbarium (Landcare Services Pty. Ltd., 1999). Several specimens were provided to the WA Herbarium.

No other significant flora were noted.

Current Status of Declared Rare Flora at Cooljarloo

Species	Populations	Number of Plants	Disturbed, or likely to be disturbed by mining activity	
			Number	%
Andersonia gracilis				
M268SA ML 70/1010	4	222	135	60.8
Total *	26	34,989	135	0.4
Anigozanthos viridis ssp. terraspectans				
M268SA ML 70/1010	1	10	-	-
Total *	5	1800	-	-

* Includes populations identified off mining lease M268SA and ML 70/1010

Terrestrial Fauna

Tiwest have undertaken fauna monitoring on mining lease M268SA since 1986. The habitat types sampled in the established transects are representative of the habitat found across the 27 200 and 28 000 orebodies. A total of 9 frog species, 37 reptile species, 96 (including 2 introduced) bird species and 16 (including 4 introduced) mammal species have been recorded to date. The total number of species identified has plateaued in recent years, which suggests the species lists recorded to date is close to a full representation of the species diversity of the area.

Three species listed on schedules under the *Wildlife Conservation Act 1950,* and two priority species (species of concern but not listed under the *Wildlife Conservation Act 1950)* have been recorded in the Cooljarloo area.

Flocks of non-breeding individuals of the Short-billed Black Cockatoo (*Calyptorhynchus latirostris*) have been observed foraging on shrub vegetation in the Cooljarloo area. This species is listed on Schedule 1 of the *Wildlife Conservation Act 1950*, primarily due to the loss of breeding habitat in the wheatbelt. Schedule 1 fauna are considered rare, or likely to become extinct.

Two Schedule 4 species (other protected fauna) have been recorded on the mining lease. The Peregrine Falcon (*Falco peregrinus)* has been observed once, and two specimens of the South-West Carpet Python (*Morelia spilota imbricata)* have been observed in native vegetation north of Mullering Farm.

Two species listed as Priority 4 – taxa in need of monitoring, have been recorded on the mining lease. The Square-tailed Kite (*Lophoictinia isura*), which is considered to have a small but widespread population, has been observed north of Mullering Farm and the Brush Wallaby (*Macropus irma)* has been observed in native vegetation south of Mullering Farm.

The primary impact of Tiwest activities on native fauna occurs through the disturbance of habitat. A maximum of 220 hectares of native vegetation will be disturbed in mining 27 200 and 28 000. This area of disturbance is not considered significant enough to impact on the diversity or geographical distribution of native fauna. The abundance of native species may reduce commensurate with the temporary habitat loss, however this is not considered significant on a local or regional scale. The rehabilitation of disturbed areas to required standards will result in the re-establishment of native fauna habitat.

Mining the additional orebodies will not result in the permanent loss of the habitat of any threatened or Priority Fauna species.

Landform

The 27 200 and 28 000 orebodies are located beneath a gently undulating dune system. The landform in the area of the orebodies will be altered by mining. The mine void associated with the 27 200 and 28 000 orebodies will be backfilled with tailings and overburden, to at least 4 metres above the expected maximum groundwater level, though not up to the original ground surface. An overburden dump will be associated with the mining of the 28 000 orebody.

Stability in the final landform is achieved through the selective deposition of overburden and application of slope and drainage design criteria to control surface runoff, which is the primary cause of hill slope erosion. Replaced overburden will be reshaped to a maximum hill slope gradient of 1:12 and a hilltop gradient of 1:100. Drainage contours will placed at a maximum 50 metre spacing, though this may be adjusted depending on the permeability of the material deposited uppermost in the profile, and final surface slopes.

Although the surface slopes of rehabilitation areas may exceed those that occur naturally, under Tiwest's existing Environmental Management Programme the final landform will be constructed to criteria that ensure a stable and self sustaining landscape that once rehabilitated, will be compatible with surrounding undisturbed areas.

Rehabilitation

Tiwest will apply established procedures for the rehabilitation of areas disturbed in mining the 27 200 and 28 000 orebodies. The 27 200 and 28 000 orebodies exist in vacant Crown Land, with no clearly defined land use. Tiwest's rehabilitation is aimed at establishing sustainable landforms with no diminution in land use capability.

Successful rehabilitation is dependent on success in a number of prerequisite contributory factors. The pre-disturbance characteristics of the area of the 27 200 and 28 000 orebodies have been defined through soil, *phytophthora*, vegetation, radiation and contour mapping and through water monitoring.

Annual topsoil and overburden plans, which will include the additional orebodies will be prepared to manage the selective removal and placement of material in preparation for rehabilitation in accordance with established criteria. Overburden material will be classified to ensure the most favourable material for water infiltration and root growth is placed uppermost in the final profile. Topsoil will be removed and deposited in two layers to ensure the seed and organic rich top 50 to 100 mm is returned to the surface. Topsoil will be directly placed (as opposed to being stockpiled) wherever permitted by the mining and rehabilitation schedules.

Cleared native vegetation, which will be mulched and spread over the final surfaces will provide additional seed and organic material to the topsoil, and also protect the topsoil from wind and water erosion. Local provenance native seed will be applied in combinations that reflect natural vegetation associations and which are appropriate for the location in the rehabilitated landscape. Select species of native seed will be treated, using smoke or hot water immersion to maximise germination rates. A cover crop of oats will also be sown to provide early foliage cover for protection against erosion in the critical first year of rehabilitation.

Tiwest's rehabilitation programmes are structured around the seasons to ensure that the final prepared, seeded and mulched surfaces are in place by the onset of seasonal rain in April/May to maximise vegetation establishment in the first year.

The progress in rehabilitation is continually monitored. Visual checks are frequently undertaken for evidence of surface (in particular drainage) instability that may warrant early remedial action. Vegetation re-establishment and the return of fauna are monitored in following years.

Larger scale areas of native rehabilitation, which has been undertaken at Cooljarloo since 1996, are developing towards Tiwest's objective of achieving stable, self sustaining ecosystems compatible with adjacent undisturbed areas. Application of the same systems to rehabilitate areas disturbed in mining the 27 200 and 28 000 orebodies is considered to have similar prospects for achieving Tiwest's objective.

Groundwater

Groundwater consumption

Tiwest utilises groundwater for potable water (after treatment), amenities, dust suppression, maintenance of optimum water levels in the dredge pond, slurrying ore (for pumping) and to produce heavy mineral concentrate in the wet separation plant.

Two significant groundwater resources exist at Cooljarloo: the unconfined, superficial aquifer and the confined Yarragadee aquifer. Tiwest is licenced by the Water and Rivers Commission to abstract 4,900,000 kL per annum and 3,880,000 kL per annum from the superficial and Yarragadee aquifers respectively. Annual abstraction to date has constituted around 20% of licence limits and has been within the recharge capacity of the superficial and Yarragadee aquifers. Groundwater consumption will not increase as a consequence of mining the 27 200 and 28 000 orebodies.

Groundwater levels

Establishment of the dredge pond to mine the 27 200 orebody and possibly the 28 000 orebody will lower groundwater levels in the superficial aquifer by around 10 metres at the dredge pond. Reductions in groundwater levels have been observed up to 4 kilometres from the existing dredge pond, though the most significant effect on groundwater levels has occurred within 1.5 km, with reductions up to 3 m at this distance from the pond. This has not, to date, resulted in any demonstrable impacts on native vegetation, which is attributed to the minimal dependence of local vegetation communities on groundwater at depth. The soil moisture characteristics within the root zone of the native vegetation appear more directly influenced by the presence, or absence, of shallower, perched water tables not directly affected by drawdown in the main aquifer.

Several permanent wetlands exist south west of mining lease M268SA, in a Nature Reserve (A 40916) and private farmland, approximately 1.2 km from the southern end of the 27 200 orebody. Groundwater modelling suggests that drawdown associated with a dredge pond established to mine the 27 000 South and 27 200 orebodies will extend to the closest of the wetlands, on private land. Water levels in the wetland will be more dependent on surface discharge (Minyulo Brook, a significant local stream discharges into the wetland) and perched groundwater, and the effect of reduced groundwater levels in the main aquifer on water levels in the wetland is not expected to be significant.

A reduction in groundwater levels of around 0.5 to 1 m is also predicted beneath the premises of the Billinue Community. This depression in groundwater levels at the Billinue Community is significantly less than the 2 to 3 m reduction which had occurred to December 1998, based on interpolations of monitoring data. The reduction in groundwater levels has not resulted in water supply problems at the Billinue Community premises.

Monitoring has indicated that groundwater will gradually return to previous levels as the impact of the dredge pond diminishes. This has occurred in areas north of Mullering Farm with the southward migration of the dredge pond. The impacts on local water resources associated with mining the 27 200 and 28 000 orebodies will be included in reports that will be submitted annually to the Water and Rivers Commission and the DEP, in accordance with licence requirements.

Groundwater quality

With the exception of biodegradable flocculants used to assist settling of clay tailings, no chemicals are used in the production of heavy mineral concentrate and the risk of groundwater contamination at Cooljarloo is therefore limited. The bulk storage of hydrocarbons will remain at Tiwest's existing workshop facilities, approximately 3 km from the orebodies. Smaller mobile field refuelling units are fully bunded. Any field hydrocarbon spillage will be contained and remediated as necessary, consistent with current practice at Cooljarloo. Floating booms and absorbents are held at Cooljarloo to contain any hydrocarbon spillage that occurs on the dredge pond.

The Cooljarloo mineral deposits and overburden are generally highly oxidised and do not contain significant acid sulphate material. There has been no indication of acid generation in ten years of mining at Cooljarloo. Acid forming ore or overburden has not been identified in the area of the 27 200 and 27 000 South orebodies and is not anticipated in the vicinity of 28 000 orebody.

There has been no detectable change in groundwater quality as a consequence of mining operations at Cooljarloo. No changes to groundwater quality are expected as a consequence of mining the 27 200 and 28 000 orebodies.

Surface Water

The occurrence of surface water bodies at Cooljarloo is limited by the generally permeable surface sands and dry climate. Mullering Brook, the only defined surface watercourse on the mining lease, flows west across Mullering Farm 1.5 km north of the 27 200 and 28 000 orebodies. There is no defined surface drainage in the vicinity of the 27 200 and 28 000 orebodies.

Under extreme rainfall events water may flow overland from the southern portion of the 27 200 orebody through a series of depressions towards a wetland south west of the orebody. A major consideration in landform design at Cooljarloo is the integration of new areas within the surrounding drainage pattern, so as not to impede surface flows that may occur under exceptional rainfall. Other criteria that are applied to limit the volumes and velocity of runoff from rehabilitated areas also serve to maintain the quality of surface runoff.

Tiwest disposes of waste to ensure that it has no adverse impact on surface waters. Domestic and light industrial rubbish is disposed offsite at approved landfill sites. Waste oils are collected and removed from site by an approved waste disposal contractor. Other materials such as batteries, tyres and drums are recycled. Domestic sewerage is treated via septic tanks prior to disposal through leach drains. Sewerage generated on the wet separation plant is processed via a sewerage treatment plant prior to discharge to the dredge pond. The quality of water in the dredge pond is regularly assessed.

There will be no impact on the quality of any surface water bodies as a consequence of mining the 27 200 and 28 000 orebodies. Mining will not compromise other existing or future uses of surface water resources, including the value for maintenance of aquatic ecosystems.

Greenhouse Gas Emissions

The mining operations at Cooljarloo represent less than 0.3% of 1995 net carbon dioxide (CO_2) emissions calculated for Western Australia. Electricity consumption (Western Power – offsite) and diesel fuel combustion account for over 96% of the greenhouse gas emissions resulting from Tiwest operations. Releases to the biosphere resulting from vegetation clearing and soil disturbance constitute less than 4% of the total greenhouse gas emissions associated with mining at Cooljarloo.

Electricity and diesel fuel consumption constitute significant costs associated with mining. The incentive to reduce energy costs also serves to reduce greenhouse gas emissions. An objective of mine planning is to minimise the distance and height over which material is pumped or hauled to minimise energy consumption. Appropriate equipment selection also contributes to reduced energy costs, and therefore reduced greenhouse gas emissions.

Tiwest aims to create native vegetation communities of comparable biomass to undisturbed native vegetation. The carbon sink associated with rehabilitation will roughly equate to carbon emissions resulting from clearing vegetation and will therefore result in no net greenhouse gas emissions to the atmosphere in the longer term.

Inclusion of the 27 200 and 28 000 orebodies in the Tiwest mining schedule will extend current mine life, and therefore the emission of carbon dioxide associated with mining and processing, by around 22 months. There will be no increase in the annual rate of CO_2 emissions as a consequence of mining the 27 200 and 28 000 orebodies.

Dust

Dredge mining typically generates low levels of airborne particulates. Higher dust levels are generated by topsoil stripping and conventional earthmoving associated with overburden removal and dry mining. The 27 200 orebody will be mined by dredge and any viable 28 000 deposit may be dredge or dry mined.

Dust emissions at Cooljarloo are regulated by Tiwest's environmental licence issued by the DEP, which requires that the increase in the ambient concentration of airborne particulates at the boundary of mining lease M268SA not exceed 260 $\mu g/m^3$(PM50, 24 hour maximum). The licence also requires that all reasonable and practicable measures be taken to minimise the generation of airborne dust.

The migration of dust across the mining lease boundary is influenced by prevailing wind conditions and travel distance. Earthmoving associated with the 27 200 orebody will on average occur around 800 metres from the western boundary, 250 metres from the southern boundary and more than 2.5 km from the eastern boundary of the lease. Any earthmoving associated with mining the 28 000 orebody based on current limited information, would occur on average 375 metres from the external boundary of ML 70/1010.

Though dust emissions are significantly influenced by moisture conditions and prevailing winds, the distance between the 27 200 orebody, the 28 000 orebody and the mining lease boundaries limits the risk of exceeding licence conditions. The risk of creating a dust nuisance at the Brand Highway or the residences of the Billinue Community, next to the south east corner of Mullering Farm is limited by Tiwest's commitment to modify earthmoving operations in the event of excessive dust emissions in these directions.

Measures implemented by Tiwest to minimise dust emissions include regular watering of haul roads and around waste disposal areas during dry conditions, use of a road sweeper on sealed roads as required and stabilisation of topsoil stockpiles with vegetation to reduce wind erosion.

Noise

Dredge mining is an inherently quiet operation and environmental noise emissions are limited by the location of the dredge very low in the landscape. The use of conventional heavy earthmoving equipment in dry mining and overburden removal are the noisiest activities at Cooljarloo. Blasting has been required on one occasion in over ten years of mining and is not expected to be required in the mining of the 27 200 and 28 000 orebodies.

Environmental noise levels are regulated by the Environmental Protection (Noise) Regulations 1997, which defines noise limits (assigned noise levels) for noise sensitive premises. The Cooljarloo Mine is remote from most noise sensitive premises. The residences of the Billinue Community are the nearest noise sensitive premises to the Tiwest operations, approximately 750m north of the 28 000 orebody.

Past Tiwest operations have occurred within 300 metres of the Billinue premises. Members of the Billinue Community have advised that while mine activity is occasionally audible, the noise is not annoying and significantly less intrusive than that generated by heavy vehicles travelling at speed along the Brand Highway, 150 metres east of the residences.

The 27 200 orebody is more than two kilometres from the Billinue Community. Mining operations are unlikely to significantly influence environmental noise levels at the Billinue premises. The northern end of any mining activity associated with the 28 000 orebody will occur within 800 metres of the Billinue Community. Given previous monitoring results Tiwest does not expect noise emissions from mining operations to be intrusive or exceed assigned noise levels determined under the Environmental Protection (Noise) Regulations 1997.

Visual Amenity

Although the mining operations may be viewed to a greater or lesser extent from any point around the mining lease M268SA boundary, the only easily accessed, well-trafficked area is Brand Highway.

The 27 200 orebody is more than 2.5 km from the Brand Highway. Mining operations and land disturbance will not be visible from the section of Brand Highway closest to the area. Disturbance associated with mining any viable 28 000 deposit will occur to within 375 metres of the Brand Highway. The highway is not elevated relative to the area of the orebody and no operations at existing ground level will be visible to passing traffic. An overburden dump will be constructed to eight metres above the existing ground to access the 28 000 orebody. The crest of the overburden dump will be around 850 metres from the Brand Highway. The distance from the highway and the application of slope criteria in landform design will ensure the rehabilitated area is compatible with surrounding, undisturbed areas.

The rehabilitation of all areas disturbed in mining the 27 200 and 28 000 orebodies will ensure there is no loss of visual amenity in the longer term.

Aboriginal Culture and Heritage

Detailed ethnographic surveys of mining lease M268SA were completed in 1987 as part of the original project approvals. No Aboriginal sites were identified in the area of the 27 200 orebody.

The area now subject to application by Tiwest for mining tenement ML 70/1010 has not yet been surveyed for the presence of Aboriginal sites. A search of the Aboriginal Affairs Department Register did not indicate any listed sites. The grant of tenement ML 70/1010 is subject to the provisions of the *Native Title Act 1993*. Tiwest is currently in consultation with Native Title claimants to gain agreement for the grant of the tenement. Appropriate ethnographic and archaeological surveys undertaken in consultation with the Aboriginal Affairs Department will form part of any agreement enabling the tenement to be issued.

Employees and contractors are required to cease work if evidence of an Aboriginal site is encountered and to report the observations immediately. Work that may impact on the area would not proceed until the necessary investigations have been completed.

COMMUNITY CONSULTATION

Tiwest regularly liaises with its nearest neighbours, members of the Billinue Community, concerning the progress of the mine. Some members of the Community are familiar with mining operations through the picking of native seed on mining lease M268SA for purchase by Tiwest.

A public open day at Cooljarloo is scheduled for 12 November 1999. Tours of mining operations and information on all aspects of Tiwest's activities, including the proposal to mine the 27 200 and 28 000 orebodies will be available on the day.

Historically Tiwest mining at Cooljarloo has not generated significant comment from the community. Many people from the local communities are employed at the mine and fully aware of mining practice. Tiwest's proposal to mine the 27 200 and 28 000 orebodies will not change the nature of mining operations and will not result in any discernible changes beyond the mining lease boundaries. The local communities are unlikely to be affected in any way.

This PER forms the basis for communicating the proposal to mine the 27 200 and 28 000 orebodies to the broader community.

CONCLUSION AND MANAGEMENT COMMITMENTS

This Public Environmental Review document describes a proposal by Tiwest to extend its mining operations at Cooljarloo to two additional titanium mineral orebodies that were not described in original project approvals issued in 1988. Approval to mine the 27 200 and the 28 000 orebodies would extend the current projected mine life at Cooljarloo by around 22 months to 17 years. No expansion of existing infrastructure or mining rates will occur as a consequence of implementing this proposal.

Tiwest has an established system of environmental management in place at Cooljarloo, which would be routinely applied to the mining of the 27 200 and 28 000 orebodies.

The primary environmental impact associated with this proposal is the disturbance of up to 220 ha of native vegetation. This area constitutes 4.3% of the native vegetation in conservation reserves within 1 km of the boundary of Tiwest's mining lease M268SA, and 0.05% of the native vegetation in reserves in the Moora regional district (as administered by the Department of Conservation and Land Management). There would be no significant impact on any rare or endangered flora or fauna species. Disturbed areas will be rehabilitated to documented standards that will re-establish stable self-sustaining ecosystems.

A summary of the commitments by Tiwest to the environmental management of mining the 27 200 and 28 000 orebodies is detailed below.

No.	Topic	Objective(s)	Action	Timing	Advice
1.	Environmental Management Programme	Manage environmental impacts arising from the proposal.	Apply the Cooljarloo Environmental Management Programme to the mining of the 27 200 and 28 000 orebodies as defined in the EMP and Cooljarloo Environmental Procedures Manual	On an ongoing basis	DEP DME CALM W&RC
2.	Environmental Management Programme	Improvement in environmental performance	Review the Cooljarloo Environmental Management Programme and update as required	Annually	DEP DRD CALM W&RC DME
3.	Native vegetation	Minimise disturbance to native vegetation	Limit clearing of native vegetation associated with mining the 27 200 and 28 000 orebodies to 220 ha.	Overall	DME DEP

A summary of the key environmental factors associated with the mining of the 27 200 and 28 000 orebodies, proposed management of these factors and predicted environmental impacts is detailed in the following table.

Environmental Factors and Management

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Biophysical					
Vegetation	Maintain the species abundance, diversity, geographic distribution and productivity of the vegetation.	• The 27 200 and 28 000 orebodies occur in a region noted for high floristic diversity. • The area supports vegetation of predominantly Banksia low woodland interspersed with areas of low sand heath. • Vegetation community type is primarily determined by position within the landscape and the availability of soil moisture.	• Up to 220 ha of native vegetation, comprised primarily of Banksia low woodland with smaller areas of wet and sand heaths, will be disturbed.	•Vegetation communities and factors dictating distribution are assessed prior to disturbance. • The areal and temporal extent of disturbance will be minimised. • Revegetation will be achieved through selective management, of topsoil and mulched native vegetation and direct broadcast of suitable seed mixes.	No discernible impact on the floristic communities at a regional scale. The species abundance, diversity, geographic distribution and productivity of the vegetation communities will be maintained.
Declared Rare Flora and Priority Species and other significant Flora	Protect declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950* and the *Endangered Species Protection Act 1992* (Cth).	• Two declared Rare Flora species, fourteen priority species and one undescribed species have been identified at Cooljarloo. • *Andersonia gracilis* (DRF) is restricted to low lying depressions subject to seasonal inundation. • *Anigozanthus viridis ssp. terraspectans* (DRF) is restricted to swamps in the Cataby area.	• *A population of Andersonia gracilis* (DRF - 9 plants) may be located within the area disturbed to mine any 28 000 deposit. This population represents 0.03% of the total known for this species.	• Fencing of DRF species remote from orebodies • Planning to minimise disturbance to known populations. • Botanical searches to better quantify the distribution of DRF species. • No disturbance of DRF without Ministerial approval.	Compliance with the Wildlife Conservation Act 1950. No significant impact on total populations of declared Rare Flora or Priority species as a consequence of mining the 27 200 and 28 000 orebodies.
Terrestrial fauna	Maintain the species abundance, diversity and geographical distribution of fauna.	• The fauna assemblage at Cooljarloo is typical of that found in the northern sandplains. • Fauna distribution is determined by vegetation communities that provide suitable habitat	• Up to 220 ha of native habitat will be disturbed.	• Native habitat is re-established through rehabilitation of landform and vegetation. • Colonisation of rehabilitated areas is monitored.	No significant impact on the species abundance, diversity and geographical distribution of native fauna.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Terrestrial fauna	Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950* and the *Endangered Species Protection Act 1992* (Cth).	•Five species of listed status have been recorded in the Cooljarloo area. One species observed in the immediate area of the 27 200 and 28 000 orebodies (Brush Wallaby) •South-West Carpet Python (*Morelia spilota imbricata*) Schedule 4 •Peregrine Falcon (*Falco peregrinus*) Schedule 4. •Short-billed Black Cockatoo (*Calyptorhynchus latirostris*) Schedule 1 •Brush Wallaby (*Macropus irma*) Priority 4 •Square-tailed Kite (*Lophoictinia isura*) Priority 4	• Up to 220 ha of native habitat will be disturbed.	• Native habitat is re-established through rehabilitation of landform and vegetation.	Mining the additional orebodies will not result in the permanent loss of the habitat of any threatened or Priority Fauna species.
Landform	Establish stable, sustainable landform consistent with surroundings.	• The area of mining lease M268SA is the subdued relief of a stabilised dune field. • The lease slopes mildly to the west. • Mullering Brook represents the only distinct drainage line upon the lease.	• Landform will be altered in the immediate vicinity of the orebodies.	• The landform of disturbed areas will be constructed to planned documented standards. • Overburden will be categorised and selectively placed. • Hillslope gradients will be limited to 1:12 with appropriate drainage, hilltop gradients to 1:100 • Re-established landform is protected with mulch and revegetated as soon as possible to minimise erosion.	The final landform will be constructed to criteria that ensure a stable and self-sustaining landscape compatible with surrounding undisturbed areas.
Rehabilitation	Ensure proposal area, and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long term land use.	As described under other relevant environmental factors.	• Up to 220 ha of native environment will require rehabilitation.	• Rehabilitation will be undertaken to documented criteria • Ongoing rehabilitation trials provide for improvement in criteria • Monitoring rehabilitation progress will ensure early remedial action if required	Areas disturbed in the mining of the 27 200 and 28 000 orebodies will be rehabilitated to produce stable, self-sustainable ecosystems compatible with adjacent undisturbed areas.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Pollution Management					
Particulates/Dust	(i) Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of particulate wastes.	• Open unrehabilitated areas are potentially at risk of wind erosion and dust creation. • Topsoil and overburden removal in dry windy conditions constitute greatest risk of excessive dust emissions. • The 27 200 orebody is remote from areas sensitive to excessive dust. • The 28 000 orebody is within 800 metres of the Billinue Community.	• Excessive airborne dust emissions beyond mining lease boundaries.	• Dust monitoring will be undertaken, in accordance with AS2724. • Haulroads and areas around overburden dumps will be regularly watered in dry conditions. • Earthmoving operations will be modified in the event the activity results in excessive dust emissions beyond mining lease boundaries.	The risk of exceeding licence limits or impacting on environmental or human health in mining the 27 200 and 28 000 orebodies is limited.
Groundwater Quality	Maintain or improve the quality of groundwater to ensure that existing or potential uses, including ecosystem maintenance are protected, consistent with the draft Guidelines for Fresh and Marine Waters (EPA, 1993).	• Two main groundwater resources exist beneath the mining lease: the superficial and Yarragadee aquifers. • Groundwater in the superficial aquifer is generally slightly acidic (pH of 5.8-6.2) with a salinity less than 1000 mg/L. • Groundwater in the Yarragadee aquifer is generally slightly acidic (pH of 6.4-6.7) with salinity less than 750 mg/L. • Dredge mining has reduced groundwater levels up to 4 km from the dredge pond.	• Limited risk of affecting groundwater quality. • Groundwater drawdown likely to have minimal impact on wetlands to the south-west of the lease. • Native vegetation in areas subject to reduced groundwater levels in the main aquifer have shown no impact to date.	• Groundwater levels and quality will be continually monitored. • Reductions in groundwater levels occur gradually with the migration of the dredge pond. • Vegetation transects are monitored annually.	Groundwater quality will not be altered as a consequence of mining the 27 200 and 28 000 orebodies. Groundwater levels will recover to pre-mining levels following rehabilitation of disturbed areas.
Surface water Quality	Maintain or improve the quality of surface water to ensure that existing or potential uses, including ecosystem and maintenance are protected, consistent with the draft Guidelines for Fresh and Marine Waters (EPA, 1993).	• Mullering Brook is the only significant drainage line across the mining lease. Flow in the brook is variable from year to year and along the length of the brook. • Several permanent wetlands exist on farmland around 1.2 km south-west of the 27 200 orebody.	• The areas to be disturbed in mining the 27 200 and 28 000 orebodies contribute runoff to the surface waterbodies only under extreme rainfall conditions.	• Landform is constructed to minimise erosion from surface run-off.	No impact on the quality of any surface water bodies as a consequence of mining the 27 200 and 28 000 orebodies.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Greenhouse Gases	(i) Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of greenhouse gases.	• Emissions resulting from clearing native vegetation constitute approximately 4% of total emissions associated with mining activity at Cooljarloo. • Total emissions associated with mining activity at Cooljarloo represent <0.3% of 1995 net emissions in Western Australia.	• Extension in the duration of greenhouse gas emissions associated with mining activity by 2 months to around 17 years. • No increase in the annual rate of greenhouse gas emissions.	•Minimisation of energy consumption (and therefore greenhouse gas emissions) through equipment selection and mine planning. • No cleared vegetation is burnt at Cooljarloo.	Greenhouse gas emissions associated with mining the 27 200 and 28 000 orebodies will not result in environmental or human health problems.
Noise	Ensure that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.	• Mining operations do not exceed assigned levels defined under the Environmental Protection (Noise) Regulations 1997. • Nearest noise sensitive premises are the Billinue Community (750 m) and Dandallen Farm (6.3 km).	• Minimal risk of an increase in environmental noise emissions.	• Environmental noise levels will be checked periodically. • Regular liaison will be maintained with members of the Billinue Community.	Environmental noise emissions associated with the 27 200 and 28 000 orebodies will not exceed assigned noise levels determined under the Environmental Protection (Noise) Regulations 1997, or adversely impact on neighbouring noise sensitive premises.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Social Surroundings					
Visual Amenity	Visual amenity of the area adjacent to the project should not be adversely affected by the proposal.	• Tiwest operations are not readily visible from the Brand Highway nearest mining activity.	• The 27 200 deposit is remote from areas of general public access. • Disturbance associated with any 28 000 deposit may occur to within 300m of Brand Highway • An overburden dump to 8 m height will be established with a crest around 850 m from the Brand Highway.	• Housekeeping and dust management will be maintained. • Disturbed areas will be rehabilitated to criteria to blend into the surrounding undisturbed environment.	Mining the 27 200 and 28 000 orebodies will not unduly affect the visual amenity of the area as assessed from the Brand Highway.
Aboriginal Culture and Heritage	(i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972;* and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	•Detailed ethnographic surveys of mining lease M268SA were completed in 1987 as part of the original project •No Aboriginal sites were identified in the area of the 27 200 orebody. •The area now subject to application by for mining tenement ML70/1010 has not been surveyed by Tiwest for the presence of Aboriginal sites. No sites are listed with the Aboriginal Affairs Department.	•Risk of disturbing Aboriginal sites is minimal.	• Completion of ethnographic and archaeological surveys over tenement ML70/1010 prior to disturbance for mining. • Consultation with local Aboriginal groups concerning the mining operations. • Application to the Minister for Aboriginal Affairs to disturb an Aboriginal site if disturbance is unavoidable.	Mining the 27 200 and 28 000 orebodies will occur in accordance with the *Aboriginal Heritage Act 1972*. Biological and physical changes associated with mining the 27 200 and 28 000 orebodies should not adversely impact any cultural associations with the area.

1.0 INTRODUCTION

1.1 BACKGROUND

Tiwest Pty Ltd (Tiwest) have mined titanium minerals at the Cooljarloo Mine, 10 km north of Cataby, since 1989. The mineral resource at Cooljarloo is the basis for Tiwest's integrated titanium minerals project which involves downstream minerals separation and processing in plants located at Muchea and Kwinana. The project was established pursuant to the *Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988.*

Environmental approval for the development of the titanium minerals mine at Cooljarloo was issued in 1988, following assessment of an Environmental Review and Management Programme (Maunsell and Partners, 1987) which outlined the extent of mineral resources known at that time. In subsequent exploration, Tiwest identified additional resources within its existing mining lease. The 27 200 orebody was confirmed during 1998, and in March 1999 Tiwest submitted a proposal to the Environmental Protection Authority (EPA) to include the orebody in its mining schedule. The EPA determined that environmental impact assessment of the proposal be conducted at the level of a formal Public Environmental Review (PER).

Tiwest had also identified the potential for an orebody to exist adjacent to the current mining lease, and had applied for a mining tenement to explore the area (ML 70/1010). The decision to apply for a mining tenement in the first instance was influenced by the limited time available to explore and then mine any proven orebody before nearby mining operations moved away from the area. Because of these time constraints, Tiwest elected to include the mining of any viable resource, that would be identified as the 28 000 orebody, within the scope of this PER. The grant of tenement ML 70/1010 is subject to the provisions of the *Native Title Act 1993* and has not yet been issued.

This PER describes the methods and procedures proposed by Tiwest to mine, and to manage the mining, of the 27 200 orebody and any viable 28 000 orebody. Tiwest has an established system of environmental management at Cooljarloo and, to a large extent this PER details current practice at the mine.

1.2 OBJECTIVES AND TIMING OF THE PROPOSAL

The objective of the proposal is the utilisation of existing employees, systems and infrastructure at Cooljarloo to mine the 27 200 orebody and any economically viable 28 000 orebody.

Tiwest proposes to commence mining the 27 200 deposit in April 2002 immediately after completing the mining of the 27 000 South deposit. The 27 200 deposit will be mined in a northerly direction and is expected to be completed in the first quarter of 2004.

The optimum time to access any viable 28 000 deposit is when the mining operations are closest in the 27 000 South deposit, which is in the period from June 2000 to June 2002.

1.3 THE PROPONENT

The proponent for the proposal is:

Tiwest Pty Ltd
1 Brodie Hall Drive
BENTLEY WA 6152

Tiwest Pty Ltd (ACN 009 343 364) is the operations manager for the Tiwest Joint Venture, an equal joint venture between:

- Subsidiaries of Ticor Resources Pty Ltd (ACN 002 376 847); and
- KMCC Western Australia Pty Ltd (ACN 009 331 195), a wholly owned subsidiary of Kerr McGee Chemical LLC (USA).

1.4 PUBLIC ENVIRONMENTAL REVIEW PROCESS AND PURPOSE

The primary purpose of the Public Environmental Review is to describe the proposed mining of the 27 200 and 28 000 orebodies in sufficient detail for the informed assessment of associated environmental impacts. The document is prepared in accordance with guidelines issued by the Environmental Protection Authority, following consultation with Tiwest and government decision making authorities. The Public Environmental Review is released for an eight week review period during which the public may present written submissions to the Environmental Protection Authority.

Issues raised in written submissions are collated and transmitted to Tiwest by the Department of Environmental Protection. Tiwest may then provide clarification or propose actions in response to issues raised. The PER, written submissions and proponent responses are forwarded to the EPA for evaluation.

Following evaluation the EPA will submit a report to the Minister for the Environment for consideration and public release. Any person may appeal against recommendations in the report to the Minister for the Environment, within 14 days of the release of the report.

The Minister will then determine the acceptability of the proposal and, in consultation with other decision making authorities, publish a statement to that effect. The statement may contain conditions and is legally binding.

The environmental impact assessment process for the PER is depicted in Figure 1.1.

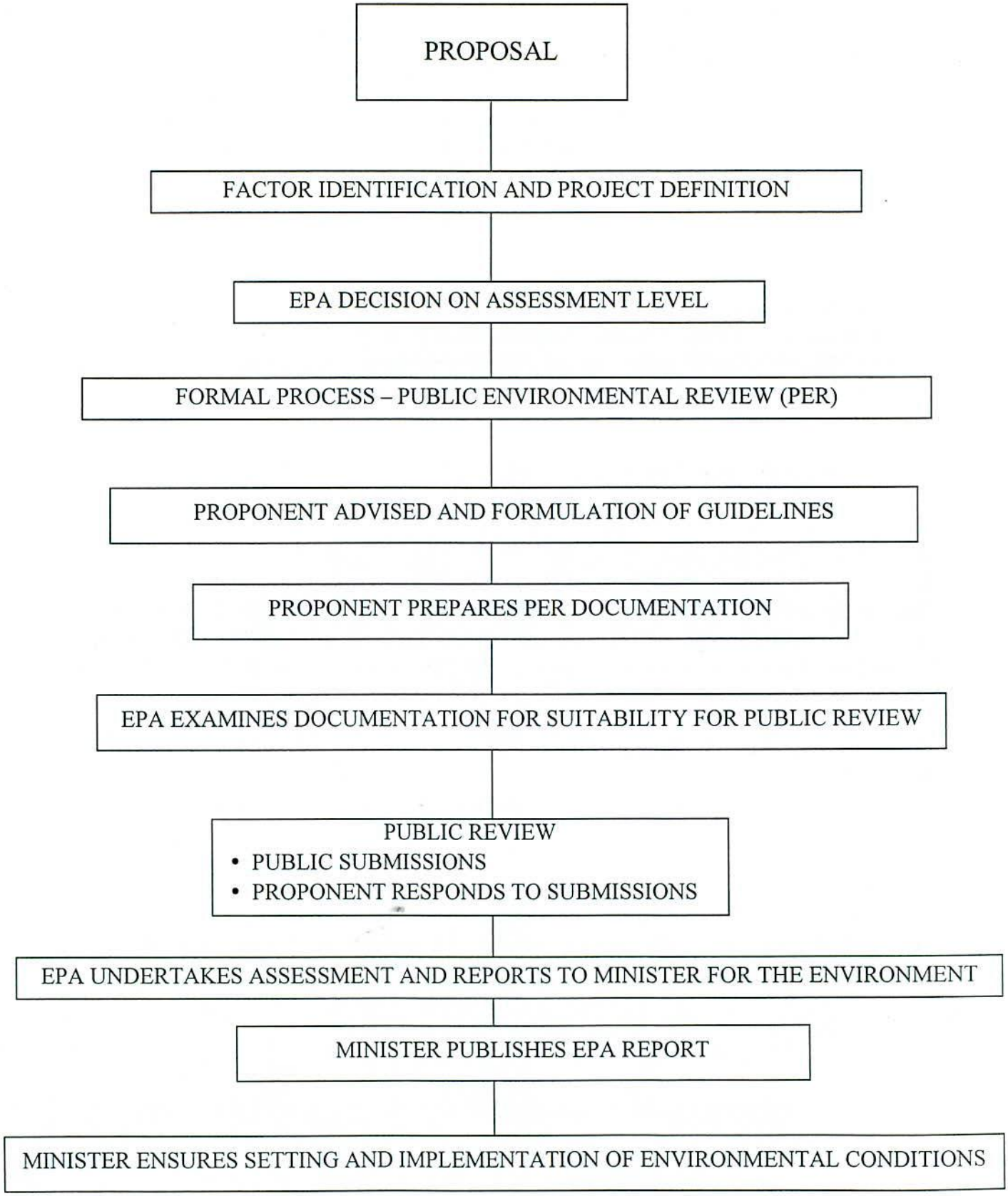


Figure 1.1 - ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

1.5 Mining Tenements and Land Titles

The Cooljarloo Mine is immediately west of the Brand Highway, 10km north of Cataby. To date all mining has occurred on mining lease M268SA, which was established under the *Mineral Sands (Cooljarloo) Mining and Processing Agreement Act 1988*. The tenement is around 87 km^2, extending north approximately 18 kilometres from the southern boundary to Wongonderrah Road (Figure 1.2). The lease is up to 6 km wide (east to west).

All of mining lease M268SA is vacant Crown Land (vCL), except for Mullering Farm (refer to Figure 1.2).

Tiwest has applied to the Department of Minerals and Energy (DME) for mining lease ML 70/1010, a 94 hectare area adjacent to the south eastern boundary of M268SA, to explore the 28 000 orebody. Tiwest would normally apply first for an exploration lease to test the existence of the deposit however, due to the limited time available in which to explore and mine any proven resource, applied directly for a mining lease in this instance.

The location of the tenements and surrounding land use is detailed in Figure 1.2.

1.6 Mine Development

Mining the 27 000 deposit, using the dredge Cooljarloo I, commenced on Mullering Farm in December 1989. Dredge mining continued on the farm until July 1999, when operations moved south to the 27 000 South deposit in vCL. A second, smaller dredge, Cooljarloo II, was commissioned in August 1999 and is used to maintain constant ore feed rates to the wet separation plant under variable dredging conditions, which is primarily a consequence of clay banding in the 27 000 South orebody.

A separate dry mining operation commenced in vCL north of the farm in April 1997 to maintain budgeted levels of heavy mineral concentrate production in the face of falling heavy mineral grades. Initially ore from the dry mine was treated by the wet separation plant servicing the dredge in a project known as the Supplementary Feed Programme, which delayed the requirement for construction of a second wet separation plant dedicated to the dry mine. A wet separation plant servicing the dry mine was commissioned in September 1999, effectively creating two discrete mining operations.

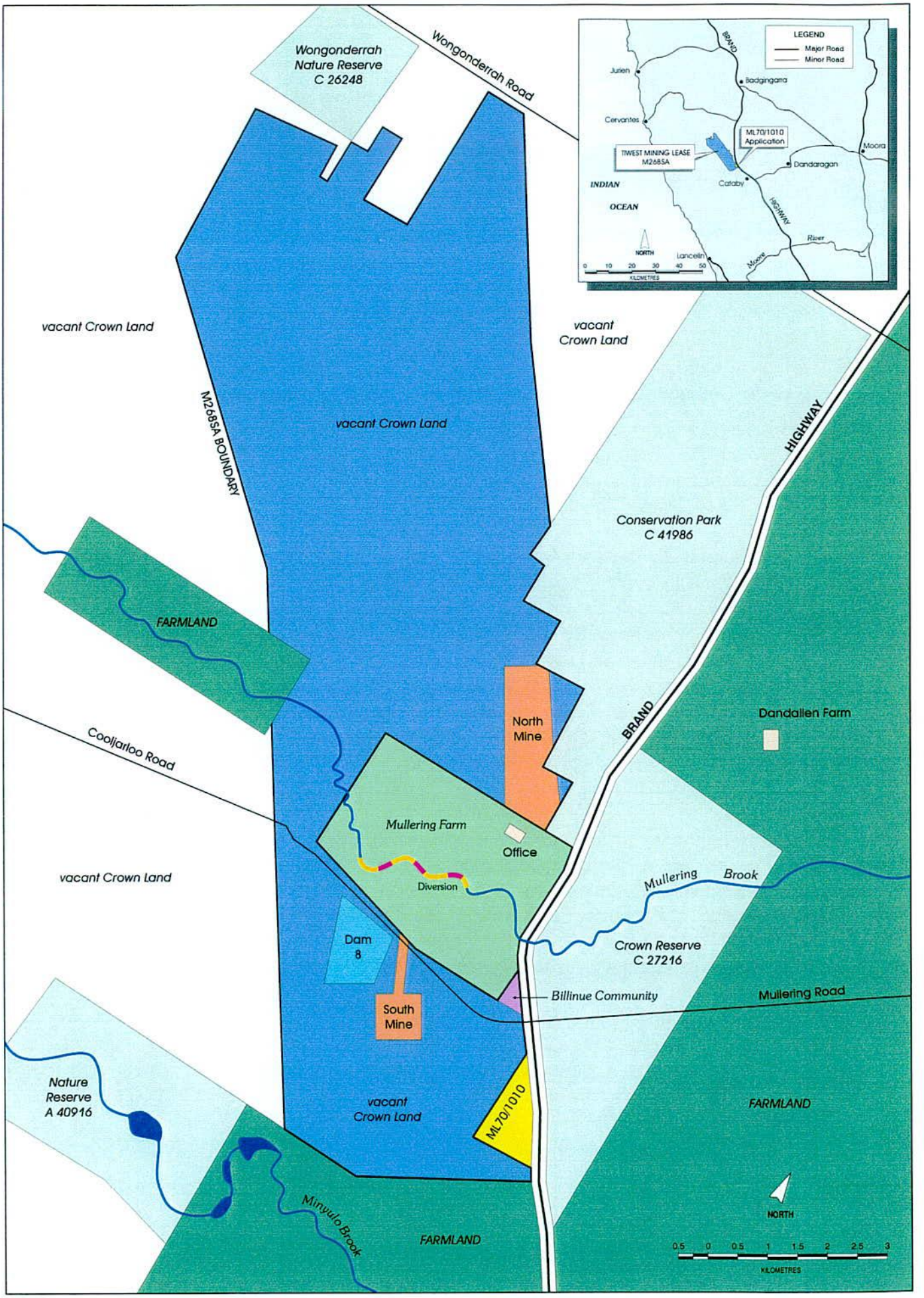


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Figure 1.2 - COOLJARLOO MINE LOCAL AND REGIONAL SETTING

1.7 Existing Environmental Approvals

The Cooljarloo Mine operates under the following primary environmental approvals:

- ***The Mineral Sands (Cooljarloo) Mining and Processing Agreement Act No. 68 of 1988* (Agreement Act).**

  The Agreement Act defines the agreement between the State and the Joint Venture Participants for the integrated titanium minerals project to proceed, subject to approvals required under the *Environmental Protection Act 1986*. Environmental provisions under the Agreement Act include requirements to prepare an Environmental Management Programme and to submit annual and triennial environmental reports.

- **Statement of Environmental Approval (No. 37, 3 October 1988), issued under Part IV of the *Environmental Protection Act 1986* by the Minister for the Environment.**

  The statement followed assessment of an Environmental Review and Management Programme (Maunsell and Partners, 1987) by the Environmental Protection Authority and set conditions to be fulfilled prior to, and during implementation of the project. A copy of the statement is included at Appendix B.

- **Environmental Protection Act Licence (No. 5319), issued under Part V of the *Environmental Protection Act 1986*.**

  The licence permits operation of a prescribed premise and sets conditions primarily aimed at pollution prevention and environmental performance reporting. Under the terms of the licence the quantity of ore processed at the Cooljarloo Mine shall not exceed 25 million tonnes and the quantity of heavy mineral concentrate produced shall not exceed 750 000 tonnes, without the prior approval of the Department of Environmental Protection (DEP).

- **Mining Lease M268SA.**

  Some of the environmental conditions set under the Agreement Act and the Ministerial Statement require environmental reporting, adherence to the proposal and implementation of an Environmental Management Programme. These requirements are replicated in the terms attached to the mining lease issued by the Department of Minerals and Energy.

- **Environmental Management Programme.**

  The Environmental Management Programme (EMP) is a principal document for environmental management at Cooljarloo, which is referenced in all the above approvals. The initial EMP for the Cooljarloo operations was approved by the EPA in November 1989. Subsequent revisions of the EMP have been approved by the DEP in March 1996, July 1996 and August 1998.

1.8 Relevant Legislation

Operations at Cooljarloo are subject to a range of state and federal legislation and regulations. A list of relevant legislation and regulations is given below.

- *Aboriginal Heritage Act 1972*
- *Agriculture and Related Resources Protection Act 1976*
- *Australian Heritage Commission Act 1975*
- *Bush Fires Act 1954*
- *Conservation and Land Management Act 1984*
- *Endangered Species Protection Act 1992*
- *Environmental Protection Act 1986*
- *Explosive and Dangerous Goods Act 1961*
- *Health Act 1911*
- *Heritage of Western Australia Act 1990*
- *Mining Act 1978*
- *Mines Safety and Inspection Act 1994*
- *Native Title Act 1993*
- *Radiation Safety Act 1975*
- *Rights in Water and Irrigation Act 1914*
- *Soil and Land Conservation Act 1945*
- *Wildlife Conservation Act 1950*

- Environmental Protection (Noise) Regulations 1997
- Dangerous Goods (Storage) Regulations 1992
- Mine Safety and Inspection Regulations 1995

1.9 Structure of the Environmental Review Document

Section 1.0 provides background to Tiwest's mining operations at Cooljarloo and the proposal to include the 27 200 and 28 000 orebodies in the mining schedule. The existing environmental approvals and legislation applicable to the mining operations, most of which will also apply to the mining of the additional orebodies, is also listed.

Section 2.0 describes specific characteristics of the proposal to mine the 27 200 and 28 000 orebodies.

Section 3.0 describes the full process of mining, from pre-disturbance environmental monitoring to rehabilitation, as it will be applied in mining the 27 200 and 28 000 orebodies at Cooljarloo.

Section 4.0 describes the environmental setting of the Cooljarloo Mine and inter-relationships between various components of local ecosystems as relevant to the proposal area. Specific environmental characteristics of the area overlying the 27 200 and 28 000 orebodies are also detailed, or referenced to other sections of the document.

Section 5.0 provides an overview of the environmental management system in place at Cooljarloo, which will be routinely applied in the mining of the 27 200 and 28 000 orebodies.

Section 6.0 examines the potential impacts associated with mining the 27 200 and 28 000 orebodies for environmental factors considered relevant to the proposal. Specific environmental management procedures are listed and evaluations of impacts relative to the objectives of the EPA are discussed, in accordance with EPA guidelines for the PER (refer to Appendix A). Where relevant, information and/or data drawn from the existing mining operations is presented to substantiate assessments, or to consider the consequence of cumulative impacts. Specific monitoring data may also be presented where that provides evidence of management work that has been undertaken.

Section 7.0 discusses community consultation concerning the proposal.

Section 8.0 presents a conclusion to the environmental assessment and lists key commitments by Tiwest for the environmental management of the proposal.

2.0 DESCRIPTION OF PROPOSAL

2.1 ADDITIONAL OREBODIES

The proposal addressed in this PER is the mining of titanium minerals in the 27 200 and 28 000 orebodies at Cooljarloo. Mining the latter deposit will depend on confirmation of a viable resource. These orebodies were first identified in 1997/1998 and therefore do not form part of the proposal originally approved in 1988. The existence of the 27 200 orebody was reported in the 1997 Triennial and 1998 Annual Environmental Reports to government agencies, and also in the 1997 Cooljarloo Environmental Management Programme (approved in August 1998).

The 27 200 and 28 000 orebodies are located in vCL south of Mullering Farm and adjacent to the major 27 000 South orebody. Mining the 27 000 South orebody, which was sanctioned under the original environmental approvals, commenced in August 1999 after ten years of mining on Mullering Farm. Tiwest proposes to employ established infrastructure and techniques at Cooljarloo to mine the 27 200 and 28 000 orebodies. Incorporating these deposits into the mine plan will extend the currently projected mine life at Cooljarloo by 22 months to around 17 years. No increase in mining rate will occur as a consequence of implementing this proposal.

The process of mining at Cooljarloo, which will apply to the additional orebodies should mining be approved, is described in Section 3.0. Tiwest's established Environmental Management System, which is described in Section 5.0, will also apply to the mining of the additional deposits. Although the detail of some monitoring procedures will change to accommodate the new areas, the standards and objectives of the current EMP (refer to Appendix F) remain relevant to the mining of the 27 200 and 28 000 orebodies.

2.2 LOCATION

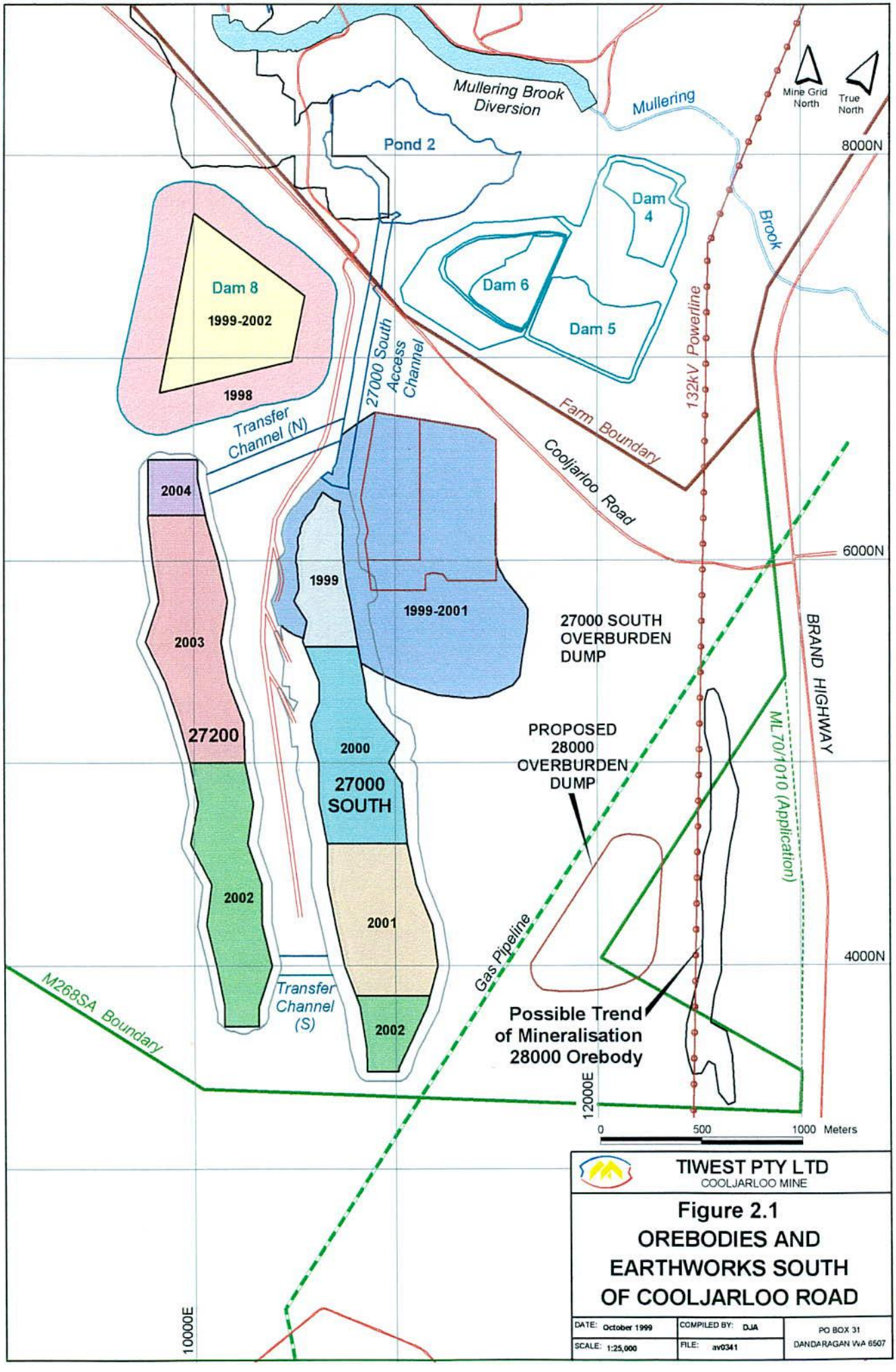
The 27 200 deposit is 300m west of 27 000 South, and within mining lease M268SA. The 28 000 orebody is east of 27 000 South and appears to be primarily within an area the subject of a mining lease application (ML 70/1010) by Tiwest (Figure 2.1). The presence of heavy minerals suggesting the existence at the 28 000 orebody, has been confirmed on areas of M268SA immediately north and south of ML 70/1010. Further exploration is required to test whether the mineralisation is continuous on ML 70/1010.

2.3 PROPOSAL CHARACTERISTICS

The specific details of the 27 200 and 28 000 orebodies, and characteristics of the proposal are detailed in Table 2.1, together with data for the main 27 000 South orebody for comparison. The details may change on the basis of additional information gained during the course of mining. The characteristics of the 28 000 orebody may be considered indicative only, and present a maximum scenario based on current knowledge of the local geology and extrapolation of limited exploration data from Tiwest's current mining lease. Figure 2.1 details the proposed schedule for mining south of Cooljarloo Road, including the 27 200 orebody. Any mining of the 28 000 orebody would occur concurrently with the 27 000 South orebody (preferably) or the 27 200 orebody (refer to following section).

Table 2.1 Characteristics of the Proposal to Mine the 27 200 and 28 000 Orebodies

ELEMENT	DESCRIPTION		
	27 000 South	**27 200**	**28 000 (Theoretical)**
• Extension to mine-life	~ 2.5 years	20 months	2 months
• Period of ore extraction	Aug 99 – Apr 2002	Apr 2002 – 1st Q 2004	Jun 2001 – Jun 2002
• Method of ore extraction	Dredge	Dredge	Dredge or dry
• Size of ore-body (t of HMC)	1,510,000	852,000	150,000
• Area of Disturbance (ha)	415	105	115
• Depth of pit (m) Maximum Typical	 52 48	 50 46	 35 30
• Infrastructure	Dredge pond, 2 dredges, floating wet concentration plant, tailings dam (dam 8), overburden dumps and topsoil stockpiles, bore water tanks, drainage channels and HMC stockpile.	Dredge pit, access and exit channels.	Dredge pit, access roads, overburden dump, shore-based pumping facility.
• Ore Mining Rate (t/hr)	Initial Cooljarloo I – 1680 Cooljarloo II – 500 Final Cooljarloo I – 1680	Cooljarloo I – 1680 Cooljarloo II – 500	Cooljarloo II – 500
• Overburden (m^3)	24 million	19 million	9 million
• Water Supply Licenced Annual Abstraction Limit (kL) Superficial aquifer and Yarragadee aquifer Proposed Annual Withdrawal (kL)	 8 780 000 1 750 000	 Unchanged	 Unchanged
• Fuel Storage Capacity (L)	Tiwest – 138,800 Contract – 100,000	Unchanged	Unchanged
• HMC transport – Truck movements Maximum Mean	 40 return trips a day @ mean load 70 t 27 return trips a day @ mean load 70 t	Unchanged	Unchanged


Mullering Brook Diversion
Mullering
Pond 2
Mine Grid North
True North
8000N
Dam 4
Dam 6
Dam 5
Brook
Dam 8
1999-2002
1998
132kV Powerline
27000 South Access Channel
Transfer Channel (N)
Farm Boundary
Cooljarloo Road
2004
2003
27200
2002
1999
1999-2001
2000
27000 SOUTH
2001
2002
6000N
27000 SOUTH OVERBURDEN DUMP
BRAND HIGHWAY
PROPOSED 28000 OVERBURDEN DUMP
ML70/1010 (Application)
Gas Pipeline
Transfer Channel (S)
M268SA Boundary
Possible Trend of Mineralisation 28000 Orebody
4000N
12000E
10000E
0
500
1000 Meters
TIWEST PTY LTD
COOLJARLOO MINE
Figure 2.1
OREBODIES AND EARTHWORKS SOUTH OF COOLJARLOO ROAD
DATE: October 1999
COMPILED BY: DJA
SCALE: 1:25,000
FILE: av0341
PO BOX 31
DANDARAGAN WA 6507

2.4 PROCESS FLOWS

The nominal process flows associated with mining the 27 200 and 28 000 orebodies are represented graphically in Figures 2.2 and 2.3. The rates indicated are dependent on many factors and may vary on a daily basis. Factors that influence process flow rates include:-

- Orebody characteristics – grade of heavy minerals, clay content, presence of cemented layers
- Aquifer characteristics – transmissivity, depth to groundwater
- Rainfall
- Equipment performance and maintenance
- Provision of services – electricity

The physical capacities of the dredges, Cooljarloo I and Cooljarloo II, and the floating wet separation plant are constant. The origin and destination of some material flows are subject to change, depending on the above factors.

Based on current data any viable 28 000 deposit will probably be mined using the smaller dredge Cooljarloo II. Irrespective of the method of ore extraction, the resulting ore will be pumped overland to the wet separation plant located on the dredge pond formed in the mining of 27 000 South. Overburden removed to expose the 28 000 orebody will be placed adjacent to the mine pit and rehabilitated.

Once the dredge pond in the 28 000 orebody is an adequate operating size (around 50 hectares), tailings from the wet separation plant will be returned to the rear of the pond to backfill the mine void in preparation for rehabilitation. Tailings will comprise the combined waste of the 27 000 and 28 000 operations.

The additional orebodies serve to extend the life of the mine rather than increase the rate of heavy mineral concentrate production.

The 27 200 orebody will be accessed at its southern extremity through a channel constructed leading west from the 27 000 South orebody. At the completion of mining in 27 200 the dredges will return to Mullering Farm through the original access channel to the 27 000 South orebody. Should the 28 000 deposit be dredged, Cooljarloo II, would be transported in several sections by heavy vehicle to the orebody and re-assembled. At the completion of mining in the 28 000 orebody the dredge would be relocated to the 27 200 orebody.

2.5 NATURAL GAS AND ELECTRICITY SERVICES

The Dongara – Pinjarra gas pipeline and the main 132kv power line traverse mining lease M268SA in the vicinity of the 27 000 South and 28 000 orebodies (Figure 2.1). The gas pipeline is buried and Tiwest would undertake the construction of crossings necessary to access the 28 000 orebody in consultation with the managers of the pipeline, CMS Gas Transmission of Australia. Tiwest relocated approximately 4 km of the 132kv power line north of Mullering Farm in 1997 to access the 12 000 orebody with the agreement of Western Power. Relocation of around 3 km of the power line will be necessary to mine any viable 28 000 orebody and would again be undertaken in consultation with Western Power.

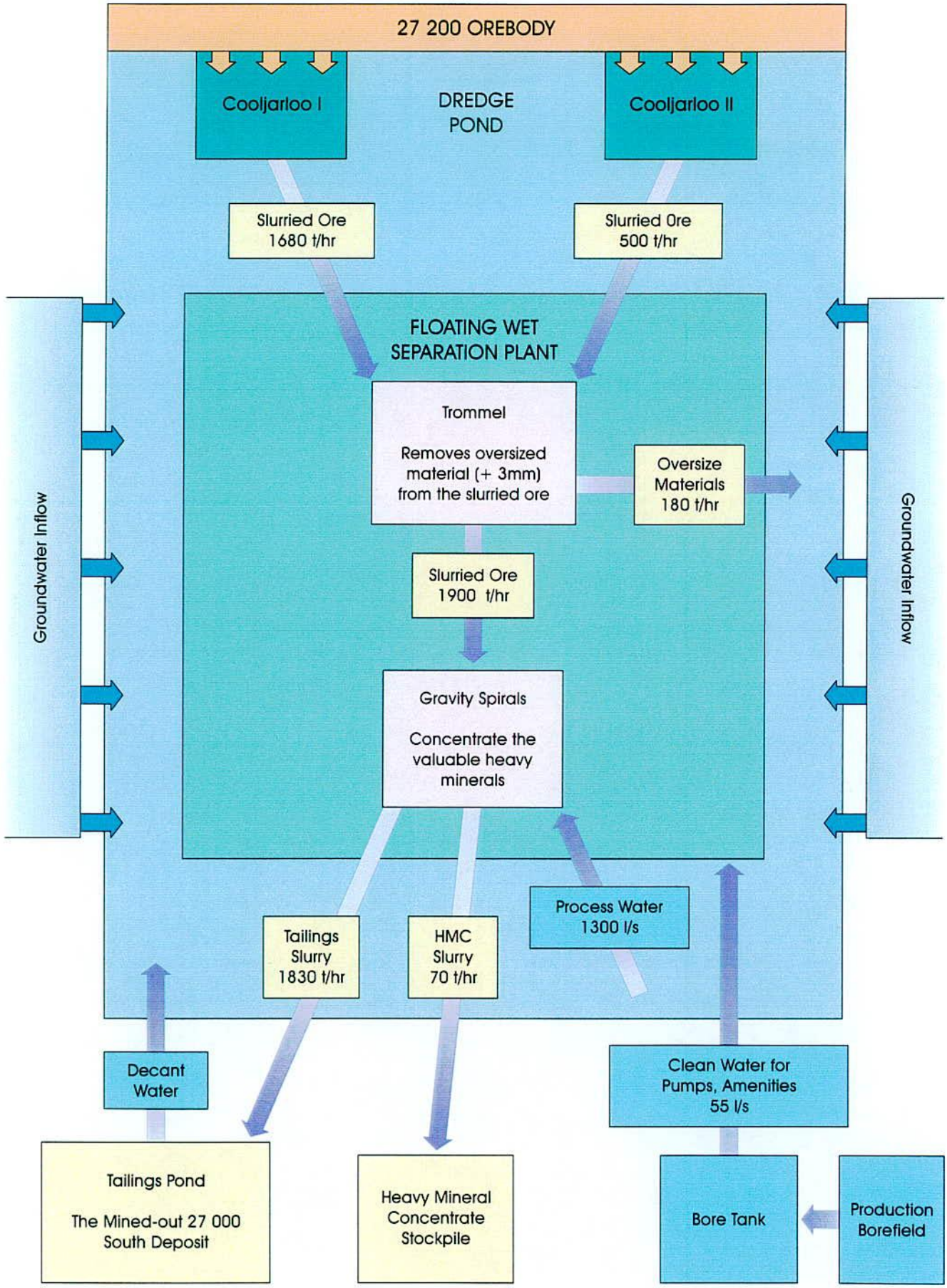


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Figure 2.2 - NOMINAL PROCESS FLOWS IN EXTRACTING THE 27 200 OREBODY

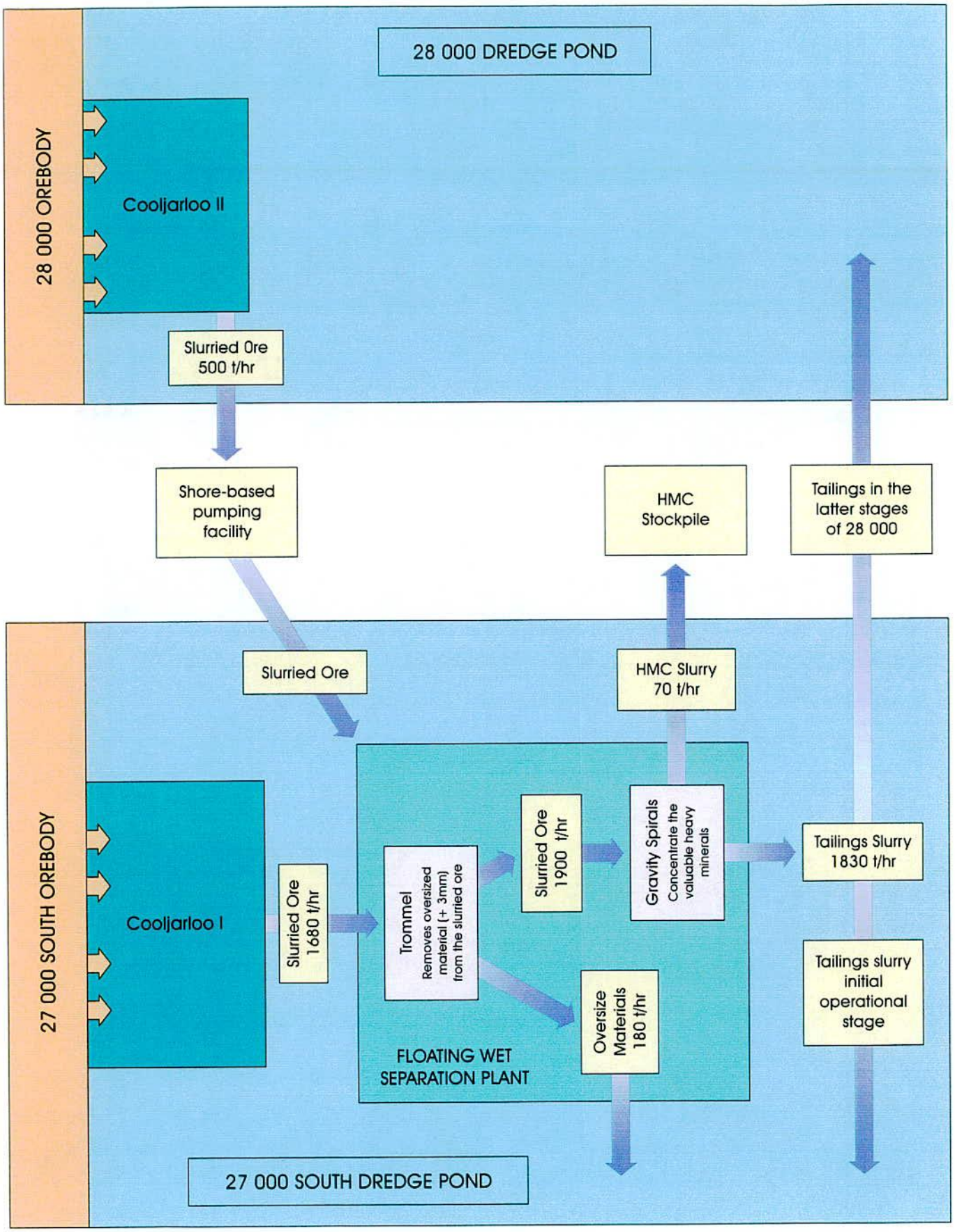

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Figure 2.3 - NOMINAL PROCESS FLOWS IN EXTRACTING THE 28 000 OREBODY

3.0 MINING PROCESS FOR THE 27 200 AND 28 000 OREBODIES

The process of mining at Cooljarloo commences with the detailed planning and scheduling of activities and ends with the post-rehabilitation monitoring of areas disturbed in the extraction of heavy minerals. This process will be followed in the mining of the 27 200 and 28 000 orebodies.

The process is described in Figure 3.1. Each stage is summarised below.

3.1 PRE-DISTURBANCE MONITORING

Prior to any disturbance the environmental characteristics of an area are described through baseline monitoring and surveys. The information is used to properly manage the ensuing vegetation clearing and topsoil stripping, and for rehabilitation planning. The following environmental data is collected:

Flora
- vegetation associations are mapped (the species density, diversity and percentage foliar cover for each vegetation association are monitored in established transects)
- the presence of any declared Rare Flora or Priority species is determined
- the distribution of any *phytophthora* species is mapped

Fauna
- the habitat characteristics are reviewed to identify any types not represented in Tiwest's established long term fauna monitoring transects

Soils
- the soil types are determined and mapped

Groundwater
- groundwater levels and quality are described through ongoing monitoring

Surface Water
- the period, magnitude and quality of flows are described through ongoing monitoring

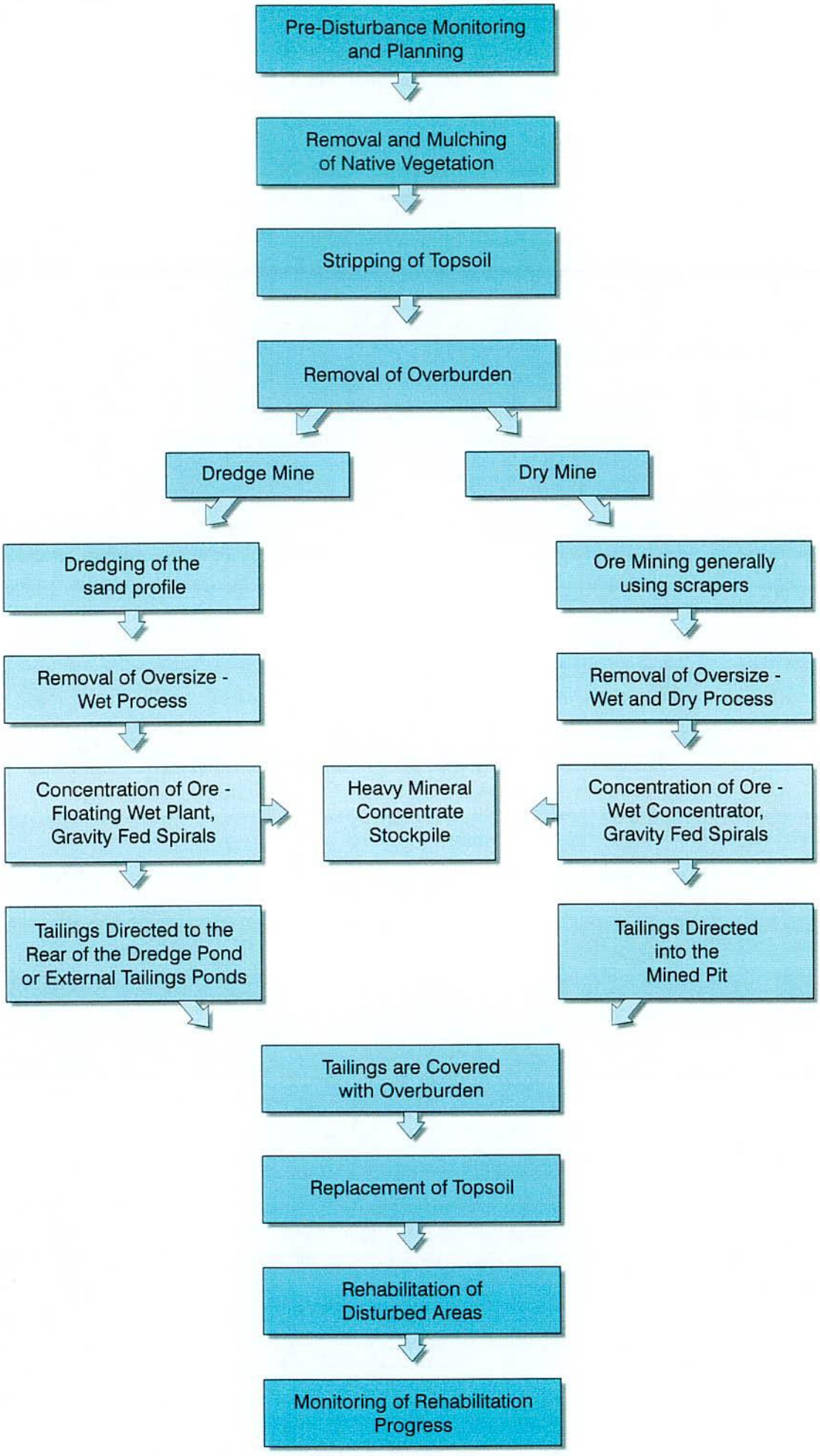
Radiation
- background radiation levels are determined

In addition, the characteristics of the orebody and overburden are defined from drilling data.

3.2 PLANNING

A mine plan is produced each year which identifies the mine path and schedule of activities for the following years, detailing the equipment, resources and services required to achieve the plan. The mine plan includes assessments of future water requirements and the proposed management of mine tailings.

Complementary topsoil management, overburden management, tailings management and rehabilitation plans are also prepared annually, on the basis of the overall mine plan. The topsoil and overburden management plans detail the selective removal of material to access the orebody and the placement or storage of material in preparation for rehabilitation. The rehabilitation plan identifies the areas targeted for rehabilitation in the following season and prescribes the rehabilitation criteria and procedures for each area.



TIWEST

Figure 3.1 - THE MINING PROCESS

3.3 REMOVAL OF NATIVE VEGETATION

No native vegetation is cleared at Cooljarloo without the written approval of the site General Manager. This approval is provided on the basis of consistency with prior approvals issued under delegated authority by the State Mining Engineer (Department of Minerals and Energy) under the *Soils and Land Conservation Act 1945*.

Wherever possible Tiwest, in partnership with the Billinue Community (refer Section 7.0), ensures areas earmarked for clearing are picked for native seed prior to disturbance. The native seed is subsequently used in rehabilitation.

Native vegetation is a valuable resource for rehabilitation. Mulched vegetation reduces the loss of soil moisture through evaporation, reduces water and wind erosion by shielding the soil surface, adds organic matter to the topsoil and when directly placed, provides a significant seed store for regeneration of plant communities.

Areas are selectively mulched according to vegetation association, which involves the harvesting of most vegetative material using an adapted forage harvester. The mulched vegetation is preferably placed directly on rehabilitated areas or stockpiled for later use. Larger, woody material is chipped using a tubgrinder and again directly placed or stockpiled. Cleared vegetation is not burnt at Cooljarloo.

3.4 STRIPPING AND STOCKPILING OF TOPSOIL

Topsoil is also a valuable resource that has a significant influence on rehabilitation performance. It is the medium for plant germination and growth and is a significant source of native seed, providing around 30% of native seed applied to rehabilitated landscapes under current procedures at Cooljarloo. Further, a high proportion of the local species propagate from root stock rather than seed in the natural environment. For example, *Adenanthos cygnorum* (woolly bush) is a common mid-storey species in the local Banksia low woodland that poses significant difficulties in seed collection but appears to generate readily from root stock.

Topsoil is collected in a two cut operation reflecting typical native soil profiles. The seed and organic rich surface 50-100 mm layer which contains the majority of seed and organic matter is removed first, followed by around 200 mm of lighter underlying material. The stripped topsoil is, wherever possible, directly spread on the reconstructed landform.

The value of stockpiled topsoil decreases over time. The viability of the seed store, the mycorrhizal populations and nutrient content all decline. Soil mycorrhizal fungi form symbiotic relationships with some native plant species that aid the plants in the acquisition of soil nutrients (Jasper, 1995). When storage is necessary, the two cuts of topsoil are stored separately in stockpiles not exceeding two metres in height to maximise the survival of mycorrhizal fungi. Stockpiles are also seeded with a cover crop or protected with mulched vegetation to minimise erosion.

3.5 REMOVAL OF OVERBURDEN

Many of the orebodies at Cooljarloo are overlain by non-mineralised material which must be removed to gain access to the ore. Overburden is excavated primarily using conventional earthmoving equipment (excavator and truck) though, depending on the depth of overburden, may also be removed by dredging. The removed overburden is generally placed over stabilised tailings to form a predetermined landform that minimises subsequent contouring work. It may also be used to construct tailing storage dams out of the mine pit if of suitable quality, or deposited adjacent to the mine pit when first accessing an orebody.

The characteristics of overburden encountered at Cooljarloo vary. Similar to topsoil, overburden is selectively managed to optimise rehabilitation performance. Overburden is categorised into three classes on the basis of key physical and chemical characteristics, though the primary determinant is clay content. Table 3.1 details the means of overburden classification. Increased clay content occurs with depth in the natural profile. Overburden containing a high percentage of clay can be prone to hard setting at the surface, with resultant low water infiltration rates. Clays drawn from depth may contain significant salt within their structure. The exchangeable sodium percentage (ESP) of clays is used as an indicator of salt content. Excess sodium can have deleterious effects on soil structure leading to surface clogging and instability (Carlstrom, Amendola, Shay and Dollhopf, 1987).

Table 3.1 – Overburden Classification

Category	Type/Colour	pH	Clay %	ESP*
Class I	Yellow sand	5.5 – 6.5	< 10	< 10
Class II	Pink clay	5.5 – 6.5	10 – 25	10 – 15
Class III	White clay	< 5.5 - > 6.5	> 25	> 15

* ESP – Exchangeable Sodium Percentage.

Overburden movement is planned to ensure appropriate placement, according to Class in the reconstructed profile. Class I overburden is placed uppermost in the profile, as it is the most permeable material suitable for root penetration and minimisation of surface runoff. Class III overburden, which is highest in clay and or salt composition is deposited at depth in the reconstructed profile.

The selective placement of overburden effectively aims to return excavated material to a position within the reconstructed profile comparable to its pre-mining location.

3.6 ORE EXTRACTION

The heavy mineral deposits at Cooljarloo are extracted by dredge and dry mining. The method selected is determined by the position of a deposit relative to local groundwater levels. Where the deposit lies predominantly above the water table dry mining is adopted, where below, dredge mining is utilised.

3.6.1 Dredge Mining

A schematic of the dredge mining process is shown in Figure 3.2.

The dredge floats in a pond created by groundwater flow into the void created by ore and overburden removal. It utilises a cutting head to disturb the ore which is then slurried and pumped via a floating pipeline to the wet separation plant situated behind the dredge. The main dredge, Cooljarloo I is capable of mining to 25 metres below the water surface. Cooljarloo II can mine to 15 metres depth.

The depth of the dredge pond is generally maintained between 22 and 25 metres. Cooljarloo I operates most efficiently at these depths. This range provides the most operational flexibility to adjust for changes in the level of the base of the orebody. Under these conditions Cooljarloo II is used to mine a bench in advance of the main dredge.

To maintain the optimum water levels in the dredge pond, additional water is occasionally required to supplement water flowing in from the surrounding water table. The 'make up' water is sourced from a production borefield and from water decanted from tailings dams.

3.6.2 Dry Mining

A schematic of the dry mining process is shown in Figure 3.3.

In the dry mining process conventional heavy earthmoving equipment is utilised to expose the orebody. Excavators are generally used for overburden removal and scrapers to collect the ore and deliver it to a screening plant.

There are two main sections to the dry mine processing plant:

- A feed preparation plant. Mined ore is initially screened to remove oversize material. A dry screen operation removes coarse material greater than 150mm diameter. The ore is then slurried and pumped to a trommel which removes material greater than 3mm diameter. The remaining ore is pumped to the wet separation plant. A mine water dam provides the water used to slurry the ore.

- A wet separation plant. The screened and slurried ore is upgraded to a heavy mineral concentrate utilising separation processes identical to those employed in the floating wet separation plant servicing the dredges. This process is known as heavy mineral recovery.

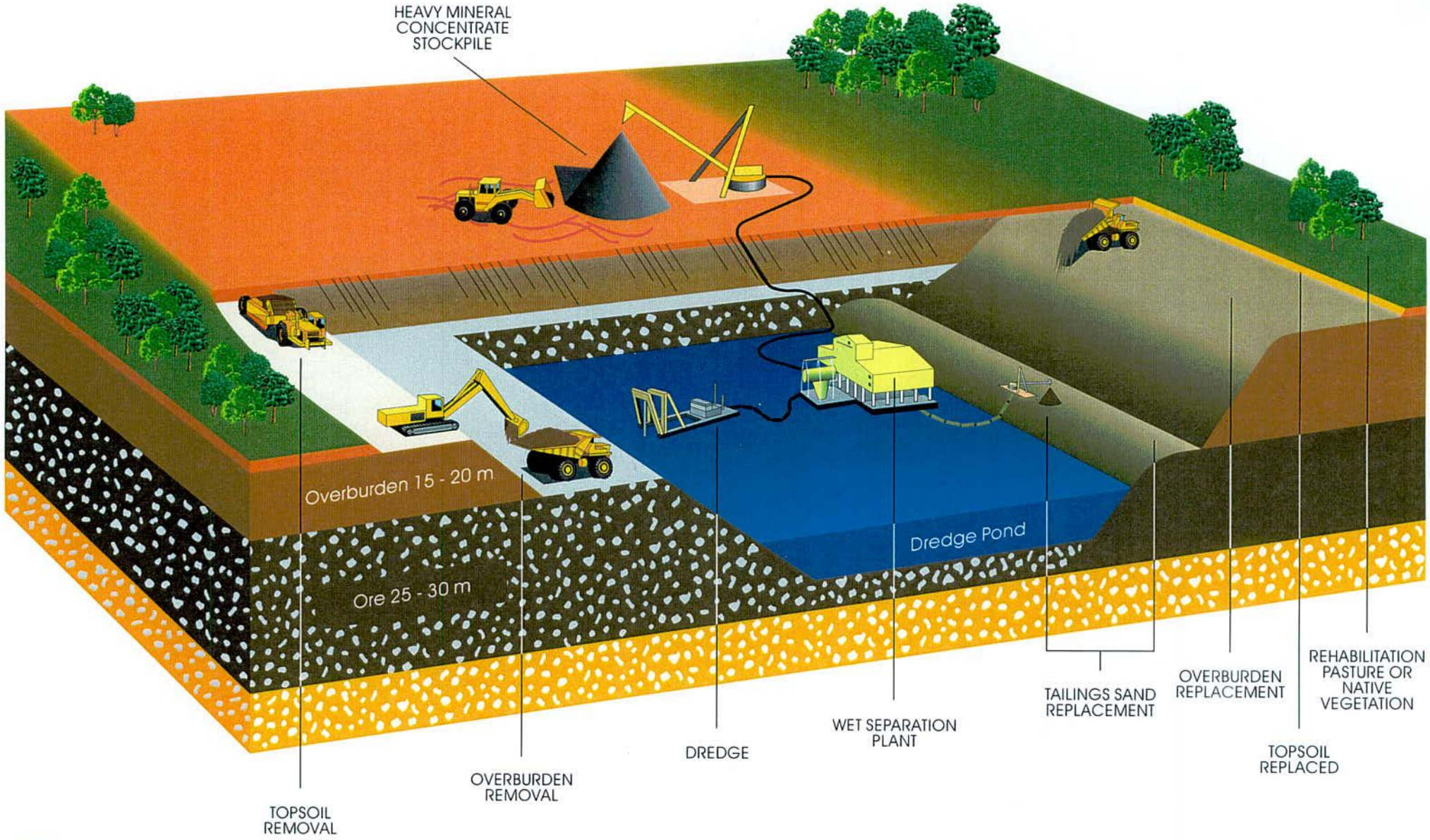


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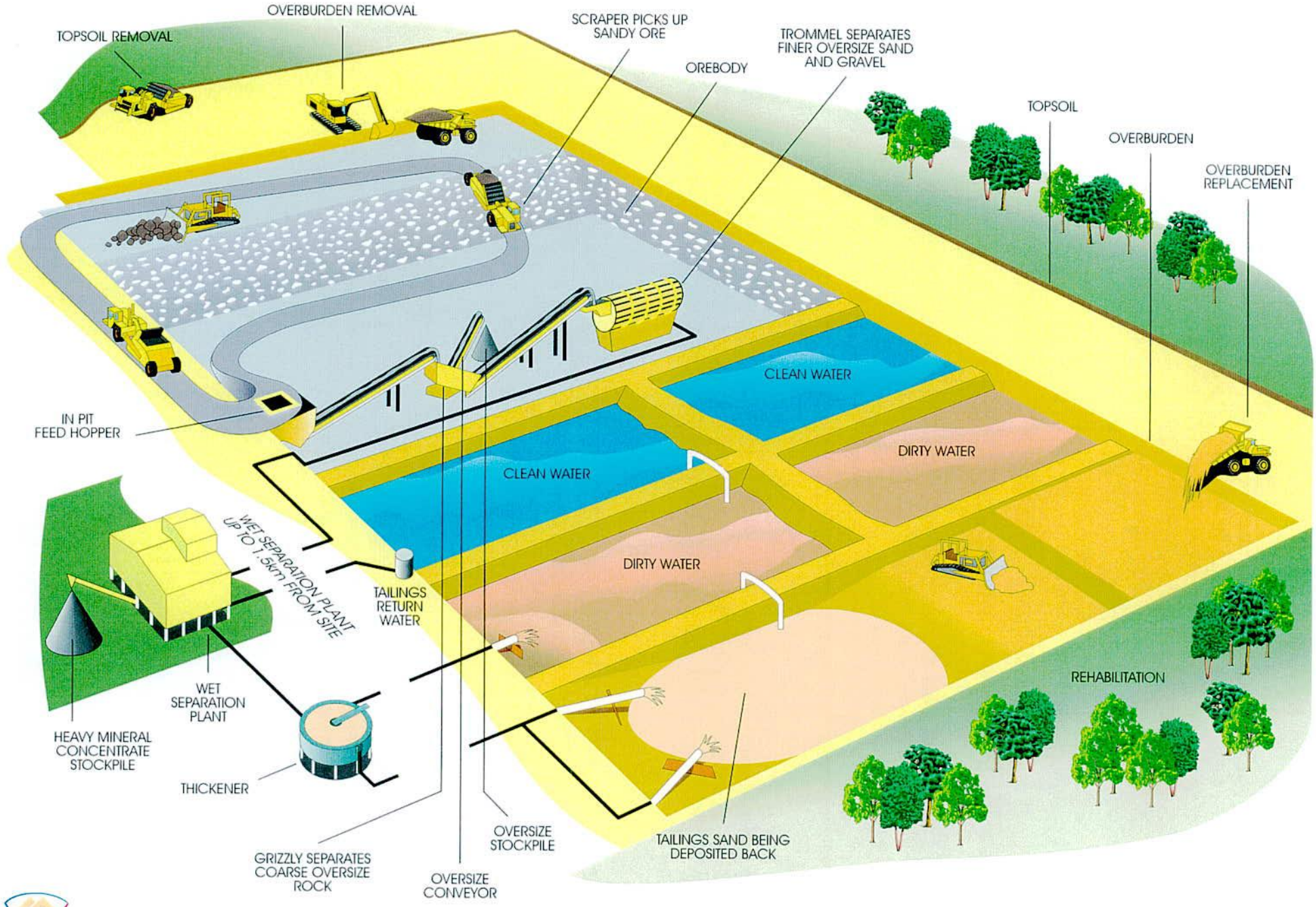
Figure 3.2 - SCHEMATIC OF DREDGE MINING PROCESS



TIWEST

Figure 3.3 - SCHEMATIC OF DRY MINING PROCESS

3.7 HEAVY MINERAL RECOVERY

The heavy minerals in the screened and slurried ore, which includes the valuable titanium minerals and zircon, are recovered in the wet separation plants. The ore is passed through a series of gravity spirals where the heavy minerals with specific gravities greater than 3.5 flow to the inside of the spirals and are separated from the principal waste mineral quartz, which has a specific gravity less than 3.0 and travels towards the outside of the spirals.

The heavy mineral concentrate is then pumped to a stockpile and excess water allowed to drain prior to transport by road to Chandala for further processing.

3.8 TAILINGS MANAGEMENT

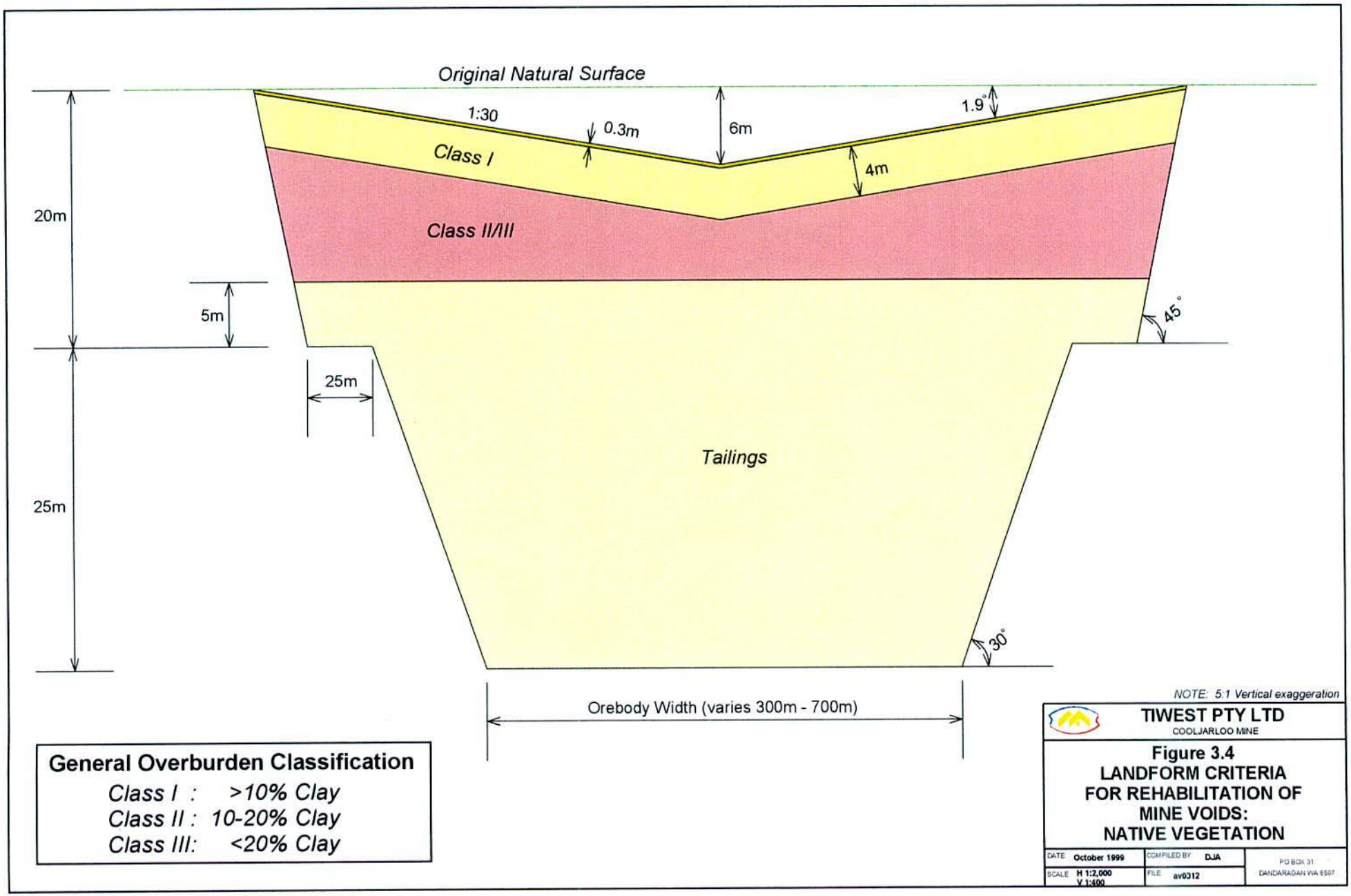
Clay and sand material rejected in the wet separation plant is referred to as tailings. Tailings are deposited at the rear of the dredge pond or mine pit. The dredge pond is kept of sufficient area (around 50 ha) to allow settling of suspended material away from the active dredging area. To initially establish a dredge pond and to maintain a pond of adequate area, tailings are sometimes disposed to external dams.

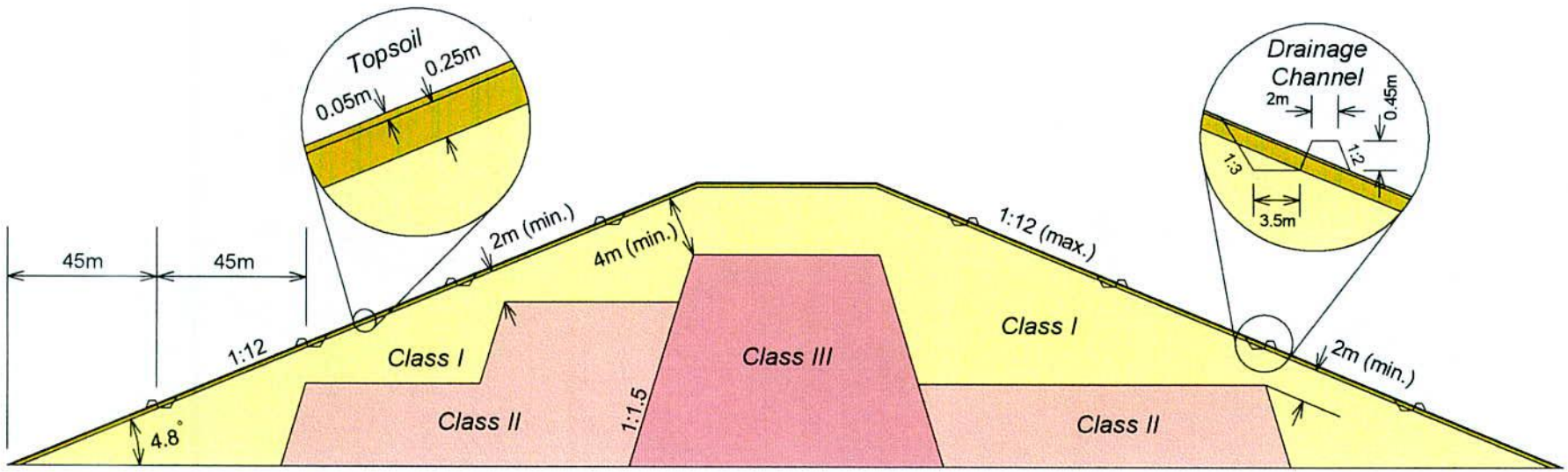
External dams, or tailings storage facilities, are constructed and managed in accordance with guidelines issued by the Department of Minerals and Energy. Various methods of tailings disposal, including multi-discharge points and co-disposal of sand and clay are employed to maximise rates of settling and drying, so that filled dams can be rehabilitated as soon as possible.

3.9 LANDFORM RECONSTRUCTION

Where tailings deposits have stabilised they are covered with overburden. The categorised overburden is selectively placed to reflect its position in the profile prior to disturbance (Figures 3.4 and 3.5). The landform is constructed to defined criteria to ensure the stability of the final profile. Hill slope gradients are limited and drains constructed at predetermined intervals and gradients to control surface runoff, which is a principal cause of erosion.

The two separate strips of topsoil are then placed over the overburden to recreate a natural soil profile. The type and origin of the topsoil is considered in its positioning in the rehabilitated landscape. Mulched vegetation is then spread over the topsoil, again using vegetation types appropriate to the position of the area undergoing rehabilitation.


Original Natural Surface
1:30
0.3m
6m
1.9°
Class I
4m
Class II/III
20m
5m
45°
25m
Tailings
25m
30°
Orebody Width (varies 300m - 700m)
NOTE: 5:1 Vertical exaggeration
General Overburden Classification
Class I : >10% Clay
Class II : 10-20% Clay
Class III: <20% Clay
TIWEST PTY LTD
COOLJARLOO MINE
Figure 3.4
LANDFORM CRITERIA
FOR REHABILITATION OF
MINE VOIDS:
NATIVE VEGETATION
DATE October 1999
COMPILED BY DJA
SCALE H 1:2,000
V 1:400
FILE av0312
PO BOX 31
DANDARAGAN WA 6507



NOTE: 5:1 Vertical exaggeration

General Overburden Classification

Class I : >10% Clay
Class II : 10-20% Clay
Class III: <20% Clay

TIWEST PTY LTD
COOLJARLOO MINE

Figure 3.5
LANDFORM CRITERIA FOR REHABILITATION OF OVERBURDEN DUMP: NATIVE VEGETATION

DATE: October 1999	COMPILED BY: DJA	PO BOX 31 DANDARAGAN WA 6507
SCALE: H 1:2,000 V 1:400	FILE: av0312	

3.10 VEGETATION RE-ESTABLISHMENT

Under Tiwest's current rehabilitation procedures mulched vegetation, topsoil and broadcast native seed all contribute to the establishment of vegetation on rehabilitated areas.

Directly applied seed includes mixtures of species that are less likely to be present in topsoil or mulch. Native seed is collected locally by approved contractors, to orders based on projected rehabilitation requirements. Combinations of native seed species are prepared that reflect natural vegetation associations. These seed mixes are selectively broadcast on rehabilitated areas to match, as far as possible the location of the associations that occur in the undisturbed landscape. For example, seed mixes intended for low lying areas the species found within these areas in undisturbed areas. The seed of particular native species is treated, using smoke or hot water immersion to maximise germination rates. Smoke treated vermiculite may also be mixed with the native seed to assist spreading and germination.

A 'cover' crop of oats is sown to provide early foliage cover to assist in protecting the exposed topsoil against water and wind erosion in the crucial first year of rehabilitation.

3.11 POST REHABILITATION MONITORING

The progress of rehabilitated areas is monitored regularly. Visual checks are carried out for signs of erosion that may require early rectification. Annual vegetation surveys are undertaken and fauna studies completed after several years as the vegetation becomes established.

A rehabilitation report is prepared which summarises the implementation of procedures compared to that planned and identifies where criteria or procedures may be improved in future rehabilitation.

4.0 EXISTING BIOPHYSICAL ENVIRONMENT

4.1 CLIMATE

The Cooljarloo Mine experiences a dry Mediterranean type climate consisting of hot, dry summers and cool, wet winters. The area receives an average annual rainfall of around 600 mm with the wettest months typically being June and July. The dry summer months may be subject to infrequent but heavy, rainfall events. Temperatures range from an average maximum of 34.5°C in January to an average minimum of 6.5°C in August. Annual evaporation exceeds 2150 mm.

4.2 GEOLOGY

The Cooljarloo heavy mineral deposits occur within a series of unconsolidated sedimentary deposits of relatively recent (Quaternary 1 – 2 million years) age. The deposits originated from the adjacent Yilgarn Block (ancient granites of Archaean origin), which has been eroded, transported by rivers and streams and deposited as beach sands along former coastlines. Sea levels have dropped and the coastline retreated, leaving linear heavy mineral deposits well inland of the present coastline.

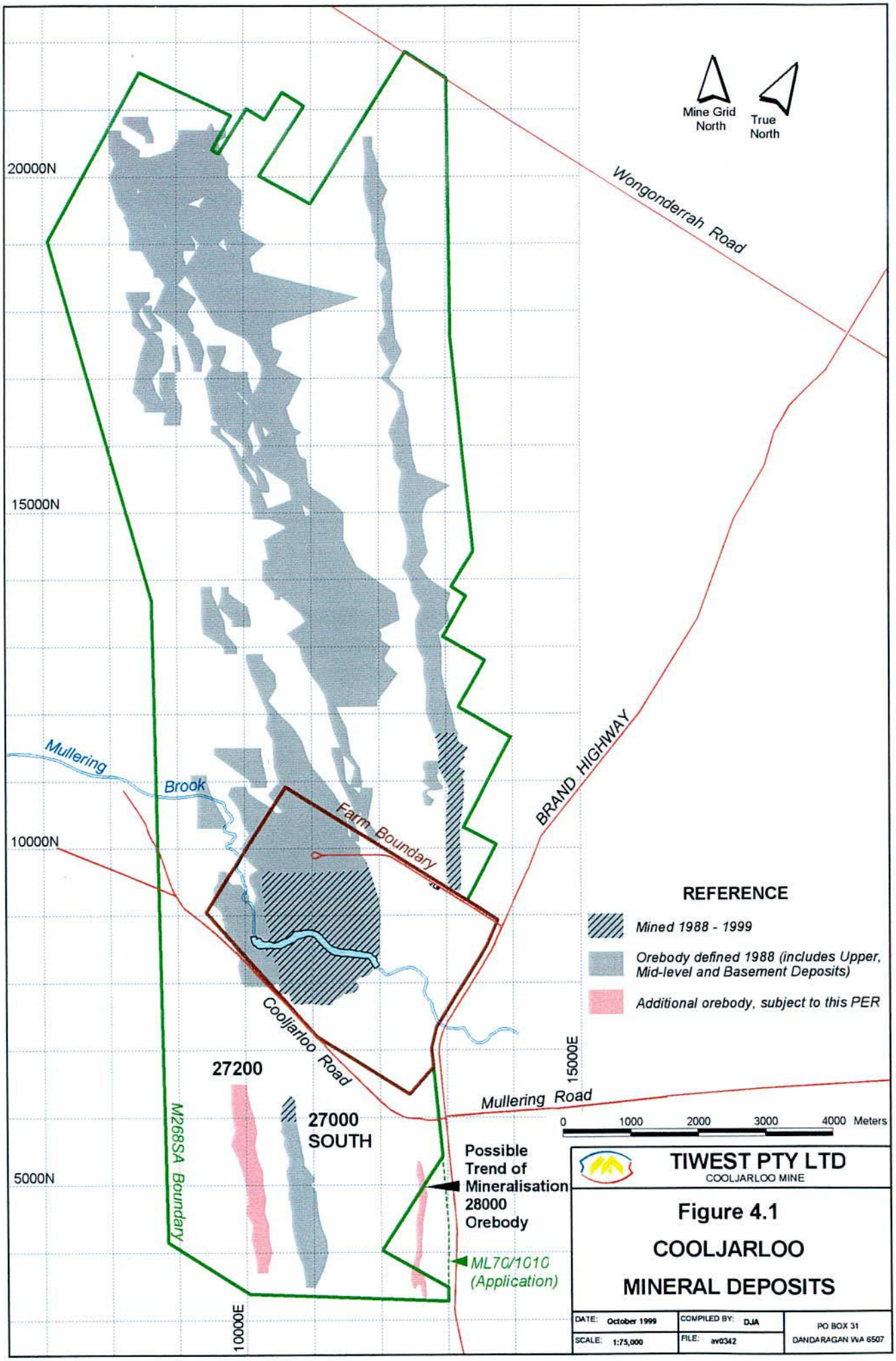
The Cooljarloo heavy mineral deposits are located in a series of ancient beach strandlines known collectively as the Munbinea Shoreline. Figure 4.1 shows the location of the mineral resources identified at Cooljarloo. The mineralised strands are 40 to 90 metres above present sea level with a gentle dip to the south.

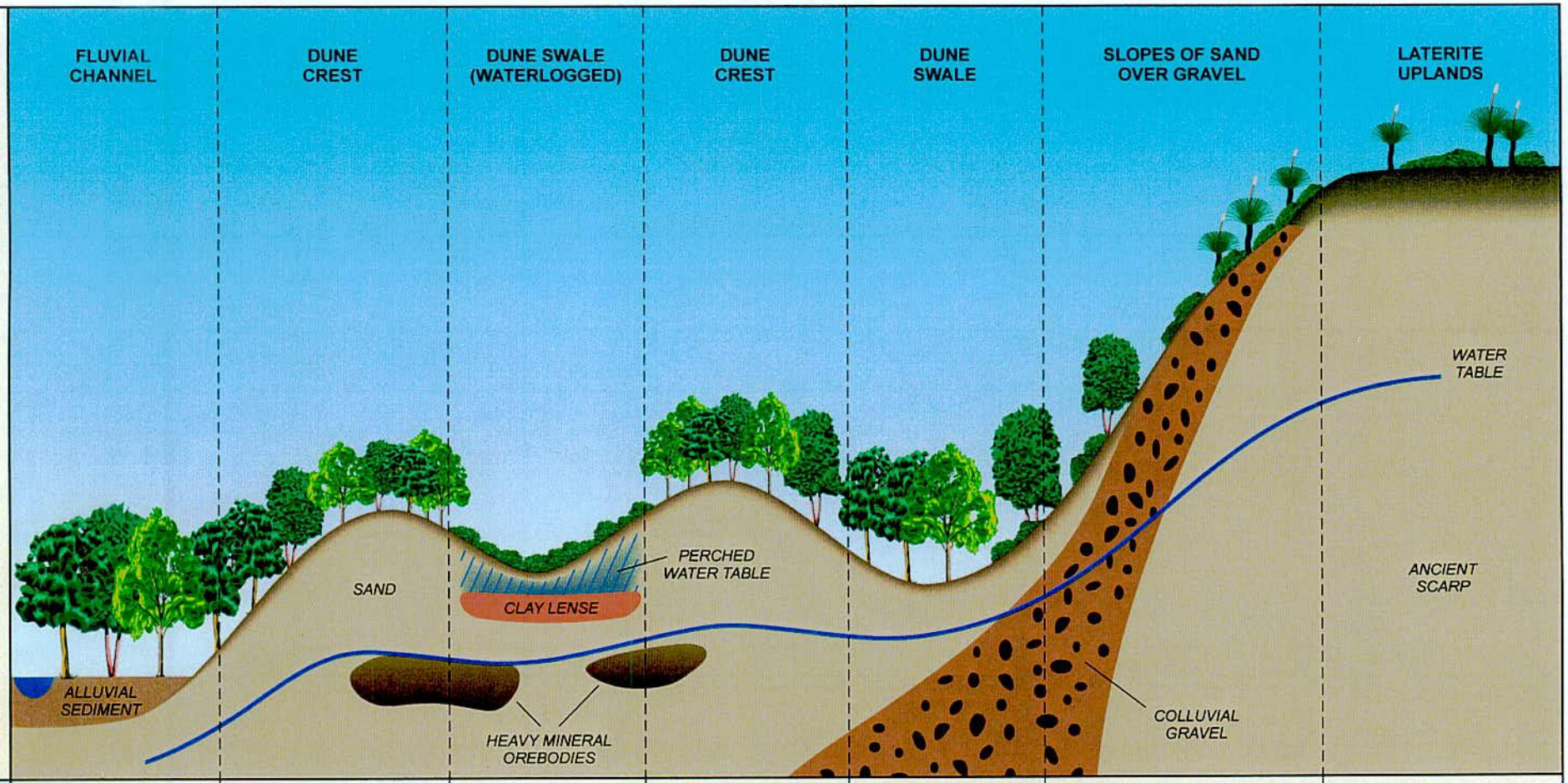
The deposits are classified into three categories according to their physical position and nature of mineralisation. Upper level deposits that either outcrop or are covered by minimal amounts of non-mineralised material (overburden), occur in the northern half of the tenement. Mid-level deposits are covered with varying depths of overburden. The 27 000 orebody (the largest mineralised strand at Cooljarloo) located on and south of Mullering Farm, and the 27 200 and 28 000 orebodies located south of Mullering Farm, are mid-level deposits. The basement deposits occur below the mid-level deposits in vCL north of Mullering Farm, and are typically more weathered and of lower heavy mineral grade.

4.3 LANDFORM

The Tiwest mining tenements are bordered to the east by the Gingin Scarp, the most prominent landform feature of the area. Below the escarpment, the landscape is gently undulating, with low dune ridges and interdunal swales that can be subject to waterlogging and seasonal swamp development. These features are typical of the Bassendean Sand Formation and are extensive on the Swan Coastal Plain. Overall, the site slopes gently to the west. Mullering Brook is the only distinct drainage line in the vicinity of the Cooljarloo Mine, originating above the Gingin Scarp and flowing west through Mullering Farm to discharge into a series of ephemeral lakes and swamps.

Landform, soils, vegetation and fauna communities in the natural environment are closely linked. Figure 4.2 provides a schematic representation of landform on the Tiwest lease. Distinct communities may exist over each landform type, with transitional areas exhibiting a mixture of characteristics from the merging formations.


Mine Grid North
True North
20000N
15000N
10000N
5000N
Wongonderrah Road
BRAND HIGHWAY
Mullering Brook
Farm Boundary
Cooljarloo Road
Mullering Road
15000E
10000E
M268SA Boundary
27200
27000 SOUTH
Possible Trend of Mineralisation 28000 Orebody
ML70/1010 (Application)
REFERENCE
Mined 1988 - 1999
Orebody defined 1988 (includes Upper, Mid-level and Basement Deposits)
Additional orebody, subject to this PER
0 1000 2000 3000 4000 Meters
TIWEST PTY LTD
COOLJARLOO MINE
Figure 4.1
COOLJARLOO
MINERAL DEPOSITS
DATE: October 1999
COMPILED BY: DJA
SCALE: 1:75,000
FILE: av0342
PO BOX 31
DANDARAGAN WA 6507



Landscape Unit	FLUVIAL CHANNEL	DUNE CREST	DUNE SWALE (WATERLOGGED)	DUNE CREST	DUNE SWALE	SLOPES OF SAND OVER GRAVEL	LATERITE UPLANDS
Soil	Heavy, relatively high clay and organic matter content	Freely drained, deep yellow sands	Grey sands, mottled at depth, occasional presence of silicrete/ferricrete pan, seasonally waterlogged	Freely drained, deep yellow sands	Freely drained white/grey sands	Grey sands thinly laid over ferruginous gravel/discontinuous laterite	Thin soils derived from the lateritic duricrust
Moisture and Nutrients	Superior moisture and nutrient retention characteristics	Nutrient poor, low capacity for water retention	Seasonally waterlogged, reductive soil environment, nutrient poor	Nutrient poor, low capacity for water retention	Nutrient poor, low capacity for moisture retention	Low nutrient, potential for the development of perched water tables in places	Low nutrient and water availability at the surface, plants able to penetrate duricrust can derive moisture from the underlying pallid zone
Vegetation	Riparian woodland - *Eucalyptus rudis* (Flooded Gum)	Banksia Low woodland - *Eucalyptus todtiana, Banksia attenuata/menziesii, Adenanthos cygnorum*	Low wetland heath or scrub heath, species reflect tolerance of waterlogging - *Banksia telematiaea, Calytrix aurea*	Banksia Low woodland - *Eucalyptus todtiana, Banksia attenuata/menziesii, Adenanthos cygnorum*	Banksia Low woodland as for dune crest	Low heath/scrub heath contains species from laterite and sand heaths - *Xanthorrhea preissii*	Low heath with *Xanthorrhea preissii, Banksia candolleana, Lambertia multiflora, Hakea costata*

TIWEST

Figure 4.2 - MINING LEASE M268SA SCHEMATIC REPRESENTATION OF LANDFORM, SOIL AND VEGETATION RELATIONSHIPS

4.4 SOILS

The major soil types on the Cooljarloo mine-site have been described in detail (Harper, 1989; BSD Consultants 1996; Soil Management Consultants 1997; ECOS Consulting (Aust) Pty. Ltd., 1998). Seven soils have been identified and grouped into three soil associations corresponding to different geomorphic zones. These groups are:

- Soils of the gently undulating, lateritised surface - comprised of sands overlying ferruginous gravel, deep white sands and pale grey, light clays.
- Soils of the dune fields - comprised of deep white sands and deep yellow sands.
- Soils adjacent to Mullering Brook - comprised of clayey sand, deep gradational sands and shallow clayey sands.

Soils at Cooljarloo exhibit two general horizons. The "A" horizon is true topsoil and the "B" horizon a deeper underlying layer. The "A" horizon is a nutrient rich, organic layer whereas the "B" horizon is usually finer and low in nutrients. Sub-horizons may be present within the topsoil. A top, darker layer contains most of the leaf litter, decomposing vegetation, seeds and nutrients and may be up to 100 mm deep. The underlying, lighter coloured sub-horizon is typically 100 to 300 mm thick, has little organic material but is an important medium for plant root penetration.

The soils of the Cooljarloo lease are generally low in nutrients. The organic content is moderate in the topsoils but nutrients are quickly leached from the sandy soils. The sandy soils have high infiltration rates but limited capacity for water retention. The presence of clay in the subsoil is associated with higher nutrient levels and increased capacity for nutrient retention and cation exchange. Clays also contain high cationic concentrations in calcium, potassium and, in the deeper materials, sodium.

The low water retention characteristics of the sandy soils causes soil moisture availability to be one of the key limiting factors in plant growth. Rainfall normally exceeds evaporation in only one month of the year (August). However, replenishment of soil moisture normally commences in June and continues through the winter months, often into early spring. The soil drying phase commences around October and extends to May.

The surface materials have pH values between 5.5-7.7, which are close to optimum for plant growth (pH 5.5-7.5).

4.5 VEGETATION

The sandplains of south-west Western Australia support vegetation communities generally referred to as the Kwongan. Kwongan communities are noted for high species diversity, the common occurrence of heath and a high degree of endemism. Vegetation is adapted to the nutritionally impoverished soils and the growth form of plants is principally determined by the availability of soil moisture (Beard, 1984). Geomorphic site conditions can strongly influence the community structure through their influence on moisture availability.

Heath communities tend to occur where limited soil moisture availability prohibits the survival of taller species. The primary soil types found on the Cooljarloo lease include massive ironstone duricrust soils, sands overlying ferruginous gravel and deep sands. Below 900mm of annual rainfall deep sands can not support anything taller than low woodland. The transition from low woodland to heath occurs at around 625 mm. The heath threshold is around 625 mm for sands over ferruginous gravel and around 450 mm for duricrust soils (Beard, 1984). The vegetation communities at Cooljarloo reflect a transitional zone between heath and low woodland communities. Small changes in relief and environmental conditions (e.g. dune crest to dune swale) can dictate community dominance on a local scale (Ekomin Pty Ltd, 1987).

The dominant structural vegetation formations at Cooljarloo are :

1. Banksia low woodland – occurring on deep sands within the dune field.
2. Sand Heath– occurring on deep sands and sands overlying ferruginous gravel.
3. Wet Heath– occurring in depressions which receive local drainage or where infiltration is hindered.
4. Lateritic heath – occurring high in the landscape over lateritised soils.
5. Eucalypt woodland – occurring on the more fertile alluvial soils and greater moisture availability along drainage lines (e.g. Mullering Brook).

Fifteen major floral associations have been identified within the broad structural formations (Ekomin Pty. Ltd, 1987, Armstrong, 1992, Wege, Lonergan and Bell, 1993, E.M. Mattiske and Associates, 1993a&b, Farming and Revegetation Consultants, 1995, Mattiske Consulting Pty. Ltd., 1996a&b, Landcare Services Pty. Ltd., 1999). Variation within each community type relates more to differences in community structure and plant spacing than differences in floristic composition (Ekomin Pty Ltd, 1987).

The vegetation associations over the 27 200 orebody are typical of the northern sandplain. They possess an upper story dominated by banksia species, eucalypts (in particular *Eucalyptus todtiana*) and melaleuca species. The understorey is diverse. The distribution of vegetation associations is determined by position within the landscape, which influences vegetation type primarily through soil type and soil moisture availability.

The vegetation associations occurring in the area of the proposal are detailed in Figure 4.3. The 27 200 orebody is situated beneath a stabilised dune field. Vegetation communities reflect the range from dune crest to swale environments.

MULLERING FARM

Mine Grid North

True North

Mullering Brook Diversion

Mullering Brook

Gravel Pit

132kV Powerline

Coojiarloo Road

Gas Pipeline

ML70/1010 (Application)

BRAND HIGHWAY

M268SA Boundary

10000N

8000N

6000N

4000N

12000E

14000E

8000E

10000E

0 250 500 750 1000 1250 1500 Meters

REFERENCE

Woodlands

- 1a.1 — Open Woodland of *Banksia attenuata* and *Banksia menziesii* over mixed Proteaceous and Myrtaceous shrubs in upper slope areas on yellow-brown sand.
- 1a.2 — Woodland of *Banksia prionotes* and *Eucalyptus todtiana* over mixed Proteaceous and Myrtaceous shrubs in upper slope areas on yellow sand.
- 1b — Woodland of *Eucalyptus todtiana, Banksia attenuata* and *Banksia menziesii* over mixed Proteaceous and Myrtaceous shrubs on lower slopes on grey sand.
- 1d — Woodland of *Eucalyptus decipiens, Eucalyptus todtiana, Banksia* spp. and *Nuytsia floribunda* over *Conostephium minus, Eremaea pauciflora* and *Calytrix leschenaultii* on lower slopes on grey sand.
- 1e — Woodland of *Banksia attenuata, Banksia menziesii* and *Nuytsia floribunda* over *Banksia incana, Beaufortia squarrosa* and *Adenanthos cygnorum* on lower slopes on grey-brown sand.
- 1f — Woodland of *Melaleuca preissiana, Banksia attenuata, Banksia menziesii* and *Eucalyptus todtiana* over *Adenanthos cygnorum, Eremaea pauciflora* and *Calytrix fraseri* over *Dasypogon obliquifolius*, on mid to lower slopes on grey-brown sand.
- 1g — Woodland of *Melaleuca preissiana, Nuytsia floribunda* and *Banksia attenuata* over *Banksia incana* and *Adenanthos cygnorum, Beaufortia scabra* spp. and *Melaleuca* in depressions on yellow-brown sand.

Heaths on sand

- 3a — Heath of occasional *Nuytsia floribunda, Banksia* spp. and *Eucalyptus todtiana* over *Beaufortia elegans, Petrophile macrostachya* and *Allocasuarina* spp. on grey sand.
- 3f — Low Heath dominated by *Calytrix aurea, Calytrix fraseri, Banksia incana* and *Beaufortia squarrosa* on yellow sandy-loam.
- 3k — Low Heath dominated by *Banksia incana*, with occasional emergent *Nuytsia floribunda* and *Eucalyptus todtiana*, on brown sandy-loam.

Winter-wet depressions

- 4a — Woodland of *Melaleuca preissiana* and *Melaleuca rhaphiophylla* over *Calothamnus quadrifidus, Jacksonia sternbergiana* and *Chamelaucium uncinatum* on brown sandy-loam.
- 4b — Woodland of *Eucalyptus rudis, Banksia prionotes* and *Banksia grandis* over *Acacia saligna, Jacksonia sternbergiana, Xanthorrhoea preissii* and *Macrozamia riedlei* over annual herbs and grasses on dark brown loam.
- 4c — Open Low Woodland of *Melaleuca rhaphiophylla* over *Regelia ciliata, Hakea varia* and *Banksia incana* over *Dryandra nivea* ssp. *nivea, Lepidosperma tenue* and *Anarthria laevis* on dark brown loam.

Swamp

TIWEST PTY LTD

COOLJARLOO MINE

Figure 4.3
VEGETATION ASSOCIATIONS SOUTH OF COOLJARLOO ROAD

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SCALE: 1:25,000	FILE: av0352	

The northern boundary of the 28 000 area is typical Banksia low woodland on deep white-grey sands. At approximately 5000N (grid north) the orebody underlies the south western extremity of a shallow depression subject to seasonal inundation. Species typical of these environments are represented (Melaleuca spp., *Banksia telematiaea*). The mid to southern areas of the orebody are vegetated by low heath. This community occurs on shallow grey sands over ferruginous gravel. The land overlying the southern end of the 28 000 orebody rises to a low dune supporting banksia low woodland over deep sand. The area around the southern boundary of the mining lease M268SA has heath vegetation on laterite or shallow grey sands overlying laterite.

Two species listed as declared Rare Flora under the *Wildlife Conservation Act 1950*. These are *Andersonis gracilis* and *Anigozanthos viridis* ssp. *terraspectans*. Significant populations of these species have been located across the mining lease (most away from the mine path) and in nearby conservation reserves. Section 6.1.2 details the known populations of the two declared Rare Flora species found at Cooljarloo.

Fourteen Priority species of flora, which are species listed by the Department of Conservation and Land Management (CALM) on the basis that the known status of the species is restricted or unclear. Appendix C includes the Priority species found on the mining lease to date.

4.6 FAUNA

The presence and distribution of fauna species is correlated with vegetation type. Increased diversity of habitat leads to increased richness in fauna assemblage. Studies in vCL north of Mullering Farm have identified 9 frog species, 37 reptile species, 96 (including 2 introduced) bird species and 16 (including 4 introduced) mammal species (Bamford, 1997a; Streamtec, 1992) (refer to Appendix D). Section 6.1.3 details the observations of three protected and two Priority species in the Cooljarloo area.

The range of habitat in vCL south of Mullering Farm is similar, though slightly impoverished to that found in the northern vCL. Subtle differences in the structure and composition of the vegetation are reflected in differences in the relative abundance of particular species. Surveys have indicated the potential for as yet unrecorded fauna species to inhabit the southern vCL is limited (Bamford, 1997b).

4.7 SURFACE WATER

Surface waters occur within the tenement in the form of ephemeral streams and damplands. The only definitive surface drainage traversing the lease is Mullering Brook, which flows west from the Gingin Scarp to discharge into a series of swamps about 20 kilometres west of Cooljarloo.

Stream flow in Mullering Brook varies considerably from year to year and along the length of the stream itself. Tiwest monitors Mullering Brook where it enters (MSW01) and exits (MSWO2) Mullering Farm, approximately 5km apart (refer to Figure 5.2). Table 4.1 summarises results obtained in the period 1996 to 1998. Typically, Mullering Brook flows for around eight weeks each year with flow rates to 5.0 m^3/sec and a total volume of around 2 million m^3. Water quality is variable and ranges from 1,000 to 3,000 mg/L total dissolved solids (TDS). The brook flows across Mullering Farm at an elevation approximately 10 metres above the water table.

Table 4.1 - Surface Water Flows in Mullering Brook, 1996-1998

Parameter	Brand Highway (upstream - MSW01)			West (downstream - MSW02)		
	1996	1997	1998	1996	1997	1998
Peak Flow (m^3/sec)	7.26	0.19	1.2	4.08	0.12	0.95
Duration of Flow (days)	104	61	113	81	14	98
Total Flow (Ml)	2173	82.2	459.4	1996	33.3	388.4

Permanent wetlands are located to the south west and the north of the Tiwest mining lease. Damplands occur throughout the mining lease in depressions that receive local drainage and in areas where relatively impermeable strata high in the profile results in seasonal perched groundwater.

4.8 GROUNDWATER

Two groundwater resources exist beneath the Cooljarloo area. The unconfined, superficial aquifer occurs up to 60 m depth and overlies the Yarragadee aquifer, which is about 1500 m in depth at Cooljarloo (Rockwater, 1999a).

The superficial formations contain alternate layers of sands and clays. The sands are moderately permeable while the clays have a low permeability that may present a barrier to groundwater flow. Clay zones near the surface can cause perched water tables that result in waterlogging and seasonal damplands or wetlands. In some areas, the deeper sands contain significant clay layers that inhibit groundwater flow. Hydraulic conductivity in the superficial formation is in the order of 0.3-0.8 metres/day. This is significantly less than groundwater flows in the Bassendean Sands near Perth (around 10 metres/day). Pre-mining groundwater contours indicated a gradient to the south west of around 5-6 metres/kilometre (Maunsell and Partners, 1987).

Seasonal fluctuation in groundwater level averages 1.5 metres. Depth to groundwater ranges between 2 metres and 15 metres from the surface, across mining lease M268SA. South of Mullering Farm groundwater rises beneath a general increase in elevation of the ground surface.

Groundwater quality is variable across the mining lease. This variation relates to the pattern of evapotranspiration, recharge and seepage. Groundwater in the superficial aquifer is generally acidic (pH of 5.8-6.2), with a salinity less than 1,000 mg/L TDS. Iron concentrations are low, generally less than 1.0 mg/L. Observation bores in the superficial aquifer in the extreme north of the mining lease (MSB1, MSB2, MSB3 and MSB4 see Figure 5.2) have indicated the presence of localised pockets of low pH (3.0-5.9) and high iron concentration (up to 110 mg/L) associated with wetland infiltration. Water from the Yarragadee Formation is slightly acidic (pH 6.4-6.7), with salinity from 565 mg/L TDS to 750 mg/L TDS. Iron levels vary from 0.1 to 15 mg/L (Rockwater, 1999a).

4.9 PHYTOPHTHORA DISEASE

Phytophthora are introduced microscopic soil-borne fungi, which can have an adverse impact on the health of many native plants, particularly Jarrah (*Eucalyptus marginata*) and banksia species.

Phytophthora species are widespread throughout the south west of Western Australia. The fungi attack the root systems and trunk of certain plant species, eventually killing those with low resistance. Natural spread of the fungi is slow unless it is transported by water flow overland or through the soil matrix. The most rapid spread of the fungi results from the movement of infected material (mud and soil etc) by human activity.

Phytophthora cinnamomi, which causes jarrah dieback, has not been identified on the Cooljarloo lease. Six other species of *Phytophthora* have been identified in the Cooljarloo area. The species *P.megasperma* var. *megasperma, P. cryptogea, P. citricola, P.undulatum, P.megasperma* var *sojae,* and *P. drechsleri,* generally have little to no impact on local native vegetation (Hart, Simpson and Associates, 1998).

P. megasperma is the most widespread species, and is confined to low lying areas. This species may cause vegetation deaths under favourable, wet conditions.

P. drechsleri has been found in the dredge pond, along Mullering Brook and in local agricultural dams. This species is considered non-pathogenic to local vegetation.

No *phytophthora* infestations have been identified in vCL south of Mullering Farm. (Hart, Simpson and Associates, 1998; Woodman Environmental Consultants, 1999).

4.10 RADIATION

The heavy mineral concentrate produced at Cooljarloo contains monazite in concentrations of the order of 0.3%. Monazite contains the radioactive elements thorium and uranium. Under Section 16 of the Mines Safety and Inspection Regulations 1995, Tiwest has prepared a Radiation Management Plan which includes a monitoring programme to detect any changes in ambient radiation levels. The radioactivity level of the heavy mineral concentrate is below 70 becquerels/g and therefore not subject to the provisions of the Code of Practice for the Safe Transport of Radioactive Substances adopted by the Radiation Safety (General) Regulations 1983.

At times the heavy mineral concentrate can exceed 0.3% monazite, which results in the stockpile at Cooljarloo exceeding a gamma radiation level of one $\mu Gy\ hr^{-1}$. Under the Radiation Safety Guidelines 'RSG12; Application of the System of Radiation Protection in Mines' (draft 1997) the stockpile has been classified as a 'Supervised Area'. The stockpile has been delineated and employees instructed to minimise time spent in the area. Gamma radiation levels may exceed one $\mu Gy\ hr^{-1}$ intermittently. However, Tiwest maintains the Supervised Area signs and boundary permanently.

Tiwest monitors radionuclides in groundwater and gamma radiation levels at the boundary of the mining lease. Gamma radiation levels are also monitored before and after mining. To date there has been no increase in radioactivity levels in mined areas or at the mining lease boundary as a consequence of mining. Previous personal dose monitoring on employees indicated there is no significant airborne radiation dose in the immediate vicinity of mining and therefore even less exposure at the boundaries.

4.11 LAND USE

Prior to Tiwest ownership, Mullering Farm was cleared farmland used primarily for sheep grazing and cropping.

The adjacent vCL has been used by apiarists, tourists (both private and commercial) and for wildflower and native seed collection. An abandoned gravel pit exists on the area of vCL subject to Tiwest's application for tenement ML 70/1010. Mineral exploration has occurred throughout the area since the 1970's.

5.0 ENVIRONMENTAL MANAGEMENT AT COOLJARLOO

5.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Tiwest has an environmental management system (EMS) in place to provide effective environmental management and continuous improvement in performance at Cooljarloo. The system essentially revolves around the implementation of documented management and monitoring procedures; evaluation and reporting of the status and effectiveness of the procedures and modification of procedures or implementation of additional procedures where appropriate to ensure objectives are met and/or performance is improved.

Core documentation relevant to environmental management at Cooljarloo includes:

- Cooljarloo Environmental Policy
- Cooljarloo Environmental Management Programme
- Environmental Procedures Manual
- Environmental Responsibilities and Obligations Manual
- Environmental Reports (internal)
- Annual and Triennial Environmental Reports (available to the public)
- Cooljarloo Environmental Handbook

The documents are described below. The purpose of each document, and the general processes of environmental management at Cooljarloo, are summarised in Figure 5.1.

5.2 COOLJARLOO ENVIRONMENTAL POLICY

The Tiwest Cooljarloo Environmental Policy is a statement of the company's commitment to environmental protection. It is a general condition of employment at every level with Tiwest that employees behave in accordance with the policy. The Cooljarloo Environmental Policy:

- Sets Tiwest's overall environmental objective
- Commits to adequate resourcing to enable required standards to be achieved
- Acknowledges that good environmental performance is essential for sustained good business performance and undertakes to routinely include environmental considerations in production and operational planning.
- Commits to continual improvement and open reporting of environmental performance.

A copy of the current Cooljarloo Environmental Policy is included at Appendix E.

5.3 ENVIRONMENTAL MANAGEMENT PROGRAMME

The primary EMS document is the Cooljarloo Environmental Management Programme (EMP). The EMP defines objectives, responsibilities and performance standards, and references management and monitoring procedures for each environmental topic at Cooljarloo.

The EMP is reviewed every year. When significant amendments are made copies of the updated document are submitted to the Departments of Environmental Protection, Conservation and Land Management, Minerals and Energy, Resources Development and the Water and Rivers Commission. A summary of the objectives defined in the current EMP is included in Appendix F.

Most of the work undertaken in preparation for and following the extraction of ore, as described in Section 3.0 - Mining Process for the 27 200 and 28 000 Orebodies is governed by the EMP. Similarly the measures and practice referenced in Section 6.0 - Environmental Impact Evaluation and Management are required by the EMP.

5.4 ENVIRONMENTAL PROCEDURES MANUAL

The Environmental Procedures Manual provides the detailed, step by step actions to be undertaken to implement the procedures referenced in the Environmental Management Programme. It is a reference document, although, through appropriate awareness and training programmes, Tiwest aims to ensure many procedures and behaviour are habitual, and frequent reference to the procedures manual therefore unnecessary.

The detail of the manual is subject to frequent change as more effective and/or efficient means of attaining environmental objectives are developed.

A key component of the procedures referenced in the EMP and detailed in the procedures manual is the monitoring of the existing environment across mining lease M268SA. The network of environmental monitoring sites is detailed in Figure 5.2.

5.5 ENVIRONMENTAL RESPONSIBILITIES AND OBLIGATIONS MANUAL

The Environmental Responsibilities and Obligations Manual lists the major statutory environmental requirements that apply at Cooljarloo. It is issued to senior and mid level management, who have the responsibility for ensuring compliance in their respective work areas.

5.6 INTERNAL ENVIRONMENTAL REPORTS

The status of environmental performance at Cooljarloo is routinely reported at several frequencies and levels of detail. A comprehensive internal report, which is completed quarterly, follows a similar format to the external environmental reports (which are discussed below) and is circulated through senior management at Tiwest.

A system of environmental incident reporting is also maintained at Cooljarloo to ensure timely notification of any incidents, and that matters arising from any environmental incidents or potential incidents are resolved.

5.7 ANNUAL AND TRIENNIAL ENVIRONMENTAL REPORTS

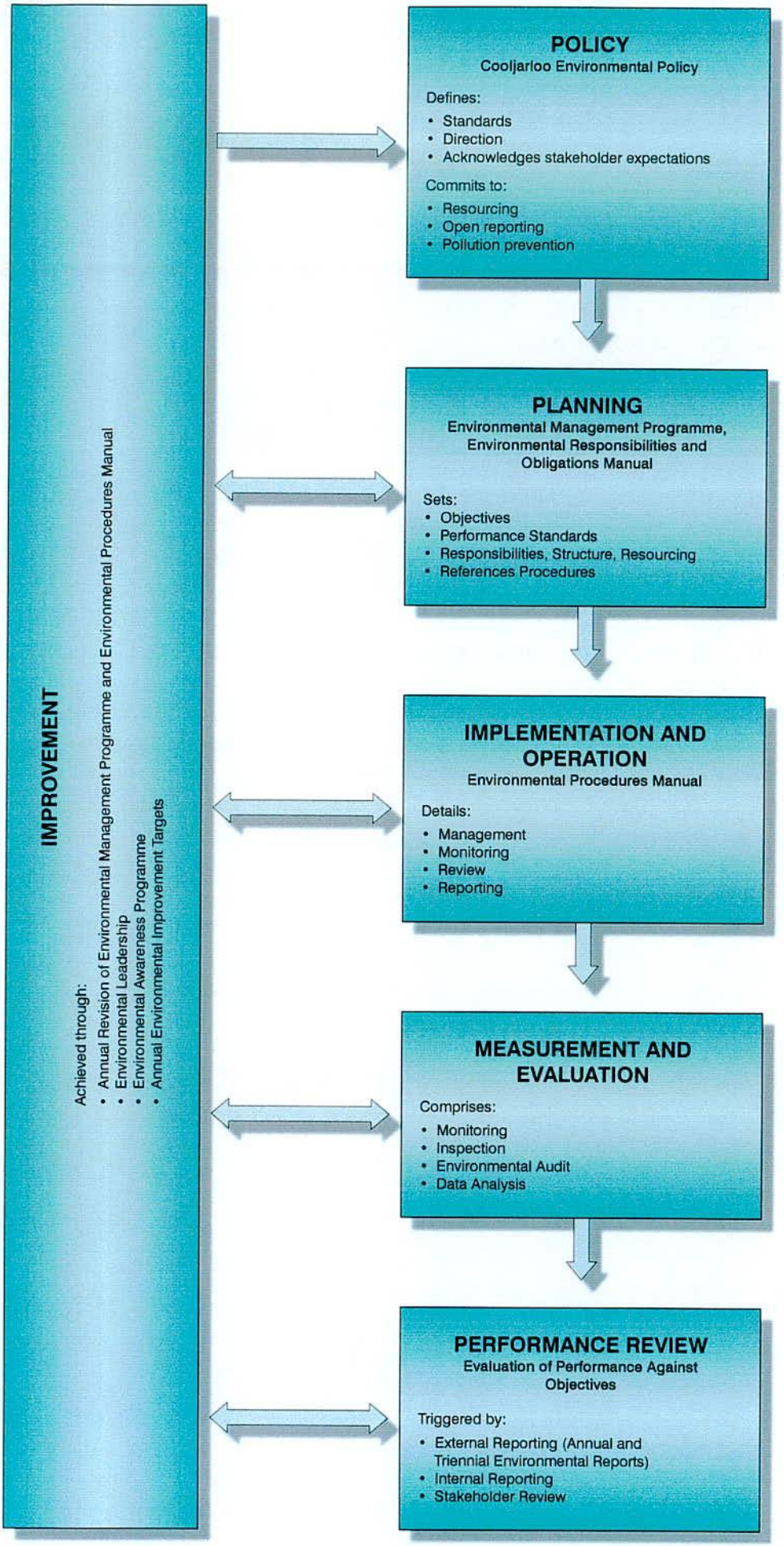
These reports are required under the State Agreement Act, Ministerial Conditions and conditions attached to mining lease M268SA. Tiwest also prepares these reports so that they fulfil reporting conditions in the Cooljarloo environmental licence. The reports describe environmental performance and compliance for most environmental aspects at Cooljarloo. General mine performance is also briefly reported. The Triennial Environmental Reports contain more detail on planned mine progress in the following three years.

The Annual and Triennial Environmental Reports are submitted through the Department of Resources Development to the Department of Environmental Protection, Department of Conservation and Land Management, Department of Minerals and Energy and the Water and Rivers Commission. Tiwest also provides copies to the Dandaragan Shire.

5.8 ENVIRONMENTAL HANDBOOK

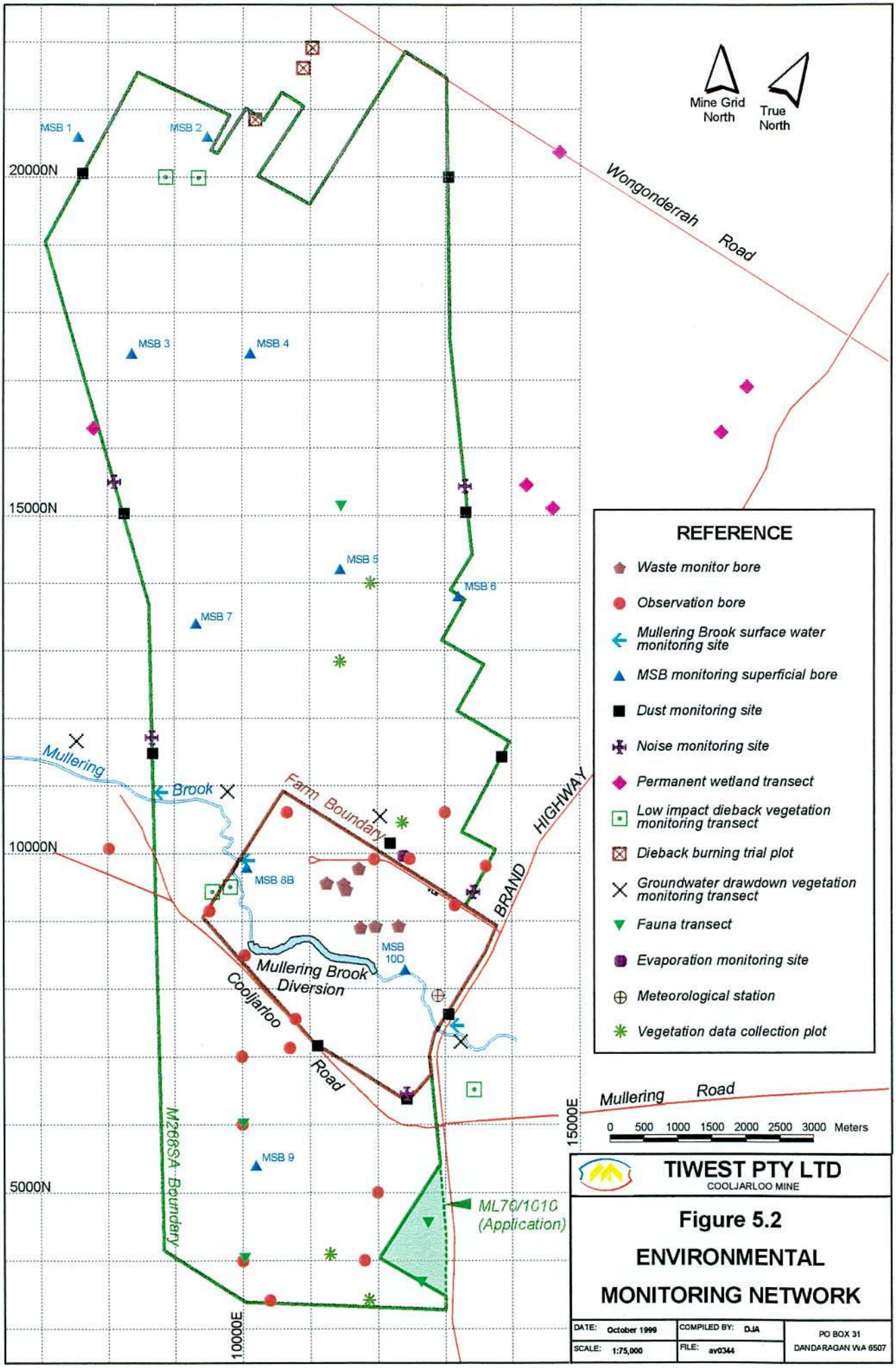
The Cooljarloo Environmental Handbook is an integral part of Tiwest's environmental awareness programme. It lists general environmental rules and provides background to key environmental aspects and required environmental behaviour at Cooljarloo.

The handbook is issued to every employee, who is required to indicate an understanding of, and commitment to, the appropriate standards by returning a signed declaration.



TIWEST

Figure 5.1 - TIWEST COOLJARLOO ENVIRONMENTAL MANAGEMENT SYSTEM


Mine Grid North
True North
Wongonderrah Road
MSB 1
MSB 2
MSB 3
MSB 4
MSB 5
MSB 6
MSB 7
MSB 8B
MSB 9
MSB 10D
20000N
15000N
10000N
5000N
10000E
15000E
Mullering Brook
Farm Boundary
HIGHWAY
BRAND
Mullering Brook Diversion
Cooljarloo Road
M266SA Boundary
ML70/1010 (Application)
Mullering Road
0 500 1000 1500 2000 2500 3000 Meters
REFERENCE
Waste monitor bore
Observation bore
Mullering Brook surface water monitoring site
MSB monitoring superficial bore
Dust monitoring site
Noise monitoring site
Permanent wetland transect
Low impact dieback vegetation monitoring transect
Dieback burning trial plot
Groundwater drawdown vegetation monitoring transect
Fauna transect
Evaporation monitoring site
Meteorological station
Vegetation data collection plot
TIWEST PTY LTD
COOLJARLOO MINE
Figure 5.2
ENVIRONMENTAL
MONITORING NETWORK
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FILE: av0344
PO BOX 31
DANDARAGAN WA 6507

6.0 ENVIRONMENTAL IMPACT EVALUATION AND MANAGEMENT

6.1 BIOPHYSICAL ENVIRONMENTAL FACTORS

6.1.1 Vegetation

EPA Objective

- Maintain the species abundance, diversity, geographic distribution and productivity of floristic communities.

Means of Achieving EPA Objective

Tiwest procedures/measures relevant to the attainment of the EPA objective include:

- Mapping the distribution of vegetation communities and establishing the characteristics of vegetation communities prior to disturbance.
- Mapping the distribution of *phytophthora* species on an annual basis, and implementation of a Dieback Management Plan.
- Implementation of controls to limit vegetation clearing.
- Assessment of the local and regional significance of the disturbed vegetation.
- Re-establishment of self sustaining vegetation communities of comparable diversity.

Assessment and Management of Impacts

Vegetation Mapping

The vegetation associations of the areas of the 27 200 and 28 000 orebodies have been mapped by botanists and the results incorporated in the existing floristic database at Cooljarloo. (Landcare Services Pty. Ltd., 1999; Mattiske Consulting Pty. Ltd., 1997). The baseline vegetation surveys are conducted in late winter and spring when flowering assists the identification of unfamiliar species. The local vegetation assemblage is reflected in the Tiwest Cooljarloo Herbarium. The herbarium is continually updated through the addition of previously uncollected species. It currently comprises over 400 species.

To ensure consistency in the Tiwest database, vegetation surveys of the areas of the 27 200 and 28 000 orebodies were conducted in accordance with the methodology and descriptions utilised in previous vegetation assessments undertaken between 1989 and 1998. Structural vegetation units were first identified from aerial photographs. The survey area was then traversed along transects at 200 metre intervals. Recordings were made within the differing structural units to complete species lists and establish the dominant species of each vegetation association.

The vegetation associations in the area of the 27 200 and 28 000 orebodies and the relationship between soils, vegetation and landform are described in Section 4.

Dieback Mapping and Management

Baseline surveys of the proposal area for the presence of *phytophthora* species has been conducted in accordance with the Cooljarloo EMP. The surveys did not detect *P.cinnamomi* or any other *phytophthora* species on mining lease M268SA south of Coojarloo Road or on ML70/1010 (G. Woodman, 1999, Hart, Simpson and Associates Pty Ltd, 1998). Tiwest undertakes dieback mapping annually.

Tiwest implements a dieback management plan to minimise the risk of introducing of *Phytophthora cinnamomi* to the mining lease. *Phytopthora cinnamomi* is generally regarded as the primary threat in terms of dieback in native vegetation. Access to the site is controlled and a chlorinated washdown facility is utilised to clean all equipment, machinery and vehicles entering or leaving the site.

Local and Regional Significance of Disturbance

Mining the 27 200 and 28 000 orebodies will result in the disturbance of up to 220 ha of native vegetation. Tiwest has compared this area to the total area of undisturbed native vegetation secured in conservation reserves within 1km (immediate proximity) and 25km (local proximity) of mining lease M268SA. The area has also been compared to native vegetation in conservation reserves in the Moora region as defined by CALM boundaries (regional proximity) (CALM, 1999). The 220 ha constitutes 4.3%, 0.44% and 0.05% of the undisturbed native vegetation in reserves on an immediate, local and regional scale respectively (Table 6.1).

Table 6.1 Disturbance on an Immediate, Local and Regional Scale Associated with Mining the 27 200 and 28 000 Orebodies.

Vicinity	Reserve	Area (Ha)	Ratio of disturbance to area in conservation reserves %
Immediate			
within 1 km of	nature reserve	1,450.9	
boundary of	conservation park	2,369.0	
existing mining	crown reserve	1,316.5	
lease M268SA	**total**	**5,136.4**	**4.3**
Local			
within radius of 25	National park	31,439.1	
km of 27 200 and	nature reserve	13,547.0	
28 000 orebodies	conservation park	2,887.8	
	crown reserve	2,369.0	
	total	**50,242.9**	**0.44**
Regional			
	National Park	118,425.6	
within Moora	native reserve	173,160.5	
district – CALM	conservation park	2,371.2	
boundary	section 5(g) reserve	2,316.4	
	unallocated crown reserve	184,000.0	
	total	**480,273.7**	**0.05**

The Cooljarloo Mine falls within a botanical area broadly referred to as the Northern Kwongan. In studies of the Northern Kwongan between the Moore and Irwin Rivers and west of the Midlands Highway, 259 regionally endemic or declared Rare Flora were identified (Griffin, Hopper and Van Leeuwen, 1990). The majority (78%) of the regionally endemic species occurred within the Arrowsmith physiographic region (Figure 6.1). The Coastal Belt and the Bassendean Dunes physiographic regions, which occupy similar areas, supported 12% and 14% respectively of the regionally endemic species. The Dandaragan Plateau (39%) and the Yarra Yarra Region (25%) supported moderate proportions of the regionally endemic species. Tiwest's existing and pending mining leases are located within the Bassendean Dune system.

Mitigation of Impacts on Local Vegetation

The impact on local vegetation will be limited by planning measures to limit the scale of initial disturbance, the requirement for approval from senior management prior to any clearing, and by rehabilitation measures designed to re-establish vegetation communities compatible with surrounding undisturbed areas (refer to Sections 3.10 and 6.1.5). In view of the limited scale of clearing, and the proximity of the proposal areas to existing disturbed areas, Tiwest has not pursued in detail the potential for "land swap" arrangements.

Conclusion

The relatively small area of disturbance limits the local and regional significance of clearing associated with mining the 27 200 and 28 000 orebody.

Rehabilitation is conducted to produce native vegetation communities suitable to the environmental conditions and consistent with that in surrounding undisturbed areas. Rehabilitated areas are subject to ongoing monitoring to determine development with time and success of the applied methods.

Through limiting the scale of initial impact and appropriate rehabilitation, there will be no discernible impact on the floristic communities at a regional scale as a consequence of mining the 27 200 and 28 000 orebodies.

There will be no reduction in species diversity or the geographic distribution of flora species. Reductions in species abundance and vegetation productivity associated with clearing up to 220 ha of native vegetation will be temporary, and reversed over time with the maturing of rehabilitation areas.

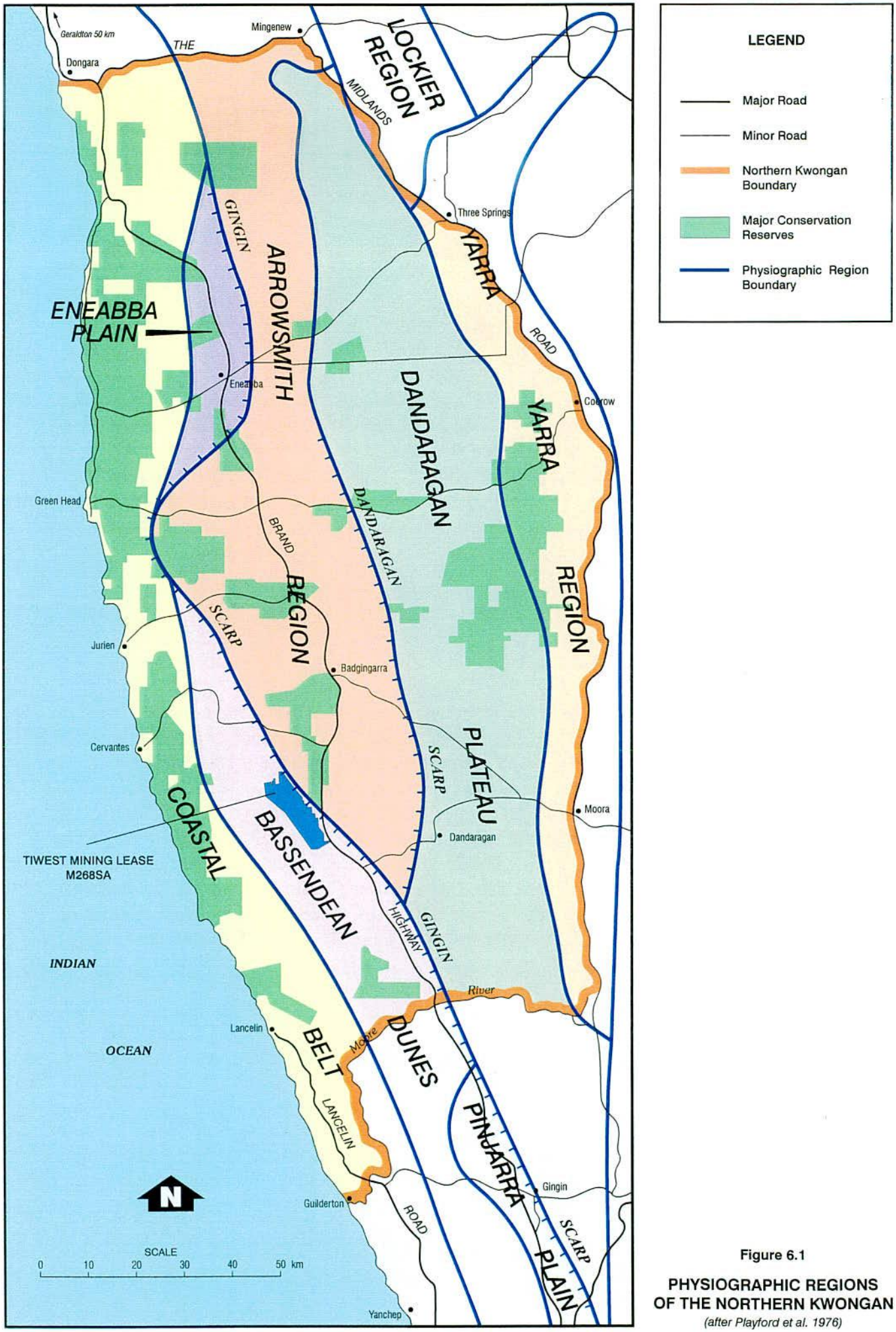


Figure 6.1

PHYSIOGRAPHIC REGIONS OF THE NORTHERN KWONGAN

(after Playford et al. 1976)

6.1.2 Declared Rare Flora and Priority Species

EPA Objective

- Protect declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950* and the *Endangered Species Protection Act 1992* (Cth).

The *Wildlife Conservation Act 1950* provides for the protection of rare flora by requiring that approval from the Minister for the Environment is issued prior to the disturbance of species on gazetted lists. The species on these lists are known as declared Rare Flora (DRF). Other species for which the status of abundance is unclear but which are under consideration by CALM for nomination as DRF are known as Priority Flora.

The *Endangered Species Protection Act 1992* (Cth) provides for the protection and recovery of listed endangered or vulnerable species and ecological communities. This act applies to the protection of species on land under Commonwealth jurisdiction, or to activities subject to other Commonwealth legislation. In practice the local species listed reflect those listed under the *Wildlife Conservation Act 1950,* with differences attributed to lag times in the gazettal or removal of species from the Commonwealth list. The *Endangered Species Protection Act 1992* (Cth) has no relevance to the mining of the 27 200 and 28 000 orebodies.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objective include:

- Detailed botanical surveys for DRF and Priority Species are undertaken in and around all areas identified for disturbance. The location of any DRF or Priority Species is recorded using a Global Positioning System. The results of these surveys are routinely forwarded to CALM. DRF and Priority Species may also be identified in other routine vegetation surveys. Surveys target, but are not limited to, DRF species likely to exist in the area as determined on the basis of previous survey results, review of a DRF database managed by CALM and known habitat types. The surveys are usually undertaken in late winter or spring when flowering assists in species identification, although through experienced gained in previous surveys DRF species have been identified in the field without the benefit of flowering. The following approach is adopted when DRF species are located:

(i) DRF species located away from areas likely to be disturbed are fenced to ensure protection.

(ii) Surveys for DRF in similar vegetation associations in nearby conservation reserves are undertaken.

(iii) Should disturbance to a DRF species be unavoidable (e.g. plants are located over an orebody) Tiwest applies to the Minister for the Environment to disturb the species. These applications include data on the known populations of the particular species found in surveys of nearby conservation reserves.

(iv) Tiwest has procedures for investigating methods of propagating DRF species.

Assessment and Management of Impacts

Several populations of DRF species have been identified in surveys of the area south of Cooljarloo Road, as detailed below (Mattiske Consulting Pty. Ltd., 1998; Landcare Services Pty. Ltd., 1999).

- Population of *Andersonia gracilis* comprising 12 plants located towards the southern boundary of the mining lease that will not be disturbed.
- Population of *Andersonia gracilis* comprising 126 plants located adjacent to the northern end of the 27 000 South orebody. Tiwest has applied to disturb this population on the basis that to construct overburden dumps around the population would result in an additional 37 hectares of native vegetation clearing. The population constitutes around 0.4% of the total known population.
- Population of *Andersonia gracilis* comprising 4 plants located over the 27 000 South orebody for which approval to disturb was issued by the Minister for the Environment in response to a Tiwest request to clear dated 4 December 1998.
- Population of *Andersonia gracilis* comprising 9 plants located in the likely vicinity of the 28 000 orebody. The requirement to disturb this population cannot be determined until the status of the 28 000 orebody is confirmed. The population constitutes 0.03% of the total known population.
- Population of *Anigozanthus viridis* spp. *terraspectans* comprising 10 plants located towards the southern boundary of the mining lease which will not be disturbed.

Tiwest has conducted specific surveys for *Andersonia gracilis* off mining lease M268SA to assess the status of the species in the local area and consequently the impact of removing several populations located over, or adjacent, to orebodies (Landcare Services Pty. Ltd., 1998b; Mattiske Consulting Pty. Ltd., 1998). Significant additional populations of the DRF, *Andersonia gracilis* exist in damplands on private land, roadside reserves, the Wongonderrah Nature Reserve and vCL adjacent to M268SA. Table 6.2 summarises the current known status of DRF species at Cooljarloo.

Fourteen Priority species of flora have been identified in vegetation surveys of M268SA and ML 70/1010. Appendix C includes the Priority species found on the mining tenements to date. Surveys will be undertaken to quantify the abundance of Priority species in adjacent conservation reserves.

One undescribed species was identified in the area of ML 70/1010. *Darwinia* sp. Cooljarloo (G Cockerton 2852) occurs in heaths on sand over laterite and has been recorded adjacent to Wongonderrah Rd north of the Cooljarloo minesite; within Reserve 27216 adjacent to Mullering Road, east of the Brand Highway (B. Charles pers. comm.) and in the wider Cataby - Badgingarra area (Dr Neville Marchant pers. comm.). It is unlikely that the species warrants priority status at present although it has limited representation within collections at the WA Herbarium (Landcare Services Pty. Ltd., 1999). Several specimens were provided to the WA Herbarium. Specimens of other significant species have been provided from surveys of the mining lease M268SA completed in previous years.

No other significant flora were noted.

Table 6.2 Current Status of Declared Rare Flora at Cooljarloo

Species	Populations	Number of Plants	Disturbed, or likely to be disturbed by mining activity	
			Number	%
Andersonia gracilis				
M268SA ML 70/1010	4	222	135	60.8
Total *	26	34,989	135	0.4
Anigozanthos viridis ssp. terraspectans				
M268SA ML 70/1010	1	10	-	-
Total *	5	1800	-	-

* Includes populations identified off mining lease M268SA and ML 70/1010

Tiwest has investigated methods of propagating *Andersonia gracilis*. The species is characterised by a relatively long taproot that hinders successful relocation of established plants. The careful, selective removal and placement of topsoil, with accompanying seed store appears the optimum means of re-establishing the species.

Conclusion

No DRF have been identified in the vicinity of the 27 200 orebody.

A small population (9 plants) of the DRF *Andersonia gracilis* exists in an area of potential disturbance associated with the 28 000 orebody. This population represents less than 0.03 % of the *Andersonia gracilis* in currently known populations. Current knowledge suggests there are encouraging prospects for re-establishing *Andersonia gracilis* in rehabilitated areas.

Tiwest has established procedures to ensure ongoing compliance with the *Wildlife Conservation Act 1950*, and should it become applicable to Tiwest operations, the *Endangered Species Protection Act 1992* (Cth).

There will be no significant impact on total populations of DRF as a consequence of mining the 27 200 and 28 000 orebodies.

Tiwest will continue to liaise with CALM to ensure impacts on Priority species are minimised.

6.1.3 Terrestrial Fauna

EPA Objectives

- Maintain the species abundance, diversity and geographical distribution of fauna.
- Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the *Wildlife Conservation Act 1950* and *the Endangered Species Protection Act 1992* (Cth)

The *Wildlife Conservation Act 1950* provides for the protection of rare fauna, birds protected under an international agreement, and other special fauna that are listed on specified schedules. Other species for which the status of abundance is unclear and there is some concern are listed as Priority fauna by CALM.

The *Endangered Species Protection Act 1992* (Cth) provides for the protection and recovery of listed endangered or vulnerable species and ecological communities. Similar to the protection of flora species, this Act generally applies to the protection of species on land under Commonwealth jurisdiction, or to activities subject to other Commonwealth legislation. It has no relevance to the mining of the 27 200 and 28 000 orebodies.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objectives include:

- Fauna monitoring is conducted and habitat requirements defined.
- The potential for threatened and priority fauna is assessed on the basis of monitoring results and known habitat types.
- Rehabilitation to standards that will provide habitat suitable for successful recolonisation by native fauna.

Assessment and Management of Impacts

Disturbance of native fauna primarily occurs through the disturbance of habitat. Mining the 27 200 and 28 000 deposits will disturb up to 220 ha of native vegetation (maximum areas of 105 and 115 ha respectively). The relevant areas comprise primarily Banksia low woodland (> 80 %) on deep sands and includes smaller areas of heath over lateritic gravel and heath subject to seasonal inundation.

Baseline surveys and subsequent fauna monitoring have been conducted by Tiwest using appropriately qualified ecologists since 1986 (J.N. Dunlop and Associates and Bamford, 1987; Bamford, 1990; 1992; 1996; 1997b and 1999). Long term transects of pitfall traps are established on mining lease M268SA north of Mullering Farm. The habitat types sampled in the northern transects are representative of the habitat found across the 27 200 and 28 000 orebodies (Bamford, 1997b; 1999). In addition four transects of pitfall traps south of Cooljarloo Road, including 2 in the area of ML 70/1010 were monitored in 1999 (Bamford, 1999).

Fauna surveys were conducted using pitfall traps (20 litre plastic buckets) at 20 metre intervals which were checked twice each day. Opportunistic observations were made during all field work. Bird counting and banding was also undertaken. Data was obtained on reptiles, frogs, mammals, birds and invertebrates.

The native vegetation on mining lease M268SA supports fauna typical of the northern sandplains. The total number of species identified has plateaued in recent years, which suggests the species lists recorded to date is a good representation of the species diversity of the area. The populations of small vertebrates varied widely in response to seasonal change and the disturbance of habitat by fire (Bamford, 1996; 1997a).

Five species of listed status have been recorded in the Cooljarloo area:-

i. South-West Carpet Python (*Morelia spilota imbricata*) - listed on Schedule 4, Other Threatened Fauna. Two specimens have been observed in the northern transects.

ii. Square-tailed Kite (*Lophoictinia isura*) - listed as Priority 4, taxa in need of monitoring. The Square-tailed Kite, which is considered to have a small but widespread population, has been observed in the northern vCL in winter.

iii. Peregrine Falcon (*Falco peregrinus*) - listed on Schedule 4, has been observed once in the northern vCL.

iv. Short-billed Black Cockatoo (*Calyptorhynchus latirostris*) – listed on Schedule 1, Endangered. This species is severely threatened primarily due to the loss of breeding habitat in the wheatbelt. Flocks of non-breeding birds have been observed foraging on shrub vegetation in the Cooljarloo area.

v. Brush Wallaby (*Macropus irma*) – listed as Priority 4 by CALM. This species was observed in native vegetation south of Cooljarloo Road.

The similiarity in habitat type between the areas of the 27 200 and 28 000 orebodies and the transects north of Mullering Farm suggest that the proposal areas are suitable habitat for the species listed in (i) to (iv) above.

Conclusion

The primary impact of Tiwest activities on native fauna occurs through the disturbance of habitat. A maximum of 220 hectares of native vegetation will be disturbed in mining 27 200 and 28 000. This area of disturbance is not considered significant enough to impact on the diversity or geographical distribution of native fauna. The abundance of native species may reduce commensurate with the temporary habitat loss, however this is not considered significant on a local or regional scale. The rehabilitation of disturbed areas to required standards will result in the re-establishment of native fauna habitat.

There will be no significant impact on species abundance, diversity or geographical distribution of native fauna as a consequence of mining the 27 200 and 28 000 orebodies. Mining these additional orebodies will not result in the permanent loss of the habitat of any Threatened or Priority Fauna species.

6.1.4 Landform

EPA Objective

- Establish a stable, sustainable landform consistent with surroundings.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objective include:

- The description of landform prior to disturbance.
- Identification of appropriate criteria for material deposition to ensure stability and minimise erosion risk.
- Reinstate the landscape to the planned profile and slope criteria and follow with appropriate revegetation techniques.

Assessment and Management of Impacts

In the planning that precedes ground disturbance, Tiwest describes the movement of topsoil, overburden and tailings materials and consequently the planned final landform. Erosion management measures incorporated into the landform design include:-

- the selective deposition of overburden (refer to Section 3.9 - Landform Reconstruction),
- overburden placement to a maximum hill slope gradient of 1:12 and a hilltop gradient of 1:100,
- drainage contours placed at 50 metre intervals, though this may be varied dependent on the permeability of the material uppermost in the profile and final slopes,
- topsoil stabilisation using a cover crop and mulched vegetation (refer to Sections 3.9 and 3.10), and
- the final landform is checked by survey to ensure design criteria have been met.

The 27 200 and 28 000 orebodies are located beneath a gently undulating dune system. Although the surface slopes of rehabilitation areas may exceed those that occur naturally, they are limited by criteria Tiwest employs to ensure a stable landform and once revegetated, blend in with surrounding areas.

As described in Section 3.0, the mine void associated with the 27 200 and 28 000 orebodies will be backfilled with tailings and overburden to at least 4 metres above the expected maximum groundwater level, though not up to the original ground surface. The resulting depressions are likely to be subject to seasonal inundation which will be accommodated by revegetation with appropriate species. This design is to ensure there will be no groundwater expression at the surface as a result of mining.

Conclusion

A stable landform is an essential component of successful rehabilitation. Tiwest has design criteria detailed in rehabilitation procedures referenced in the Cooljarloo EMP that are required to form part of rehabilitation plans for a disturbed area.

Mining the 27 200 and 28 000 deposits will result in altered landforms in the immediate areas of the orebodies. Under Tiwest's existing Environmental Management Programme the final landform will be constructed to criteria that ensure a stable and self sustaining landscape that once rehabilitated, will be compatible with surrounding undisturbed areas.

6.1.5 Rehabilitation

EPA Objective

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

Means of Achieving EPA Objective

The 27 200 and 28 000 orebodies exist in vCL, with no clearly defined land use. Tiwest's rehabilitation is aimed at establishing sustainable landforms compatible with surrounding undisturbed areas, with no diminution in land use capability. Key steps in the achievement of this include:-

- Description of the environment prior to disturbance by Tiwest.
- Staged, verified implementation of procedures recognised as maximising the probability of rehabilitation success.
- Post rehabilitation monitoring to gauge progress and identify any requirement for early remedial action.

Assessment and Management of Impacts

The environmental characteristics of an area are defined through soil, vegetation and contour mapping and through water monitoring. The monitoring undertaken by Tiwest is described in Section 3.1- Pre-disturbance Monitoring.

The process of rehabilitation is described in Section 3. Criteria for each of the following contributory processes and/or procedures are defined in the EMP (Appendix F lists the objectives within the Cooljarloo EMP).

- Planning
- Final landform design and construction
- Topsoil management
- Vegetative mulching
- Native seed selection and application
- Weed control
- Post – rehabilitation monitoring and remedial work

The creation of suitable soil profiles and landform will provide the basis for vegetation establishment in the rehabilitation of the 27 200 and 28 000 orebodies. The control of surface runoff, the categorisation and selective placement of overburden and the spread of topsoil and mulch will all contribute to stability in the final landform. Topsoil and mulch will also be selectively placed to ensure the respective seed stores are matched to site characteristics. Similarly, the seed mix for directly broadcast seed will be prepared and spread according to its intended final position within the landscape. Seed mixes will be prepared on the basis of the

reconstructed soil profile and vegetation communities found in similar conditions in neighbouring undisturbed areas.

The progressive rehabilitation of disturbed areas is also described in Section 3.0. Tiwest's rehabilitation programmes are structured around the seasons at Cooljarloo to ensure that the final prepared, seeded and mulched surfaces are in place by the onset of seasonal rain in April/May each year to maximise vegetation establishment in the critical first year. The rehabilitation cycle is depicted in Figure 6.2.

The current schedule for rehabilitation of areas disturbed in mining the 27 200 orebody is detailed in Figure 6.3. Typically 24 to 36 months may elapse between initial ground disturbance and rehabilitation. This period can be highly variable depending upon the rate and nature of the mining process.

The optimal time for mining any viable 28 000 orebody occurs when the wet separation plant is closest in the 27 000 South orebody. Development of a mining schedule on which a rehabilitation schedule would be based, is dependent on the proving of a viable resource. A similar lag between the mining and rehabilitation of disturbed areas associated with the 28 000 orebody will occur.

Infrastructure associated with ore extraction, heavy mineral separation and tailings deposition follows the active mine path (Section 3) and will therefore be removed from mined areas in the normal progression of mining.

Two Declared Plants under the *Agriculture and Related Resources Protection Act 1976*, Afghan Thistle (*Solanum hoplopetalum*) and Patersons Curse (*Echium plantagineum*) have been identified on Mullering Farm but not in native vegetation south of Cooljarloo Road. Tiwest has a spray programme to eradicate these plants. The risk of weed invasion in the areas of the 27 200 and 28 000 orebodies will be minimised through control of topsoil movement, and through eradication of any infestations as necessary.

Successful rehabilitation is dependent on success in a number of prerequisite contributory factors. By controlling the inputs to rehabilitation, through implementation to defined quantitative criteria and standards, the probability of a successful outcome is maximised (refer to Section 3 and 6.1.4). Tiwest monitors established transects in undisturbed areas to obtain data on trends in natural ecosystems, which will be used for the development of quantitative criteria to assess progress in rehabilitation. Tiwest's rehabilitation objective of stable, self–sustaining ecosystems compatible with surrounding undisturbed areas provide qualitative criteria against which rehabilitation progress will be assessed.

Other than the use of biodegradable flocculants used to assist the settling of suspended clay material in process water, no chemicals will be used in the production of heavy mineral concentrate and the risk of ground or water contamination is therefore limited. The bulk storage of hydrocarbons will remain at Tiwest's existing workshop facilities, approximately 3 km from the orebodies. Smaller mobile field refuelling units are fully bunded. Any field hydrocarbon spillage will be contained and remediated as it occurs, consistent with current practice at Cooljarloo.

Visual, qualitative checks of vegetation re-establishment and surface (in particular drainage) stability will be undertaken frequently during the first year of rehabilitation. Vegetation re-establishment and the return of fauna will be quantitatively assessed in following years.

In six year old native revegetation trials on one site type, Tiwest has recorded the return of 199 species, compared to a total recorded in the area of 415 species (Landcare Services Pty. Ltd., 1998a). Second generation plants have been observed within the rehabilitation and recruitment from adjacent undisturbed areas also recorded.

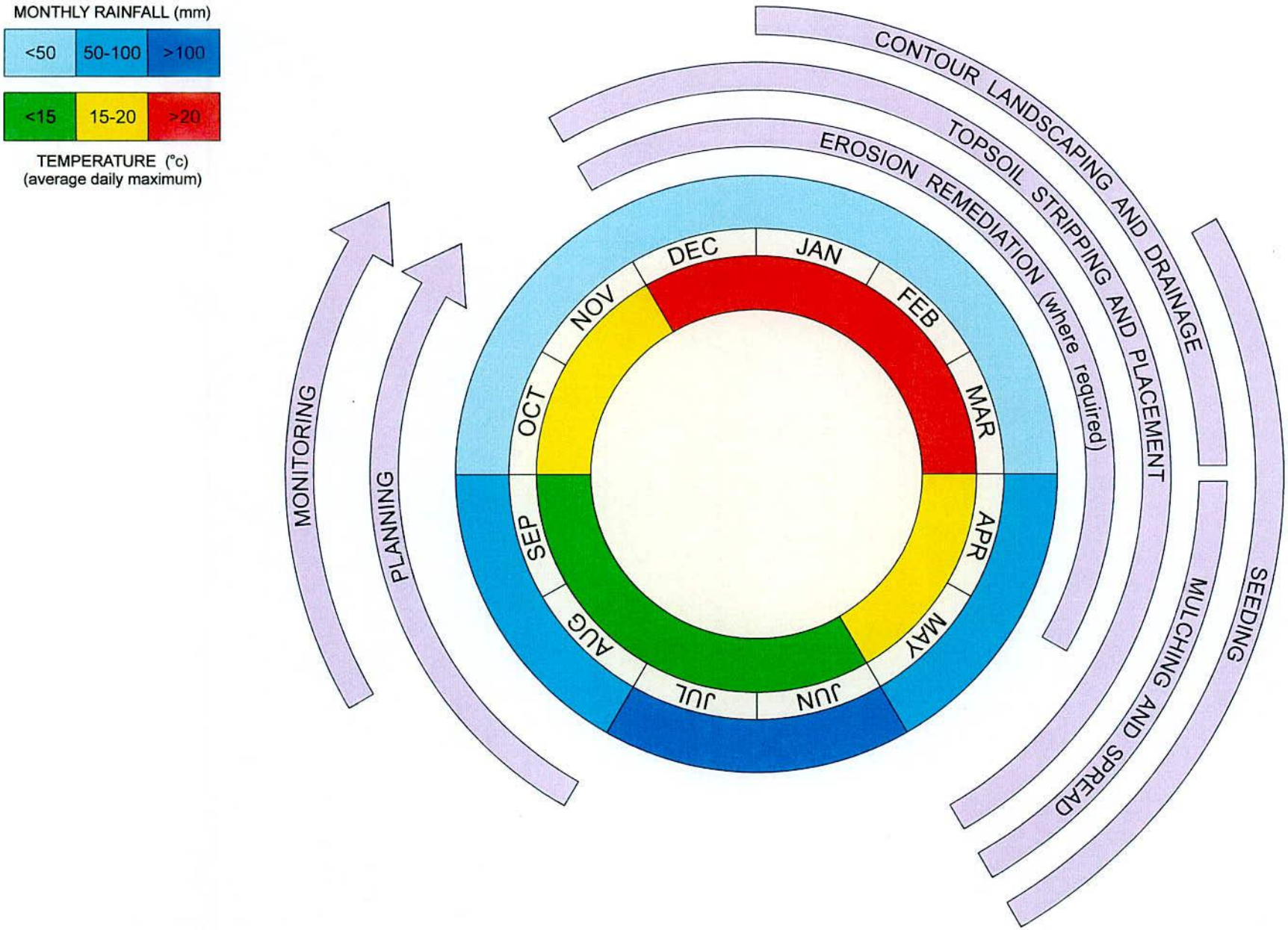
Conclusion

Tiwest's current rehabilitation programme will constitute part of the mining process that will occur in the 27 200 orebody and any viable 28 000 orebody.

The implementation of a number of inputs to standards considered prerequisite for rehabilitation success ensures that over time Tiwest's objective of achieving stable self sustaining areas of rehabilitation compatible with surrounding undisturbed areas will be achieved.

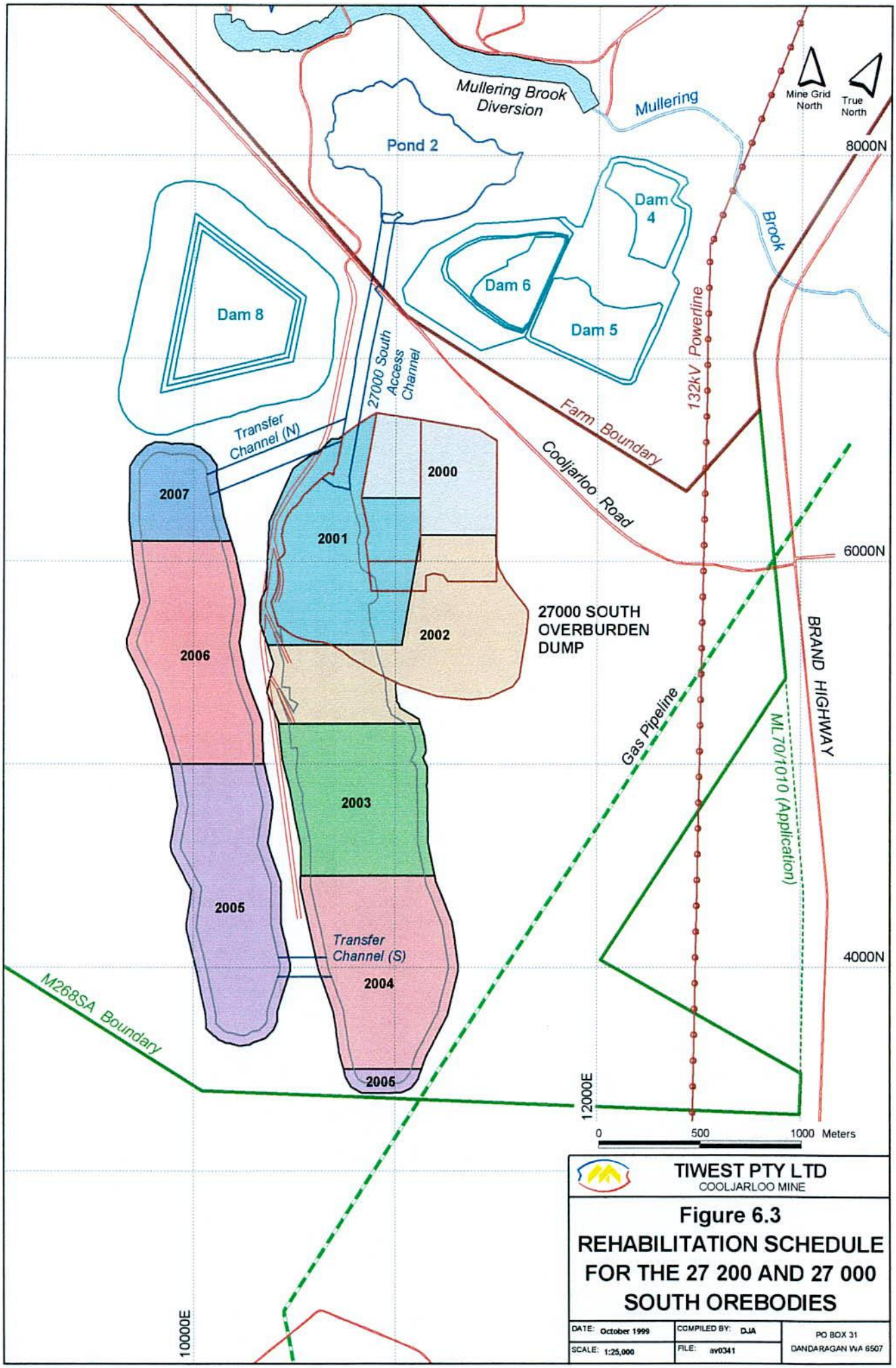
Post-rehabilitation monitoring ensures the identification of any adverse trends and the early implementation of remedial work to restore progress towards Tiwest's objective.

Areas disturbed in the mining of the 27 200 and 28 000 orebodies will be rehabilitated to produce stable, self sustaining ecosystems compatible with adjacent undisturbed areas.



TIWEST

Figure 6.2 - THE REHABILITATION CYCLE AT COOLJARLOO


Mullering Brook Diversion
Mullering Brook
Pond 2
Dam 8
Dam 6
Dam 5
Dam 4
27000 South Access Channel
Transfer Channel (N)
Transfer Channel (S)
132kV Powerline
Farm Boundary
Cooljarloo Road
BRAND HIGHWAY
Gas Pipeline
ML 70/1010 (Application)
M268SA Boundary
2000
2001
2002
2003
2004
2005
2006
2007
27000 SOUTH OVERBURDEN DUMP
Mine Grid North
True North
8000N
6000N
4000N
10000E
12000E
0
500
1000 Meters
TIWEST PTY LTD
COOLJARLOO MINE
Figure 6.3
REHABILITATION SCHEDULE FOR THE 27 200 AND 27 000 SOUTH OREBODIES
DATE: October 1999
COMPILED BY: DJA
SCALE: 1:25,000
FILE: av0341
PO BOX 31
DANDARAGAN WA 6507

6.2 POLLUTION MANAGEMENT ENVIRONMENTAL FACTORS

6.2.1 Groundwater

EPA Objective

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

The draft Guidelines for Fresh and Marine Waters (EPA, 1993) details limits, or changes in values, for physical and chemical parameters and toxicants for the protection of aquatic ecosystems. The guidelines are based on the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992). Tiwest has also discussed potential impacts on groundwater levels in this section.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objective include:

- Baseline monitoring of groundwater quality and flow.
- Ongoing monitoring and analysis to assess impacts on groundwater levels and quality.
- Provisions to adjust abstraction regimes to different areas and aquifers in the event of identifying any adverse trends.

Assessment and Management of Impacts

Water Consumption

Tiwest utilises groundwater for:-

- Potable water supply (after treatment)
- Amenities
- Dust suppression
- Maintenance of optimum water levels in the dredge pond
- Slurrying ore and production of heavy mineral concentrate in the wet separation plant

Tiwest is licenced by the Water and Rivers Commission to abstract 4,900,000 kL per annum from the superficial aquifer and 3,880,000 kL per annum from the artesian, Yarragadee aquifer. Annual abstraction to date has constituted around 20% of licence limits (Rockwater, 1999a), though mine water use increased following the commissioning of the wet separation plant for the northern dry mining operation in September 1999.

The general flow of water associated with mining is indicated in Figures 2.2 and 2.3.

A network of bores is used to monitor the impact of mining operations on the local groundwater resources. The hydrological monitoring network is detailed in Figure 5.2. The impacts on local water resources are reported annually to the Water and Rivers Commission and the DEP, in accordance with respective licence requirements.

Groundwater Levels

To date the water surface in the dredge pond has been around 10 m below the natural groundwater level. Establishment of the dredge pond has resulted in the drawdown of groundwater levels in the superficial aquifer up to 4 kilometres from the pond. The most significant effect on groundwater levels has occurred within 1.5 km of the dredge pond, with reductions in groundwater levels of up to 3 m at this distance from the pond (Rockwater, 1996). This has not, to date, resulted in any demonstrable impacts on native vegetation (Mattiske, 1997), which is attributed to the minimal dependence of local vegetation communities on groundwater at depth. The soil moisture characteristics within the root zone of the native vegetation appear more directly influenced by the presence, or absence, of shallower, perched water tables not directly affected by drawdown in the main aquifer.

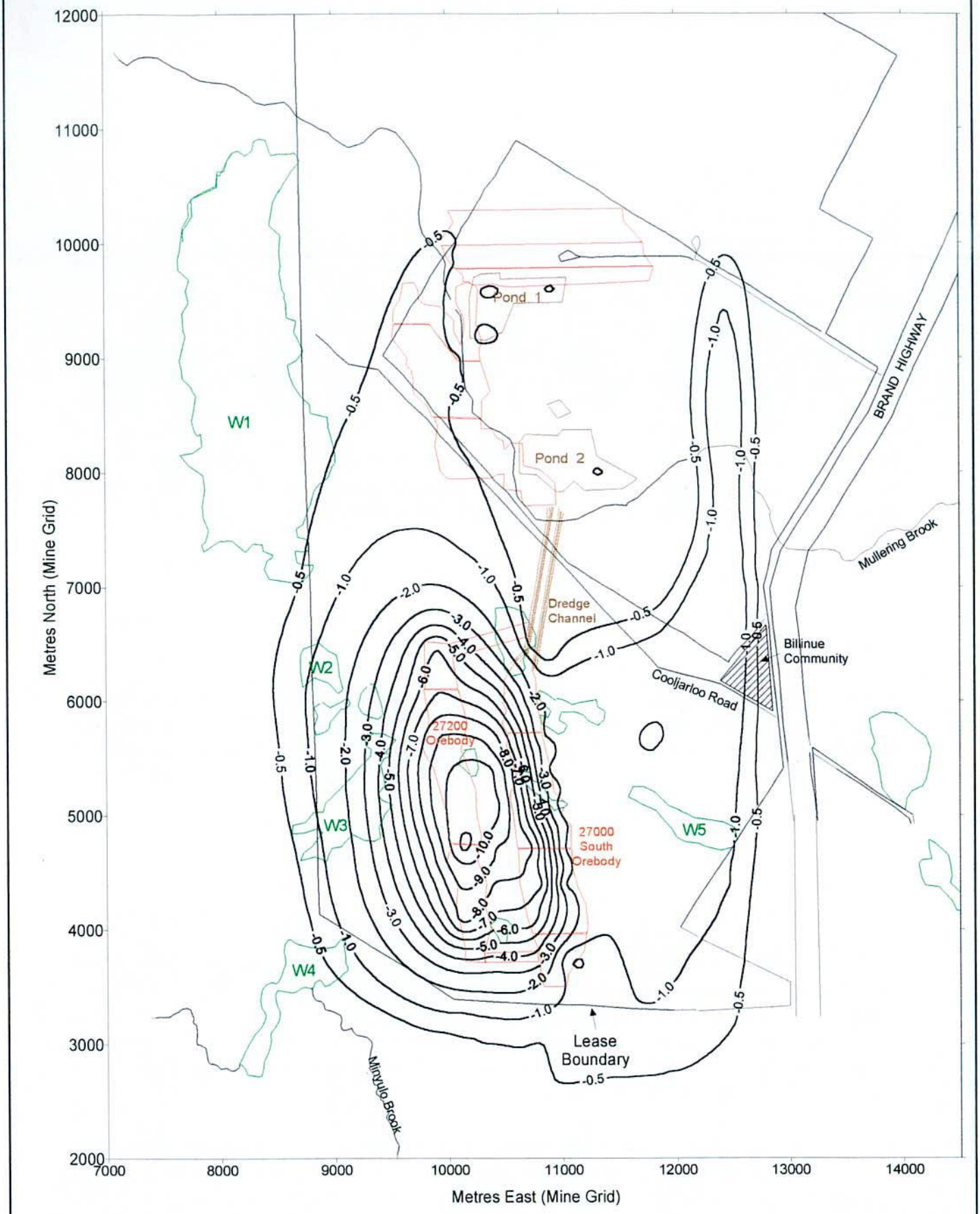
Damplands that occur in the vicinity of the 27 200 and 28 000 orebodies are associated with the presence of less permeable materials high in the profile that impede rainfall infiltration. This can result in a perched water table and, depending on rainfall patterns, seasonal inundation.

Several permanent wetlands exist south west of the M268SA, in a Nature Reserve (A 40916) and private farmland, approximately 1.2 km from the southern end of the 27 200 orebody. Significant surface drainage discharges into the wetlands. Groundwater modelling, using a model refined through application at Cooljarloo, suggests that drawdown associated with a dredge pond established to mine the 27 000 South and 27 200 orebodies will extend to the closest of the wetlands, on private land (Rockwater, 1999b). Figure 6.4 details the modelled extent of groundwater drawdown in the main aquifer. Minyulo Brook, a significant local stream discharges into the wetland and the effect of reduced groundwater levels in the main aquifer on water levels in the wetland is expected to be insignificant.

Figure 6.4 indicates a reduction in groundwater levels of around 0.5 to 1 m beneath the premises of the Billinue Community. This depression in groundwater levels at the Billinue Community is significantly less than the 2 to 3 m reduction which had occurred to December 1998, based on interpolations of monitoring data (Rockwater, 1999a). The reduction in groundwater levels has not resulted in water supply problems at the Billinue Community premises to date (M. Ryder, pers. comm.).

Tiwest monitoring has indicated that groundwater will gradually return to previous levels once the impact of the dredge pond diminishes, as has occurred in areas north of Mullering Farm with the southward migration of the dredge pond (Rockwater, 1999a).

Groundwater abstraction has to date been within the recharge capacity of the superficial and Yarragadee aquifers (Rockwater, 1999a).



LEGEND

W1, W2, W3, W5 Seasonal Damplands

W4 Permanent Wetland

Tiwest Pty Ltd: Cooljarloo Mine

Figure 6.4

MODEL-CALCULATED CHANGE IN GROUNDWATER LEVELS (m), MAIN AQUIFER, SEPTEMBER 1999 - JUNE 2004

Dwg No. 143-11/99/1-7 July 1999

Rockwater Pty Ltd

I:\143-11\surfer\s6wl3s.dat/L3dds.grd/.srf

Groundwater Quality

There have been no identifiable impacts on groundwater quality to date as a consequence of Tiwest's mining operations. As detailed in Section 6.1.5, with the exception of biodegradable flocculants used to assist settling of clay tailings, no chemicals are used in the production of heavy mineral concentrate and the risk of groundwater contamination is therefore limited.

Acidification of mine waters is associated with exposure of pyritic material during mining and its oxidation in air. The reaction may be generally described as:-

$$2FeS_2\,(s) + 2H_2O + 7O_2 \rightarrow 4H^+ + 4SO_4^{2-} + 2Fe^{2+}$$

[Manahan, 1994]

The Cooljarloo mineral deposits and overburden, are highly oxidised in nature and do not contain significant acid sulphate material. This has been determined through analysis of drill samples for the 27 200 orebody south of Cooljarloo Road. Geological interpretation suggests there is little risk of acid generating material in the vicinity of the 28 000 orebody.

There has been no indication of acid generation in ten years of mining at Cooljarloo. Figure 6.5 details the pH of the dredge pond from 1995, which has varied between pH 5.9 and pH 7.0 during this time. The surface soil horizons in some of the seasonally inundated damplands may be locally enriched in organic sulphur species. Groundwater monitoring has indicated that some wetlands north of Mullering Farm may cause a reduction in the natural pH of groundwater (pH 3.0-5.9). No similar effect has been noted during groundwater monitoring in the vCL south of Mullering Farm.

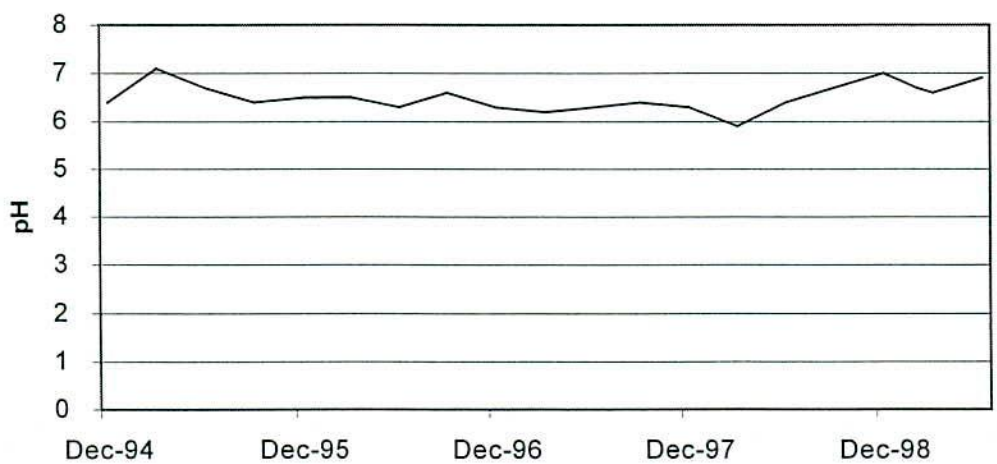


Figure 6.5 pH of the Dredge Pond, 1995 – Present

The bulk storage of hydrocarbons will remain at Tiwest's existing workshop facilities, approximately 3 km from the orebodies. Smaller mobile field refuelling units are fully bunded. Any field hydrocarbon spillage will be contained and remediated as necessary, consistent with current practice at Cooljarloo.

Floating booms and absorbents are held at Cooljarloo to contain any hydrocarbon spills that occur on the dredge pond.

Conclusion

Groundwater drawdown resulting from abstraction and management of water levels in the dredge pond has not resulted in any environmental impact to date. Dredge mining the 27 200 orebody will result in the extent of drawdown moving approximately 500 metres further west than what will occur in mining the 27 000 South deposit. The extension does not encompass any significant change in vegetation or topographical characteristics. Dredge mining the 28 000 deposit will cause drawdown to extend further east. The limited duration of mining, (12 months) and the existing depth to groundwater, limits the risk of any environmental impact.

The effect of the dredge pond on groundwater levels is transient.

There has been no detectable change in groundwater quality as a consequence of mining operations at Cooljarloo. No acid forming ore or overburden has been identified in the area of the southern orebodies and no impacts on groundwater quality are anticipated.

Groundwater quality will not be significantly altered as a consequence of mining the 27 200 and 28 000 orebodies. Mining will not compromise other existing, or future uses of groundwater, including its value for maintenance of aquatic ecosystems.

6.2.2 Surface Water Quality

EPA Objective

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

The draft Guidelines for Fresh and Marine Waters (EPA, 1993) details limits, or changes in values, for physical and chemical parameters and toxicants for the protection of aquatic ecosystems. The guidelines are based on the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992).

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objective include:

- Identification and monitoring of aquatic ecosystems with the potential to be affected by mining operations.
- Design and control of drainage from disturbed and rehabilitation areas to minimise affects on receiving water bodies.

Assessment and Management of Impacts

The Cooljarloo mine water requirements are met by groundwater abstraction and do not impact on any surface water bodies (refer to previous section).

Surface drainage at Cooljarloo is limited by the generally permeable surface sands and dry climate. Mullering Brook, the only defined surface watercourse on the mining lease flows west across Mullering Farm, 1.5 km north of the 27 200 and 28 000 orebodies. The brook is seasonal and although variable, will typically flow for around two months, in July/September each year (refer Section 4.7). Tiwest have diverted approximately 1.5 kilometres of the Mullering Brook channel to mine underlying ore from the 27 000 orebody. The diversions have been constructed to criteria aimed at minimising scour and have incorporated a sedimentation basin to capture the coarse fraction of suspended sediment prior to flowing off the mining tenement.

Tiwest monitors the quantity and quality of flow in Mullering Brook as it enters and exits the mining tenement. Elevated suspended sediment concentrations, turbidity and nutrient levels occur in the Mullering Brook. The high nutrient levels are attributed to runoff from agricultural areas upstream of the mining tenement (Streamtec, 1999). Suspended sediment concentrations are also elevated upstream of the mine and increase across the mining tenement due primarily to stream flow in the exposed diversion channel. Although fine sediment deposition is evident in sections of Mullering Brook downstream of Mullering Farm, the sediment has not resulted in any discernible impacts on aquatic invertebrates or stream health (Streamtec, 1999). Other than suspended sediment and turbidity, there have been no changes in the quality of stream flow in Mullering Brook as a consequence of mining.

To maintain the optimum water level in the dredge pond, excess water has been pumped into Mullering Brook on two occasions since 1989. The discharges to Mullering Brook have occurred in accordance with environmental licence conditions. The quality of dredge pond water and the water in Mullering Brook were monitored during the discharges. No adverse environmental impacts resulted from the discharges of dredge pond water to Mullering Brook.

Several permanent wetlands exist on farmland approximately 1.2 km south-west of the 27 200 orebody. Significant surface drainage discharges into the wetlands from Minyulo Brook south of the mining tenement. A series of depressions at the southern end of the mining tenement may also convey surface runoff into the wetlands under prolonged, intense rainfall.

A major consideration in landform design at Cooljarloo is the integration of new areas within the surrounding drainage pattern, so as not to impede surface flows that may occur under exceptional rainfall. Other rehabilitation criteria that are applied to minimise erosion by limiting the volumes and velocity of runoff from rehabilitated areas also serve to maintain the quality of surface runoff.

Phytophthora cinnamomi, the fungus responsible for dieback, has not been identified in the areas of the 27 200 and 28 000 orebodies. Hygiene procedures are in place to minimise the risk of introducing the fungus to the minesite. Procedures are in place to selectively manage any contaminated soil to ensure placement low in the landscape (from where water movement is limited) and to revegetate these areas using *phytophthora* resistant native species.

Tiwest disposes of waste to ensure that it has no adverse impact on surface waters. Domestic and light industrial rubbish is disposed offsite at approved landfill sites. Waste oils are collected and removed from site by an approved waste disposal contractor. Other materials such as batteries, tyres and drums are recycled. Domestic sewerage is treated via septic tanks prior to disposal through leach drains. Sewerage generated on the wet separation plant is processed via a sewerage treatment plant prior to discharge to the dredge pond. The quality of water in the pond dredge and groundwater is regularly assessed.

As detailed in the previous section, no acid forming ore or overburden has been identified in the area of the southern orebodies and no impacts on surface water quality are anticipated.

Conclusion

Although the northern end of the 27 200 orebody is within the catchment of Mullering Brook, the area would contribute flow to the brook only under extreme rainfall events. The remoteness from the brook and the drainage and rehabilitation criteria applied to create a stable landscape cause the risk of impact on Mullering Brook from mining the 27 200 orebody to be negligible.

There is no defined surface drainage in the vicinity of the 27 200 and 28 000 orebodies. Again, under extreme rainfall events water may flow overland from the southern portion of the 27 200 orebody through a series of depressions towards a wetland south west of the orebody. Given the low probability of occurrence, the nature of overland flow and the quality of runoff the risk of impact on the wetland from surface runoff is negligible.

There will be no impact on the quality of any surface water bodies as a consequence of mining the 27 200 and 28 000 orebodies. Mining will not compromise other existing or future uses of surface water resources, including the value for maintenance of aquatic ecosystems.

6.2.3 Greenhouse Gas Emissions

EPA Objective

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

The EPA has prepared an interim guidance statement for the consideration of greenhouse gas emissions from new proposals (EPA, 1998) that requires:

- Estimation of the amount of greenhouse gas emissions associated with the proposal
- Indication of measures to be adopted to reduce emissions
- Comparisons of greenhouse gas efficiency
- Indication of whether the project will be entered into the Greenhouse Challenge Programme

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objectives include:

- Identification of sources of greenhouse gases resulting from the mining operation
- Mine planning and equipment selection to reduce energy consumption and therefore greenhouse gas emissions

Assessment and Management of Impacts

The main greenhouse gases are carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (NO_X), non-methane volatile organic carbon compounds (NMVOC), oxides of sulphur (SO_X) and fluorocarbons (FC). The contribution of each gas to the greenhouse effect varies and is reflected in the value of the 'global warming potential' attributed to each gas. Preliminary investigations have indicated that in excess of 99% of the total global warming potential associated with Tiwest activity is caused by CO_2 emissions.

Table 6.3 summarises the estimated and projected CO_2 emissions associated with mining operations at Cooljarloo for the period 1996 to 2003. Though the CO_2 emissions from electricity generation (Western Power) are offsite, power consumption is integral to the production of heavy mineral concentrate and is therefore included in the table.

Table 6.3 Summary of Carbon Dioxide Emissions Associated with Mining at Cooljarloo, 1996 – 2003.

Year	CO_2 Emissions (tonnes x 10^3)				Tonnes CO_2/tonne of material moved (ore and overburden)
	Electricity	Earthmoving	Vegetation Clearing	Total	
1996	33.8	10.5	0.3	44.6	2.1
1997	45.1	17.5	0.9	63.5	2.8
1998	61.5	18.4	2.2	82.1	3.5
1999	80.6	29.1	3.5	113.2	3.1
2000	82.4	24.2	3.9	110.5	3.1
2001	82.4	26.0	5.0	113.4	3.0
2002	82.4	25.1	5.9	113.4	3.1
2003	82.4	21.4	6.7	110.5	3.5

Electricity consumption and diesel fuel combustion account for over 96% of the potential greenhouse gas emissions resulting from Tiwest operations. Releases to the biosphere resulting from vegetation clearing and soil disturbance constitute less than 4% of the total greenhouse gas emissions associated with mining at Cooljarloo.

Tiwest aims to create native vegetation communities of comparable biomass to undisturbed native vegetation. The carbon sink associated with rehabilitation will roughly equate to carbon emissions resulting from clearing vegetation and will therefore result in no net greenhouse gas emissions to the atmosphere in the longer term.

Though some carbon losses globally occur with the decay of cleared vegetation over time, around 90% occurs in the burning of cleared vegetation. To optimise the soil carbon store, all native vegetation cleared at Cooljarloo is chipped or mulched for use in rehabilitation. No cleared vegetation is burnt at Cooljarloo.

The increase in greenhouse gas emissions at Cooljarloo is the consequence of moving increasing volumes of overburden and ore to maintain production of HMC in declining ore grades. The composition of the orebody and overburden, which influences the ease of excavation or dredging will also affect power or fuel consumption and therefore CO_2 emissions.

Implementation of the proposal would result in an extension of greenhouse gas emission activities for 22 months at current mining rates. The mining operations at Cooljarloo represent less than 0.3% of 1995 net CO_2 emissions calculated for Western Australia (Australian Greenhouse Office, 1998).

Electricity and diesel fuel consumption constitute significant costs associated with mining. That is, the incentive to reduce energy costs also serves to reduce greenhouse gas emissions. Tiwest aims, through mine planning, to minimise the distance and height over which material is pumped or hauled to minimise energy consumption. Appropriate equipment selection also contributes to reduced energy costs, and therefore reduced greenhouse gas emissions.

Tiwest monitors and reports greenhouse gas emissions in Annual and Triennial Environmental Reports. Opportunities to reduce emissions are a routine consideration of mine planning by virtue of the correlation with reduced energy costs. Tiwest does not intend to enter the federal Greenhouse Challenge Programme at this stage.

Conclusion

Inclusion of the 27 200 and 28 000 orebodies in the Tiwest mining schedule will extend current mine life, and therefore the emission of carbon dioxide associated with mining and processing, by around 22 months. There will be no increase in the annual rate of CO_2 emissions as a consequence of mining the 27 200 and 28 000 orebodies.

Tiwest is committed to reducing greenhouse gas emissions as far as practicable through equipment selection and mine planning.

Greenhouse gas emissions associated with mining the 27 200 and 28 000 orebodies will not result in environmental or human health problems, or cause an increase in the annual rate of emissions from the Cooljarloo operations.

The minimisation of energy consumption (and therefore greenhouse gas emissions) through equipment selection and mine planning will remain a routine objective of Tiwest in mining the 27 200 and 28 000 orebodies.

6.2.4 Dust

EPA Objectives

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

Dust emissions at Cooljarloo are regulated by Tiwest's environmental licence issued by the DEP, which requires that the increase in the ambient concentration of airborne particulates at the boundary of mining lease M268SA not exceed 260 $\mu g/m^3$ (PM50, 24 hour maximum). The licence also requires that all reasonable and practicable measures be taken to minimise the generation of airborne dust.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objectives include:

- Maintenance of housekeeping and dust suppression measures to minimise dust levels.

- Airborne particulate monitoring to provide checks on dust emissions from mining operations.

Assessment and Management of Impacts

Dredge mining typically generates low levels of airborne particulates. Higher dust levels are generated by topsoil stripping and conventional earthmoving associated with overburden removal and dry mining. The 27 200 orebody will be mined by dredge and current indications are that any viable 28 000 deposit will be dredge mined.

The migration of dust across the mining lease boundary is influenced by prevailing wind conditions and travel distance. Earthmoving associated with the 27 200 orebody will on average occur around 800 metres from the western boundary, 250 metres from the southern boundary and more than 2.5km from the eastern boundary of the lease. Any earthmoving associated with mining the 28 000 orebody based on current limited information, would occur on average 375 metres from the external boundary of ML 70/1010.

Dust monitoring undertaken to date using a high volume air sampler in accordance with Australian Standard 2724, has occurred on the mining lease boundary within 300 metres of earthmoving activity. Total ambient particulate concentrations recorded have not exceeded 50 $\mu g/m^3$ at the mining lease boundary.

The residences of the Billinue Community are sufficiently close to mining operations to be affected by dust emissions. In addition, the Brand Highway runs approximately parallel to and 100 metres from the south eastern boundary of mining lease, M268SA. Tiwest has procedures to scale down or cease earthmoving activity in areas where prevailing wind conditions result in excessive dust emissions in the direction of the Billinue Community or Brand Highway.

Measures documented in the Cooljarloo EMP to minimise dust emissions include:-

- Regular watering of haul roads and around waste disposal areas during dry conditions.
- Use of a road sweeper on sealed roads as required.
- Stabilisation of topsoil stockpiles with vegetation to reduce wind erosion.

Conclusion

Though dust emissions are significantly influenced by moisture conditions and prevailing winds, the distance between the 27 200 orebody, the 28 000 orebody and the mining lease boundaries, limits the risk of exceeding licence conditions. The risk of creating a dust nuisance at the Brand Highway or the residences of the Billinue Community is limited by Tiwest's commitment to modify earthmoving operations in the event of excessive dust emissions in this direction.

Through dust suppression measures, monitoring and the ability to modify operations in adverse conditions, the risk of airborne particulates associated with mining the 27 200 and 28 000 orebodies exceeding licence limits or impacting on environmental or human health is limited.

6.2.5 Noise

EPA Objective

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

Environmental noise levels are regulated by the Environmental Protection (Noise) Regulations 1997, which defines noise limits (assigned noise levels) for noise sensitive premises.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objective include:

- Determination of baseline and mine operation noise levels.

- Identification of noise sensitive premises and assessment of the noise contribution from Tiwest operations.

Assessment and Management of Impacts

Dredge mining is an inherently quiet operation and environmental noise emissions are limited by the location of the dredge very low in the landscape. The use of conventional heavy earthmoving equipment in dry mining and overburden removal are the noisiest activities at Cooljarloo. Blasting has been required on one occasion in over ten years of mining and is not expected to be required in the mining of the 27 200 and 28 000 orebodies.

The attenuation of noise with distance between the noise source and the receiving point is a key factor in determining ambient noise levels. The Cooljarloo Mine is remote from most noise sensitive premises. The residences of the Billinue Community are the nearest noise sensitive premises to the Tiwest operations, approximately 750m north of the 28 000 orebody. Dandallen Farm is the next closest, approximately 6.3km from the nearest Tiwest activity (refer to Figure 1.2).

Past Tiwest operations have occurred within 300 metres of the Billinue premises. Members of the Billinue Community have advised that while mine activity is occasionally audible, the noise is not annoying and significantly less intrusive than that generated by heavy vehicles travelling at speed along the Brand Highway, 150 metres east of the residences (Malcolm Ryder, pers comm). Environmental noise monitoring undertaken in August 1998 when earthmoving activity occurred within 300 to 500 metres of the residences indicated compliance with assigned noise levels. The results of that monitoring are summarised in Table 6.4, next page.

Noise monitoring in 1996 confirmed there is minimal risk of breaching assigned noise levels at Dandallen Farm (SVT Engineering Consultants, 1996).

Table 6.4 – Measured Noise Levels at the Billinue Community Premises

Time of Day	Noise Level dB (A)		
	L_{A10}	L_{A1}	L_{Amax}
0700 to 1900 hours Monday to Saturday Assigned level – Residential premises **Measured level**	 54 45	 64 49	 74 57
0900 to 1900 Sunday and public holidays Assigned level – Residential premises **Measured level**	 49 41	 59 47	 74 51
1900 to 2200 hours All days Assigned level – Residential premises **Measured level**	 49 41	 59 47	 64 51
2200 hours on any day to 0700 hours Monday to Saturday And 0900 hours Sunday and public holidays Assigned level – Residential premises **Measured level**	 44 39	 54 42	 64 49

(Source: SVT Engineering Consultants, 1998)

Conclusion

The 27 200 orebody is more than two kilometres from the Billinue Community. Mining operations are unlikely to significantly influence environmental noise levels at the Billinue premises. The northern end of any mining activity associated with the 28 000 orebody will occur within 800 metres of the Billinue Community. Given previous monitoring results Tiwest does not expect noise emissions from mining operations to be intrusive or exceed assigned noise levels determined under the Environmental Protection (Noise) Regulations 1997.

Environmental noise emissions associated with the 27 200 and 28 000 orebodies will not breach assigned noise levels determined under the Environmental Protection (Noise) Regulations 1997, or otherwise adversely impact on neighbouring noise sensitive premises.

6.3 SOCIAL FACTORS

6.3.1 Visual Amenity

EPA Objective

- The visual amenity of the area adjacent to the proposal should not be unduly affected by the proposal.

Means of Achieving EPA Objective

Although the mining operations may be viewed to a greater or lesser extent from any point around the mining lease M268SA boundary, the only easily accessed, well-trafficked area is Brand Highway.

Tiwest procedures relevant to the attainment of the EPA objective include:-

- Maintenance of an appropriate visual buffer between Brand Highway and mining operations.
- Adherence to required housekeeping standards.
- Appropriate landform design for areas of rehabilitation.

Assessment and Management of Impacts

The general area of the orebodies south of Cooljarloo Road is visible from a rise in Brand Highway approximately 10 km north east. At this distance, although the land disturbance associated with mining the 27 000 South orebody is visible, the details and altered land contours are not discernible.

The 27 200 orebody is more than 2.5 km from the Brand Highway. Mining operations and land disturbance will not be visible from the section of Brand Highway closest to the area.

Disturbance associated with mining any viable 28 000 deposit will occur to within 375 metres of the Brand Highway. The highway is not elevated relative to the area of the orebody and no operations at existing ground level will be visible to passing traffic. An overburden dump will be constructed to eight metres above the existing ground surface to gain access to the orebody. The crest of the overburden dump will be around 850 metres from the Brand Highway. The distance from the highway and the application of slope criteria in landform design will ensure the rehabilitated area is compatible with surrounding, undisturbed areas (refer to Section 3.9 and Section 6.1.5).

Housekeeping and dust management minimise the risk of offsite impacts and consequently any loss of visual amenity.

Conclusion

Brand Highway is the only readily accessed vantage point in proximity of the 27 200 and 28 000 orebodies. The maintenance of at least 300 metres of natural vegetation between the highway and mining operations and the low, relative elevation of the highway will result in negligible impact (if any) on visual amenity. An increase in the elevation of the Brand Highway approximately 10 km north east of the proposal area is too distant for mining operations to have a significant impact.

The rehabilitation of all disturbed areas will ensure there is no loss of visual amenity in the longer term.

Mining the 27 200 and 28 000 orebodies will not unduly affect the visual amenity of the area as assessed from the Brand Highway.

6.3.2 Aboriginal Culture and Heritage

EPA Objectives

- Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*.
- Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.

The *Aboriginal Heritage Act 1972* provides for the recording and protection of areas and artefacts used by the original inhabitants of Australia.

Means of Achieving EPA Objective

Tiwest procedures relevant to the attainment of the EPA objectives include:

- Completion of ethnographic and archaeological surveys prior to disturbance for mining.
- Preservation of Aboriginal sites wherever possible.
- Application to the Minister for Aboriginal Affairs to disturb an Aboriginal site if disturbance is unavoidable (for example the site is located directly over an orebody).
- Consultation with local Aboriginal groups concerning the mining operations.
- Requirements of employees and contractors to cease work if evidence of an Aboriginal site is encountered and to report the observations immediately.

Assessment and Management of Impacts

Detailed ethnographic surveys of mining lease M268SA were completed in 1987 as part of the original project approvals (O'Connor and Quartermaine, 1987). One archaeological site was identified adjacent to Mullering Brook. The site has been fenced and remains undisturbed. No Aboriginal sites were identified in the area of the 27 200 orebody.

Consultation with Aboriginal representatives concerning mining on mining lease M268SA also occurred as part of the original project approvals. The Minister for Aboriginal Affairs approved the project on 27 August 1987, under Section 18 of the *Aboriginal Heritage Act 1972*.

The area now subject to application by Tiwest for mining tenement ML 70/1010 has not yet been surveyed for the presence of Aboriginal sites. A search of the Aboriginal Affairs Department (AAD) Register, undertaken as part of processing the tenement application, did not indicate any listed sites on the area of proposed tenement ML 70/1010 (DME letter, 22 September 1999). The grant of tenement ML 70/1010 is subject to the provisions of the *Native Title Act 1993*. Tiwest is currently in consultation with Native Title claimants to gain agreement for the grant of the tenement. Appropriate ethnographic and archaeological surveys will form part of any agreement and should also fulfil survey requirements of the *Aboriginal Heritage Act 1972*. The AAD will be consulted as to their survey requirements and the results of surveys forwarded to the AAD immediately on completion of the relevant surveys.

Tiwest regularly liaises with members of the Billinue Community to discuss mining operations. In particular the endorsement of the Community members was sought in considering the diversion of Mullering Brook.

Tiwest's rehabilitation objective is to re-establish areas compatible with surrounding undisturbed areas. Although the landform of some areas will be permanently altered, the physical and biological processes of the natural environment should be restored, thereby minimising any impact on any ongoing cultural associations with the area.

Conclusion

No Aboriginal sites were identified in the vicinity of the 27 200 orebody, which is wholly within mining lease M268SA.

Any mining of the 28 000 orebody will not occur until tenement ML 70/1010 is issued. The grant of mining lease ML 70/1010 will only occur following agreement with relevant Native Title claimants, which will involve the completion of appropriate ethnographic surveys. The management of any sites identified will occur in agreement with the Native Title claimants and in accordance with the *Aboriginal Heritage Act 1972*.

Mining the 27 200 and 28 000 orebodies will occur in accordance with the *Aboriginal Heritage Act 1972*. Biological and physical changes associated with mining the 27 200 and 28 000 orebodies will occur with the agreement of local Aboriginal groups and should not adversely impact any cultural associations with the area.

6.4 BIODIVERSITY

EPA Objective

- Maintain biodiversity where that represents the variety of living organisms at the level of genetic diversity, species diversity and ecosystem diversity.

Means of Achieving EPA Objective

Through the management of the environmental factors listed in Sections 6.1 and 6.2 Tiwest will ensure there will be no significant or irreversible impacts that will affect biodiversity.

Conclusion

The disturbance of natural ecosystems associated with this proposal is not significant on a local or regional scale.

The disturbed areas will be rehabilitated to a standard that exhibits a biodiversity typical of the surrounding undisturbed landscape.

There will be no significant reduction in biodiversity as a consequence of mining the 27 200 and 28 000 orebodies. Effective management of underlying, contributory environmental factors will produce, over time, rehabilitated landscapes with biodiversity characteristics typical of the undisturbed surrounding area.

7.0 COMMUNITY CONSULTATION

Through its Environmental Policy, Tiwest is committed to openly communicating environmental performance at Cooljarloo.

Tiwest regularly liaises with its nearest neighbours, members of the Billinue Community, concerning the progress of the mine. Some members of the Community are familiar with mining operations through picking native seed on mining lease M268SA to fulfil orders placed by Tiwest.

Tiwest has also discussed mining operations with Native Title claimants with whom an agreement is required before mining tenement ML 70/1010 will be granted by the Department of Minerals and Energy (refer to Section 6.3.2, Aboriginal Culture and Heritage).

Members of the Dandaragan Shire Council visited the Cooljarloo Mine in April 1999. The progress of the dredge mining operation in the 27 000 South orebody and possibly the 27 200 orebody was raised in the context of future mine direction and the general performance of the Cooljarloo Mine.

A public open day at Cooljarloo is scheduled for 12 November 1999. Tours of mining operations and information on all aspects of Tiwest's activities, including the proposal to mine the 27 200 and 28 000 orebodies will be available on the day.

Historically Tiwest mining at Cooljarloo has not generated significant comment from the community. Many people from the local community are employed at the mine and fully aware of mining practice. If implemented, Tiwest's proposal to mine the 27 200 and 28 000 orebodies will not result in any significant change in mining activity and the local community will not be affected in any way.

This PER forms the basis for communicating the proposal to mine the 27 200 and 28 000 orebodies to the broader community.

8.0 CONCLUSION AND MANAGEMENT COMMITMENTS

This Public Environmental Review document describes a proposal by Tiwest to extend its mining operations at Cooljarloo to two additional titanium mineral orebodies that were not described in original project approvals issued in 1988.

Tiwest commenced mining at Cooljarloo in 1989. Approval to mine the 27 200 and the 28 000 orebodies would extend the current projected mine life at Cooljarloo by around 22 months to 17 years. No expansion of existing infrastructure or mining rates will occur as a consequence of implementing this proposal.

Tiwest has an established system of environmental management in place at Cooljarloo, which would be routinely applied to the mining of the 27 200 and 28 000 orebodies.

The primary environmental impact associated with this proposal is the disturbance of up to 220 ha of native vegetation. This area constitutes 4.3% of the native vegetation in conservation reserves within 1 km of the boundary of Tiwest's mining lease M268SA, and 0.05% of the native vegetation in reserves in the Moora regional district (as administered by CALM). There would be no significant impact on any rare or endangered flora or fauna species. Disturbed areas will be rehabilitated to documented standards that will re-establish stable, self-sustaining ecosystems.

A summary of the commitments by Tiwest to the environmental management of mining the 27 200 and 28 000 orebodies is detailed in Table 8.1 below.

TABLE 8.1 ENVIRONMENTAL MANAGEMENT COMMITMENTS

No.	Topic	Objective(s)	Action	Timing	Advice
1.	Environmental Management Programme	Manage environmental impacts arising from the proposal.	Apply the Cooljarloo Environmental Management Programme to the mining of the 27 200 and 28 000 orebodies as defined in the EMP and Cooljarloo Environmental Procedures Manual	On an ongoing basis	DEP DME CALM W&RC
2.	Environmental Management Programme	Improvement in environmental performance	Review the Cooljarloo Environmental Management Programme Review objectives and procedures and update as required	Annually	DEP DRD CALM W&RC DME
3.	Native vegetation	Minimise disturbance to native vegetation	Limit clearing of native vegetation associated with mining the 27 200 and 28 000 orebodies to 220 ha.	Overall	DME DEP

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10.0 GLOSSARY / ABBREVIATIONS

ANZECC	Australian and New Zealand Environment and Conservation Council
Bassendean Dune System	Oldest, most eastern coastal dune system.
Biodiversity	The variety of life – the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form.
CALM	Department of Conservation and Land Management
CO_2	carbon dioxide
DEP	Department of Environmental Protection
Duricrust	Impenetrable crust found at the surface of the lateritic profile.
damplands	Areas subject to seasonal waterlogging.
dB(A)	decibels 'A' weighted
DME	Department of Minerals and Energy
Drawdown	A decline in the level of groundwater due to abstraction.
DRD	Department of Resources Development
DRF	Declared Rare Flora
Ecosystem	A defined community of organisms, their interactions, and their physical surroundings.
ERMP	Environmental Review and Management Programme
EMP	Environmental Management Programme
EPM	Environmental Procedures Manual
Endemism	Occurrence is geographically restricted.
EPA	Environmental Protection Authority
ESP	Exchangeable Sodium Percentage
EMS	Environmental Management System
Ferruginous	Composed primarily of weathered iron oxides.
Geomorphic	Concerned with the structure, origin and development of the topographical features of the earth's crust.
Heath	Low ($\pm$ 1m) shrub vegetation
HMC	Heavy mineral concentrate
Kwongan	A term for the Western Australian sandplain and associated vegetation.
km	kilometre
Laterite	Broadly used to describe the cemented layer of aluminium and iron oxides found at the surface of strongly weathered relict soils.
mg/L	milligrams per litre
Mycorrhizal fungi	Soil dwelling fungi that form symbiotic associations with plants.
Pallid zone	Grey and white clays found at the base of the lateritic profile.
PER	Public Environmental Review
Perched water table	A water table which occurs above an impermeable zone, which is underlain by unsaturated materials.
pH	A measure of the alkalinity or acidity of a substance. A pH of 7 is regarded as neither acid or alkaline. 0 is extremely acidic and 14 is similarly extremely alkaline.

Pyritic	Mineral aggregate that contains any of various metallic looking sulphides of which pyrite ("iron pyrites") is most common.
Sulphidic	Containing the anion sulphide (S^{2-}). The presence of sulphides generally indicates the presence of anaerobic conditions.
Superficial aquifer	Aquifer near the ground surface that can be recharged from rainfall.
Symbiotic	A relationship between two or more organisms where the presence of the other is either prerequisite or an aid to their own survival.
TDS	Total Dissolved Salts. Amount of dissolved salts in given volume of water.
Transect	A line used to survey the distribution of organisms across an area.
TSS	Total Suspended Solids. Total soluble components of water.
vCL	vacant Crown Land
Water table	The top of the saturated soil in an unconfined aquifer.
WRC	Water and Rivers Commission
$\mu g/m^3$	microgram per cubic metre
$\mu Gy\ hr^{-1}$	microGray per hour
becquerels/g	becquerels per gramme

APPENDIX A

EPA GUIDELINES FOR ENVIRONMENTAL ASSESSMENT

Environmental Protection Authority
Guidelines

MINERAL SANDS MINING TO OREBODY 27200 (M268SA) AND OREBODY 28000 (ML70/1010 & M268SA), COOLJARLOO MINE, DANDARAGAN

(Assessment Number 1272)

Part A	Specific Guidelines for the preparation of the Public Environmental Review
Part B	Generic Guidelines for the preparation of an environmental review document

Attachment 1	Example of the invitation to make a submission
Attachment 2	Advertising the environmental review
Attachment 3	Project location maps

These guidelines are provided for the preparation of the proponent's environmental review document. The specific environmental factors to be addressed are identified in Part A. The generic guidelines for the format of an environmental review document are provided in Part B.

The environmental review document must address all elements of Part 'A' and Part 'B' of these guidelines prior to approval being given to commence the public review.

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

1. The proposal

Tiwest Pty Ltd intends to mine mineral sands of Orebody 27200 (M268SA) and Orebody 28000 (ML70/1010 & M268SA) at Cooljarloo Mine, Dandaragan. The proposed project areas are located within Vacant Crown Land and are indicated on the attached plans (Attachment 3).

Orebody 27200 is located within M268SA. Mining is proposed to be undertaken by one to two floating dredges. The dredge will be connected to the existing floating wet separation plant that will produce a wet concentrate on site. The wet concentrate will then be further processed at Tiwest Pty Ltd's existing Chandala processing plant.

Mining of Orebody 28000 (ML70/1010 & M268SA) is proposed to be either dry mined or dredge mined depending on the economic viability of the mining lease.

2. Environmental factors relevant to this proposal

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

CONTENT	SCOPE OF WORK	
Integrating Process	**EPA Objective**	**Work required for the environmental review**
Biodiversity	Maintain biodiversity where that represents the variety of living organisms at the levels of genetic diversity, species diversity and ecosystem diversity.	Through studies carried out for the following environmental factors, demonstrate that, on a regional basis, biodiversity and ecosystem function will not be compromised by this proposal.

CONTENT		SCOPE OF WORK	
Factor	**Site Specific Factor**	**EPA Objective**	**Work required for the environmental review**
Terrestrial Flora	Vegetation	Maintain the species abundance, diversity, geographic distribution and productivity of the vegetation.	Baseline studies by appropriately trained and experienced persons under appropriate seasonal conditions to identify existing vegetation and dieback occurrence within the proposal area. Map and describe the vegetation and relate these mapped units to soil/ landform types. Provide an assessment of the regional significance of the floristic communities present in the proposal area. Assessment of potential impacts (direct and indirect) on vegetation (local and regional, terrestrial and aquatic) as a result of mining and associated activities. Propose measures to mitigate impacts (including potential for "land swap" arrangements).
	Declared Rare and Priority and other significant Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act and the Commonwealth Endangered Species Act.	Targeted search by appropriately trained and experienced persons under appropriate seasonal conditions to identify Declared Rare and Priority flora likely to occur on the subject land. Analysis of likelihood of occurrence of taxa not flowering at time of survey. Identify other species of significance which may be impacted by the proposals and discuss the reason for their conservation significance. These species may include undescribed species, new records for the region, species or taxa that are endemic to the region, or species confined to specific sites of limited occurrence in the region. Retain voucher specimens from all significant species and lodge them with the WA Herbarium. Propose measures to manage and/or mitigate impacts.
Terrestrial Fauna	Terrestrial Fauna	Maintain the species abundance, diversity and geographical distribution of fauna.	Baseline studies to identify existing fauna in the project area. Assessment of potential impacts (direct and indirect) on fauna (local and regional, terrestrial and aquatic) as a result of mining and associated activities. Propose measures to manage impacts.

CONTENT		SCOPE OF WORK	
Factor	**Site Specific Factor**	**EPA Objective**	**Work required for the environmental review**
	Specially Protected (Threatened) and Priority Fauna	Protect Specially Protected (Threatened) and Priority Fauna and their habitats, consistent with the provisions of the Wildlife Conservation Act and the Commonwealth Endangered Species Act.	Baseline study/ or targeted search by appropriately trained persons for Specially Protected (threatened) and Priority Fauna which may occur in the project area. Analysis of the values of affected land as habitat for endangered fauna. Propose measures to manage impacts.
Land	Landform	Establish stable, sustainable landform consistent with surroundings.	Assessment of potential impacts of the proposal on existing landforms. Detail of erosion management measures.
	Rehabilitation	Ensure proposal area, and any other area affected by the proposal, is rehabilitated to a standard consistent with the intended post mining long term land use.	Detail of measures proposed to rehabilitate the impacted area, including: • removal of infrastructure; • weed control and management; • completion criteria (in qualitative and quantitative terms); • how progressive rehabilitation will be implemented; • timetable for rehabilitation; • clean-up of any contaminated areas; and • monitoring of rehabilitation performance criteria.
POLLUTION MANAGEMENT			
Air	Particulates / Dust	(i) Ensure that particulate emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of particulate wastes.	Baseline studies to identify existing sources of dust. Assessment of potential increases in dust resulting from the construction and operation of the mine and associated activities. Assessment of potential impacts of increased dust on the surrounding environment and the amenity of surrounding land users from the construction and operation of the mine and associated activities. Propose measures to manage impacts.

CONTENT		SCOPE OF WORK	
Factor	**Site Specific Factor**	**EPA Objective**	**Work required for the environmental review**
Water	Groundwater quality	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft Guidelines for Fresh and marine Waters (EPA, 1993).	Detail of water requirements for any on-site processing and mine operations. Detail of drainage and fate of water used in any on-site processing and mine operations. Assessment of impact from any change in groundwater quality, including from acid sulfate soils, on surrounding environment. Detail of impact from hydrocarbons (hydraulic fluids) use on surrounding environment. Propose measures to manage impacts.
Water	Surface water quality	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft Guidelines for Fresh and Marine Waters (EPA, 1993).	Detail of water requirements for any on-site processing and mine operations. Detail of drainage and fate of water used in any on-site processing and mine operations. Detail of disposal of plant site waste, particularly sewage. Detail of how surface water discharge will be managed to minimise risk of erosion and risk of Dieback spread. Assessment of potential impact on the Mullering Brook. Assessment of impact from any change in surface water quality, including from acid sulfate soils, on surrounding environment. Propose measures to manage impacts.
	Greenhouse gases	(i) Ensure that greenhouse gas emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of greenhouse gases.	Detail source(s) and amounts of greenhouse gases released or absorbed as a result of mining or rehabilitation activities. This analysis is to include net greenhouse gas emissions resulting from vegetation clearance.

CONTENT		SCOPE OF WORK	
Factor	**Site Specific Factor**	**EPA Objective**	**Work required for the environmental review**
Non-chemical Emissions	Noise	Ensuring that noise impacts emanating from the proposal comply with statutory requirements and acceptable standards.	Baseline studies to identify existing sources of noise. Assessment of potential increases in noise resulting from the construction and operation of the mine and associated activities (including trucking movements). Assessment of potential impacts of any increased noise on the amenity of surrounding land users. Propose measures to manage impacts.
SOCIAL SURROUNDINGS			
Aesthetic	Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal.	Assessment of potential impacts on visual amenity of the project area and surrounds from the proposal, particularly in relation to the Brand Highway. Propose measures to manage impacts.
Culture and Heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Identify any Aboriginal cultural and heritage sites/issues of significance through archaeological and ethnographical surveys of the project area and through consultation with local Aboriginal groups, Native Title claimants and the Aboriginal Affairs Department. Identify potential impacts on any identified sites. Propose measures to manage impacts.

These factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA expects to address these factors in its report to the Minister for the Environment.

The EPA expects the proponent to take due care in ensuring any other relevant environmental factors which may be of interest to the public are addressed.

3. Availability of the environmental review

3.1 Copies for distribution free of charge

Supplied to DEP:

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

Distributed by the proponent to:

Government departments	• Department of Minerals and Energy.....3 • Water and Rivers Commission .....3 • Department of Conservation and Land Management... 3 • Department of Land Administration.....1 • Aboriginal Affairs Department.....1 • Department of Resources Development.....2
Local government authorities	• Shire of Dandaragan .....1 • Geraldton City Council 1
Libraries	• J S Battye Library .....3 • The Environment Centre.....2 • Geraldton City Regional Library .....2 • Dandaragan Local Library.....2
Other	• Conservation Council of WA .....1 • Mid West Development Commission .....1 • Billinue Aboriginal Community 1

3.2 Available for public viewing

- Department of Environmental Protection Library, Perth;
- Department of Environmental Protection Library Midwest Region Office;
- Geraldton City Regional Library;
- J S Battye Library;
- The Environment Centre; and
- Dandaragan Local Library.

Part B: Generic Guidelines for the preparation of an environmental review document

1. Overview

All environmental reviews have the objective of protecting the environment. Environmental impact assessment is deliberately a public process in order to obtain broad ranging advice. The review requires the proponent to describe:

- the proposal;
- receiving environment;
- potential impacts of the proposal on factors of the environment; and
- proposed management strategies to ensure those environmental factors are appropriately protected.

Throughout the assessment process it is the objective of the Environmental Protection Authority (EPA) to help the proponent to improve the proposal so the environment is protected. The DEP administers the environmental impact assessment process on behalf of the EPA.

The primary purpose of the environmental review is to provide information on the proposal within the local and regional framework to the EPA, with the aim of emphasising how the proposal may impact the relevant environmental factors and how those impacts may be mitigated and managed.

The language used in the body of the environmental review should be kept simple and concise, considering the audience includes non-technical people, and any extensive, technical detail should either be referenced or appended to the environmental review. The environmental review will form the legal basis of the Minister for the Environment's consideration of the proposal and therefore it should include a description of all the main and ancillary components of the proposal, including options where relevant.

Information used to reach conclusions should be properly referenced, including personal communications. Such information should not be misleading or presented in a way that could be construed to mislead readers. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinion, and each assessment should lead to a discussion of the management of the environmental factor.

2. Objectives of the environmental review

The objectives of the environmental review are to:

- place this proposal in the context of the local and regional environment;
- adequately describe all components of the proposal, so that the Minister for the Environment can consider approval of a well-defined project;
- provide the basis of the proponent's environmental management program, which shows that the environmental impacts resulting from the proposal, including cumulative impact, can be acceptably managed; and
- communicate clearly with the public (including government agencies), so that the EPA can obtain informed public comment to assist in providing advice to government.

3. Environmental management

The EPA expects the proponent to have in place an environmental management system appropriate to the scale and impacts of the proposal including provisions for performance review and a commitment to continuous improvement. The system may be integrated with quality and health and safety systems and should include the following elements:

- environmental policy and commitment;
- planning of environmental requirements;
- implementation and operation of environmental requirements;
- measurement and evaluation of environmental performance;
- review and improvement of environmental outcomes.

A description of the proposed environmental management system should be included in the environmental review documentation. If appropriate, the documentation can be incorporated into a formal environmental management system (such as AS/NZS ISO 14001). Public accountability should be incorporated into the approach on environmental management.

4. Format of the environmental review document

The environmental review should be provided to the DEP officer for comment. At this stage the document should have all figures produced in the final format and colours.

Following approval to release the review for public comment, the final document should also be provided to the DEP in an electronic format.

The proponent is requested to supply the project officer with an electronic copy of the environmental review document for use on Macintosh, Microsoft Word Version 6, and any scanned figures. Where possible, figures should be reproducible in a black and white format.

5. Contents of the environmental review document

The contents of the environmental review should include an executive summary, introduction and at least the following:

5.1 The proposal

A comprehensive description of the proposal including its location (address and certificate of title details where relevant) is required.

Justification and alternatives

- justification and objectives for the proposed development;
- the legal framework, including existing zoning and environmental approvals, and decision making authorities and involved agencies; and
- consideration of alternative options.

Key characteristics

The Minister's statement will bind the proponent to implementing the proposal in accordance with any technical specifications and key characteristics[1] in the environmental review document. It is important therefore, that the level of technical detail in the environmental review, while sufficient for environmental assessment, does not bind the proponent in areas where the project is likely to change in ways that have no environmental significance.

Include a description of the components of the proposal, including the nature and extent of works proposed. This information must be summarised in the form of a table as follows:

[1] Changes to the key characteristics of the proposal following final approval, would require assessment of the change and can be treated as non-substantial and approved by the Minister, if the environmental impacts are not significant. If the change is significant, it would require assessment under section 38 or section 46. Changes to other aspects of the proposal are generally inconsequential and can be implemented without further assessment. It is prudent to consult with the Department of Environmental Protection about changes to the proposal.

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	< 5yrs (continual operation)
Size of ore body	682 000 tonnes (upper limit)
Area of disturbance (including access)	100 hectares
List of major components • pit • waste dump • infrastructure (water supply, roads, etc)	refer plans, specifications, charts section immediately below for details of map requirements
Ore mining rate • maximum	 • 200 000 tonnes per year
Solid waste materials • maximum	 • 800,000 tonnes per year
Water supply • source • maximum hourly requirement • maximum annual requirement	 • XYZ borefield, ABC aquifer • 180 cubic metres • 1 000 000 cubic metres
Fuel storage capacity and quantity used	litres; litres per year
Heavy mineral concentrate transport • truck movements (maximum)	 • 75 return truck loads per week

Plans, Specifications, Charts

Adequately dimensioned plans showing clearly the location and elements of the proposal which are significant from the point of view of environmental protection, should be included. The location and dimensions (for progressive stages of development, if relevant) of plant, amenities buildings, accessways, stockpile areas, dredge areas, waste product disposal and treatment areas, all dams and water storage areas, mining areas, storage areas including fuel storage, landscaped areas etc.

Only those elements of plans, specifications and charts that are significant from the point of view of environmental protection are of relevance here.

Figures that should always be included are:

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;
- a map showing the proposal in the regional context; and, if appropriate,
- a process chart / mass balance diagram showing inputs, outputs and waste streams.

The plan/s should include contours, a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, and a title. If the data is overlaid on an aerial photo then the date of the aerial photo should be shown.

Other logistics

- timing and staging of project; and
- ownership and liability for waste during transport, disposal operations and long-term disposal (where appropriate to the proposal).

5.2 Environmental factors

The environmental review should focus on the relevant environmental factors for the proposal, and these should be agreed in consultation with the EPA and DEP and relevant public and government agencies. Preliminary environmental factors identified for the proposal are shown in Part A of these guidelines.

Further environmental factors may be identified during the preparation of the environmental review, therefore on-going consultation with the EPA, DEP and other relevant agencies is recommended. The DEP can advise the proponent on the recommended EPA objective for any new environmental factors raised. Minor matters which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

Items that should be discussed under each environmental factor are:

- a clear definition of the area of assessment for this factor;
- the EPA objective for this factor;
- a description of what is being affected - why this factor is relevant to the proposal;
- a description of how this factor is being affected by the proposal - the predicted extent of impact;
- a description of where this factor fits into the broader environmental / ecological context (only if relevant - this may not be applicable to all factors);
- a straightforward description or explanation of any relevant standards / regulations / policy;
- environmental evaluation - does the proposal meet the EPA's objective as defined above;
- if not, environmental management proposed to ensure the EPA's objective is met;
- predicted outcome.

The proponent should provide a summary table of the above information for all environmental factors, under the three categories of biophysical, pollution management and social surroundings:

Table 2: Environmental factors and management (example only)

Environmental Factor	EPA Objective	Existing environment	Potential impact	Environmental management	Predicted outcome
BIOPHYSICAL					
vegetation community types 3b and 20b	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation community types 3b and 20b	Reserve 34587 contains 45 ha of community type 20b and 34 ha of community type 3b	Proposal avoids all areas of community types 20b and 3b	Surrounding area will be fully rehabilitated following construction	Community types 20b and 3b will remain untouched Area surrounding will be revegetated with seed stock of 20b and 3b community types
POLLUTION MANAGEMENT					
Dust	Ensure that the dust levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards	Light industrial area - three other dust producing industries in close vicinity Nearest residential area is 800 metres	Proposal may generate dust on two days of each working week.	Dust Control Plan will be implemented	Dust can be managed to meet EPA's objective
SOCIAL SURROUNDINGS					
Visual amenity	Visual amenity of the area adjacent to the project should not be unduly affected by the proposal	Area already built-up	This proposal will contribute negligibly to the overall visual amenity of the area	Main building will be in 'forest colours' and screening trees will be planted on road	Proposal will blend well with existing visual amenity and the EPA's objective can be met

5.3 Environmental management commitments

The implementation of the key characteristics of the proposal and the environmental management commitments made by the proponent become legally enforceable under the conditions of environmental approval issued in the statement by the Minister for the Environment. All the auditable environmental management commitments should be consolidated in the public review document in a list (usually in an Appendix). This list is attached to the Minister's statement and becomes part of the conditions of approval.

The proponent's compliance with the consolidated environmental management commitments will be audited by the DEP, so they must be expressed in a way which enables them to be audited.

A commitment needs to contain most (if not all) of the following elements to be auditable:

- who (eg. the proponent)

- will do what (eg. prepare a plan, take action)
- why (to meet an environmental objective)
- where/how (detail the action and where it applies)
- when (in which phase, eg. before construction starts)
- to what standard (recognised standard or agency to be satisfied)
- on advice from (agency to be consulted).

The proponent may make other 'commitments', which address less significant or non-environmental matters, to show an intention to good general management of the project. Such 'commitments' (or management strategies/policies) would not be included in the consolidated list of environmental management commitments appended to the statement.

Continuous improvement during the implementation of the consolidated commitments may necessitate changes whilst ensuring the environmental objective is still achieved; these can be made in updates to the environmental management plan. Modified and/or additional proponent commitments arising from the fulfilment of environmental conditions will be audited by the DEP and should follow the accepted format.

Once the proposal is approved under a statement of conditions, any proposed modifications or additional commitments should be referred to the EPA for consideration of the environmental impacts. Such changes to the consolidated list of commitments would normally be dealt with through the audit process; however, if significant impacts are involved, the proposed changes may constitute a change to the proposal which would require assessment.

Examples of the preferred format for typical commitments are shown in the following table:

Table 3: Summary of proponent's commitments (example only)

Who/What Commitment	When plan prepared Timing	Why Objective	How/Where Action	Whose advice expert consulted	Evidence Standard Compliance criteria
1. The Proponent will develop and implement a rehabilitation plan	before construction commences	to protect the abundance, species diversity, geographic distribution and productivity of the vegetation community types 3b and 20b (fig 3.1, EMP)	by limiting construction to 10 ha of Reserve 34587 and rehabilitating the area	on advice of CALM.	similarity rating of rehab'd area consistent with vegetation community types 3b and 20b.
2. The Proponent will prepare and implement a dust control plan	before the start of construction	to minimise dust generation and impact on nearby land owners	by measures such as watering roads and monitoring wind direction	preparation of the plan on advice of DEP.	1000mg/m3 (EPA Dust Control Criteria)

Commitments should preferably be written in tabular format, preferably with some specification of ways in which the commitment can be measured, or how compliance can be demonstrated.

Draft commitments, whether in textual or tabular format, which are not in a format that can be audited will not be accepted by DEP assessment officers for public review documentation.

5.4 Public consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the environmental review. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the EPA process can be noted and referenced.

5.5 Other information

Additional detail and description of the proposal, if provided, should go in a separate section.

Attachment 1

The first page of the proponent's environmental review document must be the following invitation to make a submission, with the parts in square brackets amended to apply to each specific proposal. Its purpose is to explain what submissions are used for and to detail why and how to make a submission.

Invitation to make a submission

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

Tiwest Pty Ltd intends to mine mineral sands of Orebody 27200 (M268SA) and Orebody 28000 (ML70/1010 & M268SA) at Cooljarloo Mine, Dandaragan. In accordance with the *Environmental Protection Act 1986*, a PER has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 8 weeks from **[date]** closing on **[date]**.

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

Why write a submission?

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

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

Why not join a group?

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

Developing a submission

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

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

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

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different 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 may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: **[date]**

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention: Mr Ben von Perger

Attachment 2

Advertising the environmental review

The proponent is responsible for advertising the release and arranging the availability of the environmental review document in accordance with the following guidelines:

Format and content

The format and content of the advertisement should be approved by the DEP before appearing in the media. For joint State-Commonwealth assessments, the Commonwealth also has to approve the advertisement. The advertisement should be consistent with the attached example.

Note that the DEP officer's name should appear in the advertisement.

Size

The size of the advertisement should be two newspaper columns (about 10 cm) wide by about 14 cm long. Dimensions less than these would be difficult to read.

Location

The approved advertisement should, for CER's, appear in the news section of the main local newspaper and, for PER's and ERMP's, appear in the news section of the main daily paper's ("The West Australian") Saturday edition, and in the news section of the main local paper at the commencement of the public review period and again two weeks prior to the closure of the public review period.

Timing

Within the guidelines already given, it is the proponent's prerogative to set the time of release, although the DEP should be informed. The advertisement should not go out before the report is actually available, or the review period may need to be extended.

Example of the newspaper advertisement

SCM CHEMICALS LTD

Public Environmental Review

EXTENSION TO DALYELLUP RESIDUE DISPOSAL PROGRAM

(Public Review Period: **[date]** to **[date]**)

SCM Chemicals Ltd is planning to extend the company's existing residue disposal program at Dalyellup, south of Bunbury, from March 1992 to March 1993.

A Public Environmental Review (PER) has been prepared by the company to examine the environmental effects associated with the proposed development, in accordance with Western Australian Government procedures. The PER describes the proposal, examines the likely environmental effects and the proposed environmental management procedures.

SCM has prepared a project summary which is available free of charge from the company's office on Old Coast Road, Australind.

Copies of the PER may be purchased for $10 from:

SCM Chemicals Ltd
Old Coast Road
AUSTRALIND WA 6230
Telephone: (08) 9467 2356

Copies of the complete Public Environmental Review will be available for examination at:

- Environmental Protection Authority
  Library Information Centre
  8th Floor, Westralia Square
  141 St George's Terrace
  PERTH WA 6000
- Department of Environmental Protection
  South West Region Office
  61 Victoria Street
  BUNBURY WA 6231
- City of Bunbury public libraries
- Shire of Capel libraries
- Shire of Harvey library (Australind)
- Shire of Dardanup (Eaton)

Submissions on this proposal are invited by **[closing date]**. Please address your submission to:

Chairman
Environmental Protection Authority
8th Floor, Westralia Square
141 St George's Terrace
PERTH WA 6000
Attention: Mr Ben von Perger

If you have any questions on how to make a submission, please ring the project officer, Ben von Perger, on (08) 9222 8642.

APPENDIX B

STATEMENT OF ENVIRONMENTAL APPROVAL

MINISTER FOR ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

COOLJARLOO MINERAL SANDS PROJECT
(Excluding the Proposed Dry Processing Plant at Muchea)

TiO_2 CORPORATION NL

This proposal may be implemented subject to the following conditions:

1. The proponent shall adhere to the proposal (excluding the dry processing plant at Muchea) as assessed by the Environmental Protection Authority and shall fulfil the commitments made in the Environmental Review and Management Programme with the exception of those commitments relating to the proposed dry processing plant (copy of commitments attached).

2. Prior to commencement of mining, the proponent shall undertake a detailed dieback survey, to the satisfaction of the Environmental Protection Authority following advice from the Department of Conservation and Land Management, in the proposed mining areas, in order to identify any occurrences of Phytophthora spp. within these areas.

3. The proponent shall restrict mining and related activities to areas that are proven to be uninfected by Phytophthora pathogens as a result of the survey required in condition 2, until detailed dieback isolation and treatment programmes are developed to the satisfaction of the Environmental Protection Authority following advice from the Department of Conservation and Land Management.

4. The proponent shall fund research programmes with the objectives of developing:

   (i) an understanding of the epidemiology of Phytophthora spp. pathogens on northern sandplain vegetation types, and effective disease management and control strategies; and

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7th Floor, May Holman Centre,
32 ST. GEORGE'S TERRACE, PERTH, 6000, WESTERN AUSTRALIA

Phone (09) 325 4133
Facsimile (09) 325 1873

4. (cont'd)

(ii) cost-efficient methods of sterilization treatment of localised disease infections in the field and in industrial process water bodies where appropriate.

The results of the research programmes shall be forwarded to the Environmental Protection Authority and the Department of Conservation and Land Management.

5. The proponent shall not undertake productive mining activities in the area subject to the Environmental Protection Authority's 'Red Book' Recommendations for Badgingarra National Park (5.22) until:

(i) a review of the recommendations for this area has been carried out by the task force established for this purpose in accordance with Government initiatives relating to mining in national parks and nature conservation reserves;

(ii) implementation of the resulting recommendation has been fully approved by Government, and

(iii) access has been approved through either the revised recommendation or procedures outlined in the Government's policy for mining in national parks and nature conservation reserves.

6. Prior to the commencement of mining activities, the proponent shall develop and implement, to the satisfaction of the Water Authority of Western Australia, a groundwater and surface water monitoring programme, including regular reporting of monitoring results, with the objective of conserving and minimising impact on water resources.

7. Prior to the commencement of productive mining, the proponent shall prepare and implement an environmental management programme relating to all aspects of environmental monitoring and management requirements for mining operations described in the ERMP, to the satisfaction of the Department of Mines and the Environmental Protection Authority.

8. The proponent shall submit brief annual and comprehensive triennial reports to the Department of Mines (and hence to the Environmental Protection Authority) discussing various aspects of the Environmental Management Programme and monitoring of the project, including rehabilitation programmes and other aspects detailed in the Environmental Management Programme. The Environmental Protection Authority will advise the Department of Mines as to the acceptability of these reports and the programme performance.

9. Prior to an application for extension of mining activities beyond those described in the Environmental Review and Management Programme, the proponent shall refer the proposed extension to the Environmental Protection Authority for its assessment.

.../3

Procedures

The following procedures shall be followed with respect to the implementation of the above conditions.

Where the proponent is required to report on monitoring results, or to undertake action to the specification of the Department of Mines and the Environmental Protection Authority, the proponent need only provide advice to or seek approvals from the Department of Mines. That Department shall then refer the advice or request to the Environmental Protection Authority and shall ensure that its requirements are incorporated into approvals or requirements issued to the proponent by the Department of Mines.

Barry Hodge, MLA
MINISTER FOR ENVIRONMENT

- 3 OCT 1988

ENVIRONMENTAL MANAGEMENT COMMITMENTS
FOR THE PROPOSED COOLJARLOO MINERAL SANDS PROJECT
(EXCLUDING THE DRY PROCESSING PLANT)

TiO_2 Corporation NL will undertake the following commitments with respect to the Cooljarloo Mineral Sands Project:

1. TiO_2 Corporation NL is committed to achieve a very high standard of mine-site rehabilitation and in particular to:

   - carry out detailed soil profile analyses, and flora and vegetation studies in front of the mine path to provide site specific information for rehabilitation planning;

   - supplement rehabilitation measures by seeding and planting using local indigenous species;

   - consult closely with Government agencies and especially the Rehabilitation Section of the Department of Mines;

   - establish long-term monitoring studies to assess revegetation and recolonisation by fauna; and

   - encourage independent research programmes into rehabilitation methods.

2. TiO_2 Corporation NL will develop, in consultation with the Department of Conservation and Land Management and the Central West Coast Fire Protection Committee, a comprehensive fire management plan for the Cooljarloo tenements. This will have the objectives of providing protection to rehabilitation and of encouraging ecological diversity and vigour generally. A fully equipped fire truck and trained personnel will be maintained on site for this purpose.

3. A commitment is also made to maintain groundwater levels at Cooljarloo within naturally occurring seasonal levels so as to reduce risks of adverse impact on vegetation due to drawdown. Should monitoring detect indications of drawdown, the proponents will take action to restore groundwater levels. Surface hydrological features will also be maintained by the reconstruction of Mullering Brook after mining and by incorporating wet depressions in the rehabilitation in appropriate places.

4. Install water table monitoring bores at the Cooljarloo site. Results of drilling, tests and monitoring will be submitted to the EPA and Water Authority.

5. TiO_2 Corporation NL will assess changes in vegetation in the vicinity of the minesite with respect to variations in the water table.

6. As monazite is radioactive, strict adherence to all Western Australian regulations and the Commonwealth Code of Practice relating to radiation protection will be adopted as described in Section 7.4. This will include specifically:

   a comprehensive radiation level monitoring programme at the minesite and environs and of monazite transport units;

- comprehensive dust suppression measures; and

- specific precautions in the handling, storage and transport of monazite product.

7. TiO_2 Corporation NL is committed to a high level of environmental management and monitoring as an integral part of the Cooljarloo project. It intends to conduct its operations with the highest level of corporate social responsibility and is firmly committed to the principle that mining should involve a transient impact on the environment.

8. Liaise with the Department of Conservation and Land Management on matters relating to the prevention of dieback spread.

9. Conduct a survey of dieback infested areas occurring within the mining tenements.

10. Develop and implement, as part of a staff education programme, precautions to avoid the spread of dieback.

11. Commission a study to determine a cost effective mechanism of sterilising spots of dieback infection and apply the resulting procedures to treat dieback infections in the mining path and others which may affect the mining operation.

12. Material sources, especially sand and gravel sources, will be checked for dieback infection prior to any cartage to the Cooljarloo site. Infected sources will be rejected.

13. The Company will routinely monitor industrial waters for dieback infection and will develop a contingency plan in association with the Department of Conservation and Land Management to prevent the spread of dieback if there is an infection and to return the waters to a dieback free condition in line with their recommended solution.

14. TiO_2 Corporation NL will install an access road at Cooljarloo along which all vehicles entering the tenement on lawful business will be required to travel. This will have a dieback control facility through which all vehicles will be required to pass. Earthmoving equipment entering or re-entering the site will be subject to stringent cleaning for dieback control. TiO_2 cannot be responsible for non-company vehicles entering the tenement areas from other directions. But, in liaison with the Government, TiO_2 will discuss the possibility of closing off all other tracks which enter the tenement area.

15. A disease free nursery, using local sources of seed, will be established near Cooljarloo to provide plants for rehabilitation.

16. TiO_2 Corporation NL will be undertaking and promoting research into the propagation and establishment of those native species which grow on the tenement. TiO_2 Corporation NL will report its mining and rehabilitation plans, and the results of its rehabilitation research to the State Mining Engineer on an annual and triennial basis as requested.

17. TiO_2 Corporation NL recognises the operations areas which are subject to regulation under the Radiation Safety Act, and will abide by the requirements of the Act or any amendments made to that Act.

18. TiO_2 Corporation NL has undertaken to abide by the Commonwealth Code of Practice. Referring to the Radiation Safety Officer, that Code requires that person to have "qualifications and experience acceptable to the appropriate authority". (Clause 9(19))

19. Wastes containing radioactive residues will be disposed of to standards approved by the appropriate authority.

20. Recognising that the inhalation of radioactivity as airborne dust presents the most severe operating restriction in terms of occupational and public health considerations, TiO_2 Corporation NL to maintain compliance with statutory requirements will wash concentrates free of dust material prior to transport.

APPENDIX C

LIST OF DECLARED RARE FLORA AND PRIORITY SPECIES

(nb. A complete list of native vegetation species has been compiled from numerous botanist reports and is held by Tiwest)

List of Declared Rare Flora and Priority Flora on M268SA and ML 70/1010

Species	Conservation Status	Total Number of Plants
Andersonia gracilis	DRF	222
Anigozanthos viridis ssp. terraspectans	DRF	10
Calytrix drummondii	Priority 2	62
Tricoryne robusta	Priority 2	1
Lasiopetalum lineare	Priority 3	4
Dryandra tortifolia	Priority 3	> 206*
Hakea spathulata	Priority 3	43
Beaufortia bicolor	Priority 3	10
Leucopogon oliganthus	Priority 3	200
Jacksonia carduaceae	Priority 3	200
Darwinia sanguinea	Priority 4	6
Eucalyptus macrocarpa ssp. Elechantha	Priority 4	65
Grevillea saccata	Priority 4	68
Boronia tenuis	Priority 4	5
Conostephium minus	Priority 4	> 1060

* - Vegetation mapping in ML 70/1010 has identified further populations of *Conostephium minus* and *Dryandra tortifolia* however numbers were simply defined as "common".

APPENDIX D

LIST OF VERTEBRATE SPECIES

SPECIES		Recorded south of Cooljarloo Road
AMPHIBIA		
MYOBATRACHIDAE OR LEPTODACTILYDAE (GROUND FROGS)		
	Crinia pseudinsignifera	
Spotted Burrowing Frog	*Heleioporus albopunctatus*	
Moaning Frog	*Heleioporus eyrei*	✓
Bonk Frog or Pobblebonk	*Limnodynastes dorsalis*	✓
Turtle Frog	*Myobatrachus gouldii*	✓
Humming Frog	*Neobatrachus pelobatoides*	
	Pseudophryne guentheri	✓
Hylidae (Tree Frogs)		
Slender Tree Frog	*Litoria adelaidensis*	
Motor Bike Frog	*Litoria moorei*	
FISH		
Native minnow	*Galaxis occidentalis*	
REPTILES		
Long-necked Tortoise	*Chelodina oblonga*	
Pygopodidae (Legless Lizards)		
	Aprasia repens	
	Aclys concinna	
Fraser's Legless Lizard	*Delma fraseri*	
	Delma grayii	
Burton's Legless Lizard	*Lialis burtonis*	
	Pletholax gracilis	
Common Scaleyfoot	*Pygopus lepidopodus*	
Gekkonidae (Geckoes)		
	Diplodactylus alboguttatus	
Spiny-tailed Gecko	*Diplodactylus spinigerus*	
Marbled Gecko	*Phyllodactylus marmoratus*	
Agamidae (Dragon Lizards)		
Bearded Dragon	*Pogona minor*	✓
Sandhill or Heath Dragon	*Tympanocryptis adelaidensis*	
Varanidae (Goannas or Monitor Lizards)		
Goulds Sand Goanna	*Varanus gouldii*	
Scincidae (Skink Lizards)		
	Ctenotus gemmula	
	Ctenotus fallens	
	Ctenotus impar	
	Ctenotus leseurii	
	Ctenotus pantherinus	
Fence Skink	*Cryptoblepharus plagiocephalus*	✓

SPECIES		Recorded south of Cooljarloo Road
REPTILES (ctd)		
Salmon-bellied Skink	*Egernia napoleonis*	
Bull-headed Skink	*Egernia multiscutata bos*	
	Lerista elegans	
	Lerista praepedita	
Dwarf Skink	*Menetia greyii*	
	Morethia lineocellata	
	Morethia obscura	✓
Western Bluetongue	*Tiliqua occipitalis*	
Bobtail	*Tiliqua rugosa*	✓
Typhlopidae (Blind Snakes)		
	Ramphotyphlops australis	
Boidae (Pythons)		
Carpet Python	*Morelia spilota*	
Elapidae (Front-fanged Snakes)		
Yellow-faced Whip Snake	*Demansia reticulata*	✓
Bardick	*Notechis curtis*	✓
Mulga Snake	*Pseudechis australis*	
Gwarder	*Pseudonaja nuchalis*	
Gould's Whip Snake	*Rhinoplocephalus gouldii*	
Black-naped Snake	*Vermicella bimaculata*	
Black-striped Snake	*Vermicella calonatus*	
	Vermicella fasciolata	
BIRDS		
Casuaridae (Cassowaries and Emus)		
Emu	*Dromaius novaehollandiae*	✓
Phasianidae (Quails and Pheasants)		
Stubble Quail	*Coturnix novaezealandiae*	
Anatidae (Ducks and Swans)		
Australian Shelduck	*Tadorna tadornoides*	
Maned Duck *	*Chenonetta jubata*	
Pacific Black Duck	*Anus superciliosus*	
Australasian Shoveler	*Anas rhynchotis*	
Grey Teal	*Anas gibberifrons*	
Chestnut Teal	*Anas castanea*	
Ardeidae (Herons)		
White-faced Heron *	*Egretta novaehollandiae*	
Nankeen Night Heron	*Nyticorax caledonicus*	
Threskiornithidae (Ibis and Spoonbills)		
Straw-necked Ibis	*Threskiornis spinicollis*	✓
Yellow-billed Spoonbill	*Platalea flavipes*	
Accipitridae (Kites and Eagles)		
Black-shouldered Kite	*Elanus notatus*	✓
Square-tailed Kite	*Lophoictinia isura*	
Whistling Kite	*Haliaster sphenurus*	

SPECIES		Recorded south of Cooljarloo Road
BIRDS (ctd)		
Collared Sparrowhawk	*Accipiter cirrhocephalus*	✓
Wedge-tailed Eagle	*Aquila audax*	✓
Little Eagle	*Hieraaetus morphnoides*	
Falconidae (Falcons)		
Brown Falcon	*Falco berigora*	✓
Nankeen Kestrel	*Falco cenchroides*	✓
Peregrine Falcon	*Falco peregrinus*	
Otididae (Bustards)		
Australian Bustard	*Ardeotis australis*	
Turnicidae (Button-quails)		
Painted Button-quail	*Turnix varia*	
Little Button-quail	*Turnix velox*	
Recurvirostridae (Stilts and Avocets)		
Black-winged Stilt	*Himantopus himantopus*	
Charadriidae (Plovers and Lapwings)		
Banded Lapwing	*Vanellus tricolor*	
Black-fronted Dotterel *	*Chaladrius melanops*	
Red-capped Plover	*Charadrius ruficapillus*	
Columbidae (Pigeons and Doves)		
Crested Pigeon	*Ocyphaps lophotes*	✓
Common Bronzewing	*Phaps chalcoptera*	✓
Laughing Turtle-Dove[int]	*Streptopelia senegalensis*	
Cacatuidae (Cockatoos)		
Galah	*Cacatua rosiecapilla*	✓
Western Corella	*Cacatua pastinator*	✓
Short-billed Black-Cockatoo	*Calyptorhynchus latirostris*	✓
Psittacidae (Parrots)		
Regent Parrot	*Polytelis anthropelus*	
Australian Ring-neck	*Barnardius zonarius*	
Elegant Parrot	*Neophema elegans*	
Cuculidae (Cuckoos)		
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	
Pallid Cuckoo	*Cuculus pallidus*	✓
Horsfields Bronze-Cuckoo	*Crysococcyx basalis*	✓
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	
Strigidae (Hawk-Owls)		
Southern Boobook Owl	*Ninox novaseelandiae*	
Podargidae (Frogmouths)		
Tawny Frogmouth	*Podargus strigoides*	
Caprimulgidae (Nightjars)		
Spotted Nightjar	*Eurostopodus argus*	
Halcyonidae (Forest Kingfishers)		
Laughing Kookaburra[int]	*Dacelo novaguineae*	

SPECIES		Recorded south of Cooljarloo Road
BIRDS (ctd)		
Sacred Kingfisher	*Todiramphus sanctus*	
Meropidae (Bee-eaters)		
Rainbow Bee-eater	*Merops ornatus*	
Maluridae (Fairy-wrens and Allies)		
Splendid Fairy-wren	*Malurus splendens*	✓
White-winged Fairy-wren	*Malurus leucopterus*	✓
Variegated Fairy-wren	*Malurus lamberti*	✓
Pardalotidae (Pardolotes, Gerygones and Thornbills)		
Striated Pardalote	*Pardolotus striatus*	
White-browed Scrubwren	*Sericornis frontalis*	
Striated Feildwren	*Calamanthus fuliginosus*	
Western Gerygone	*Gerygone fusca*	✓
Western Thornbill	*Acanthiza inornata*	✓
Inland Thornbill	*Acanthiza apicalis*	✓
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	✓
Meliphagidae (Honeyeaters and Chats)		
Little Wattlebird	*Anthochaera crysoptera*	✓
Red Wattlebird	*Anthochaera carunculata*	✓
Yellow-throated Miner	*Manorina flavigula*	
Singing Honeyeater	*Lichenostomus virescens*	✓
Brown-headed Honeyeater	*Melithreptus brevirostris*	✓
Brown Honeyeater	*Lichmera indistincta*	✓
White-cheeked Honeyeater	*Phylidonyris nigra*	✓
Tawny-crowned Honeyeater	*Phylidonyris melanops*	✓
Western Spinebill	*Acanthorynchus superciliosus*	✓
Black Honeyeater	*Certhionyx niger*	
White-fronted Chat	*Epthianura albifrons*	
Petroicidae (Australian Robins)		
Red-capped Robin	*Petroica goodenovii*	
Scarlet Robin *	*Petroica multicolor*	✓
Hooded Robin	*Melanodryas cucullata*	
White-breasted Robin	*Eopsaltria georgina*	
Neosittidae (Sittellas)		
Varied Sittella	*Daphoenositta chrysoptera*	✓
Pachycephalidae (Whistlers and Allies)		
Rufous Whistler	*Pachycephela rufiventris*	✓
Grey Shrike-thrush	*Colluricincla harmonica*	✓
Crested Bellbird	*Oreoica gutturalis*	✓
Dicruridae (Flycatchers, Fantails and Allies)		
Magpie-lark	*Grallina cyanoleuca*	✓

SPECIES		Recorded south of Cooljarloo Road
BIRDS (ctd)		
Grey Fantail	*Rhipidura fuliginosa*	✓
Willie Wagtail	*Rhipidura leucophrys*	✓
Campephagidae (Cuckoo-shrikes)		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	✓
White-winged Triller	*Lalage suerii*	✓
Artamidae (Woodswallows and Allies)		
Masked Woodswallow	***Artamus personatus***	
Black-faced Woodswallow	*Artamus cinereus*	✓
Grey Butcherbird	*Cracticus torquatus*	✓
Pied Butcherbird	*Cracticus nigrogularis*	
Australian Magpie	*Gymnorhina tibicen*	✓
Corvidae (Ravens and Crows)		
Australian Raven	*Corvus coronoides*	✓
Motacillidae (Pipits and True Wagtails)		
Richards Pipit	*Anthus novaseelandiae*	✓
Passeridae (Finches and Sparrows)		
Zebra Finch *	*Poephila guttata*	
Dicaeidae (mistletoebirds)		
Mistletoebird	*Dicaeum hirundinaceum*	✓
Hirundinidae (Swallows and Martins)		
White-backed Swallow	*Cheramoeca leucosternum*	
Welcome Swallow	*Hirundo neoxena*	
Tree Martin	*Hirundo nigricans*	
Sylviidae (Old World Warblers)		
Brown Songlark	*Cincloramphus cruralis*	
Rufous Songlark	*Cinloramphus mathewsi*	
ZOSTEROPIDAE (SILVEREYES)		
Silvereye	*Zosterops lateralis*	✓
MAMMALS		
Tachyglossidae (Echidnas)		
Echidna	*Tachyglossus aculeatus*	✓
Dasyuridae (Dunnarts and Allies)		
White-bellied Dunnart	*Sminthopsis dolichura*	
Coastal Dunnart	*Sminthopsis griseoventer*	✓
White-tailed Dunnart	*Sminthopsis granulipes*	
Tarsipedoidae (Honey Possums)		
Honey Possums	*Tarsipes rostratus*	✓
Macropodidae (Kangaroos and Wallabies)		
Western Grey Kangaroo	*Macropus fuliginosus*	✓
Brush or Black-gloved Wallaby	*Macropus irma*	✓
Mollosidae (Mastiff-Bats)		
White-striped Mastiff Bat	*Tadarida australis*	

SPECIES		Recorded south of Cooljarloo Road
MAMMALS (ctd)		
Vespertilionidae (Vesper Bats)		
Greater Long-eared Bat	*Nyctophilyus major (unconfirmed)*	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	
Gould's Wattled Bat	*Chalinolobus gouldii*	
King Rive Eptesicus	*Eptesicus regulus*	
Muridae (Rats of Mice)		
Noodji or Ashy-Grey Mouse	*Pseudomys albocinereus*	
House Mouse[int]	*Mus musculus*	✓
Moodit or Southern Bush Rat	*Rattus fuscipes*	
Leporidae (Rabbits and Hares)		
Rabbit[int]	*Oryctolagus cuniculus*	✓
Canidae (Dogs and Foxes)		
Red Fox[int]	*Vulpes vulpes*	✓
Felidae (cats)		
Feral Cat[int]	*Felis catus*	✓

APPENDIX E

COOLJARLOO ENVIRONMENTAL POLICY

TIWEST PTY LTD
COOLJARLOO MINE

Environmental Policy

All Tiwest employees at Cooljarloo, the Joint Venture Participants, its customers, suppliers and the communities in which Tiwest operates have a right to expect excellence in environmental performance at Tiwest Cooljarloo.

Tiwest at Cooljarloo is committed to fulfilling all relevant statutory environmental obligations and will manage the technical, administrative and human factors to ensure that these standards are met.

Environmental management of the Cooljarloo minesite is achieved by ensuring the integration and regular review of production planning and environmental systems and is documented in Tiwest Cooljarloo's Environmental Management Programme (EMP).

Tiwest at Cooljarloo is committed to preventing pollution, to continually improving its environmental performance and to openly communicating environmental performance to all stakeholders.

S J MERRICK
General Manager, Cooljarloo
4 January 1999

Review Date: 31 December 1999

APPENDIX F

COOLJARLOO ENVIRONMENTAL MANAGEMENT PROGRAMME

SUMMARY OF OBJECTIVES

OBJECTIVES

1.0 METEOROLOGY

- Collect and analyse meteorological data for use in mine and rehabilitation programming.

2.0 VEGETATION

- Provide comparative standards for the assessment of species richness, density and total cover of rehabilitated areas.
- Provide baseline data on vegetation to assess any impact from mining operations.
- Ensure rare and endangered or priority species are not adversely impacted by mining operations.
- Monitor the impacts, if any, of mining operations on vegetation in areas adjacent to operations.
- Develop the site herbarium.
- Improve knowledge of biological aspects of seeds and plants to enhance rehabilitation.

3.0 FAUNA

- Improve the understanding and knowledge of fauna and their migratory behaviour.
- Identify the presence of threatened species.
- Obtain knowledge on the habitat requirements for native species.
- Obtain knowledge on the effect of fire on fauna and their habitats.
- Successfully recolonise fauna in rehabilitated areas.

4.0 PHYTOPHTHORA DISEASE

- To prevent introduction of *P. cinnamomi* to the Cooljarloo lease.
- To minimise the spread of *Phytophthora* species occurring on the Cooljarloo lease.
- To develop and enhance techniques to control the disease.

5.0 HYDROLOGY

- To quantify the impact of mining operations on groundwater levels and groundwater quality.
- To provide information for the management of impacts, if any.
- To characterise the hydrological regime of Mullering Brook and to assess any impacts on flow caused by mining operations.

6.0 RADIATION ISSUES

- To comply with the *Mines Safety and Inspection Act 1994* and Regulations 1995.
- To obtain relevant data to ensure that there is no development of radiation issues which could affect the public or the workplace.

7.0 REHABILITATION

Rehabilitation is achieved through the consistent achievement of underlying objectives.

7.1 - Ground Disturbance

- Minimise the area of land disturbed by mining;
- Optimise rehabilitation of open, non-active areas.

7.2 - Planning

- Approval of detailed plans by the General Manager prior to commencement of rehabilitation.
- Strict adherence to the approved plans.

7.3 - Final Landform

- A final landform that is stable and blends into the surrounding landscape.

7.4 - Topsoil

- Maximise the viability and utilisation of the topsoil resource in rehabilitation through appropriate, and timely, stripping and deposition methods.
- Maximise the direct placement of topsoil over areas prepared for rehabilitation.

7.5 - Mulching

- To maximise the quantity of mulch which is recovered from native vegetation directly in the mine path.
- To utilise mulch selectively to meet specific landform/profile requirements.
- To minimise the need for stockpiling mulch.

7.6 - Seeding

- Establish diverse self-sustaining native vegetation communities on vacant Crown Land.
- Establish pasture species on Mullering Farm.

8.0 DUST

- Provide checks on dust emissions from mining operations.
- Maintain housekeeping and dust suppression to minimise dust levels.

9.0 NOISE

- To ensure noise from mining operations does not affect the public and neighbouring premises.
- To obtain baseline and current noise levels for the Minesite.

10.0 ABORIGINAL SITES

- To meet the commitment of Tiwest to protect Aboriginal sites of significance.
- To comply with the *Aboriginal Heritage Act 1972.*

11.0 FIRE MANAGEMENT

- Minimise the risk of wildfire occurrence on the mining lease.
- Minimise the severity and extent of the fires that do occur.

12.0 TRANSPORT

- To transport ore from the mine and waste to the mine in a safe and environmentally sound manner.

13.0 WASTE MANAGEMENT

13.1 - Disposal of Wastes from Chandala and Kwinana

- To safely dispose of processing wastes at a stable and secure location

13.2 - Oily and Domestic Waste Disposal

- To ensure that waste produced in mining operations and support activities does not adversely impact on the environment.

- Off-site disposal of wastes is environmentally sound and in accordance with relevant regulations.

14.0 WEED CONTROL

- To control any outbreaks of nuisance weeds on Mullering Farm.

- To minimise the risk of weed introduction to vacant Crown Land

15.0 STAKEHOLDER LIAISON

- To openly report environmental performance to all stakeholders.

- To respond to all concerns, enquiries, and complaints received from the community.

16.0 EDUCATION AND TRAINING

- To ensure employees and contractors are able to understand and meet individual environmental responsibilities and can contribute to corporate environmental performance.