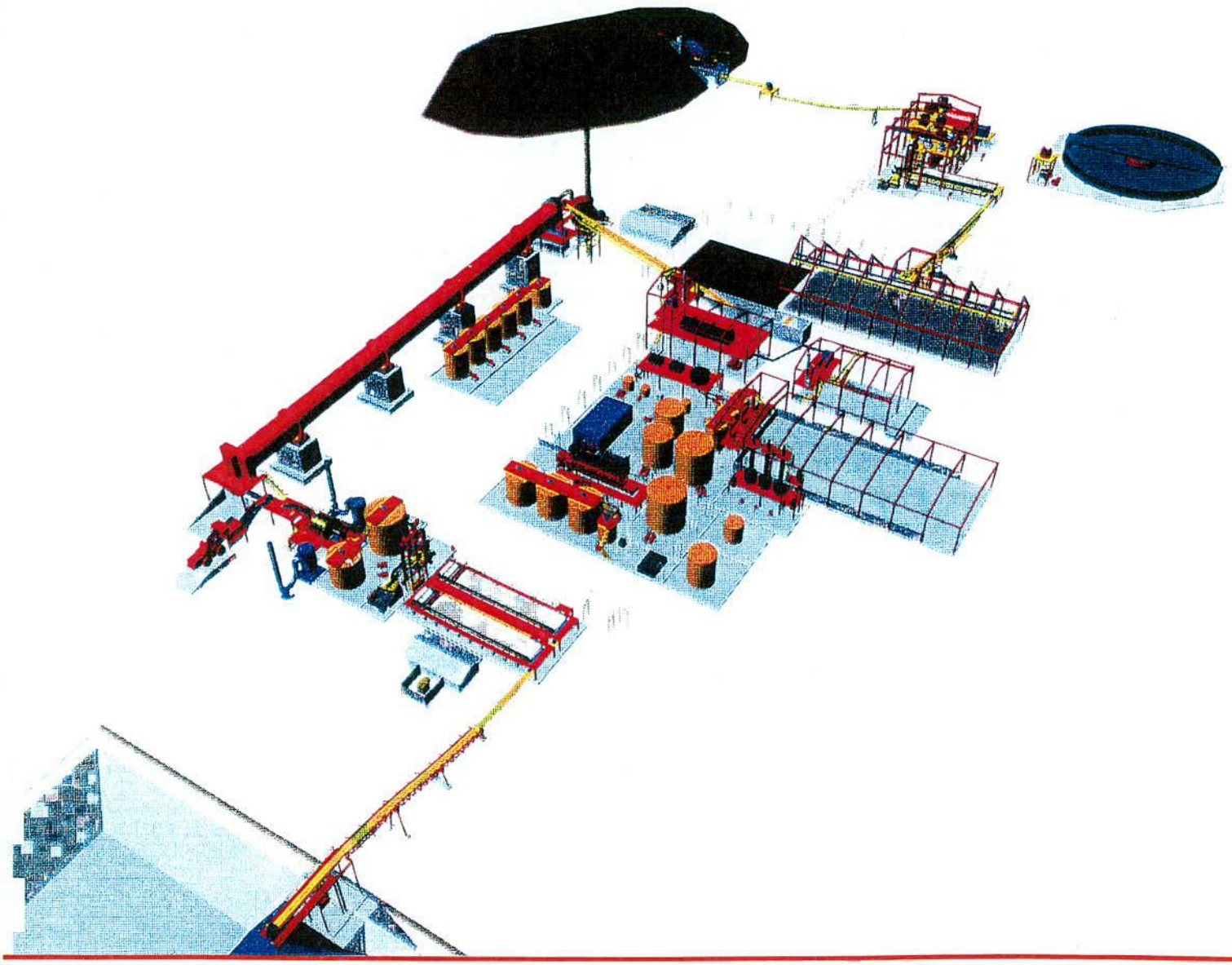
PRECIOUS METALS AUSTRALIA

THE WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT, APPLICATION FOR AMENDMENT TO ENVIRONMENTAL APPROVAL, SECTION 46 OF THE ENVIRONMENTAL PROTECTION ACT 1986



ALAN TINGAY & ASSOCIATES

FEBRUARY 1998

PRECIOUS METALS AUSTRALIA

WAGOO HILLS VANADIUM PROJECT, PROJECT CHANGES, SECTION 46 ENVIRONMENTAL REVIEW DOCUMENT

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FEBRUARY 1998

REPORT NO: 98/03

AN INVITATION TO COMMENT ON THIS ENVIRONMENTAL REVIEW DOCUMENT

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

Precious Metals Australia proposes to construct and operate a vanadium ore open pit mining and processing operation, at Windimurra station, approximately 80km south-east of Mt Magnet. In accordance with Section 46 of the Environmental Protection Act, 1986 an environmental review document has been prepared which describes this proposal and its likely effects on the environment. The document is available for a public review period of two weeks from February 23, 1998 to March 9, 1998.

The EPA gave environmental approval to a similar proposal in 1992 and this Environmental Review describes minor changes and enhancements to the original proposal.

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, or comment on, the general issues discussed in the document 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 significant.

When making you comments on specific elements of the document,

- 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 to each point to the appropriate section, chapter or recommendation in the document.
- 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 any factual information you may wish to provide and give any 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 the submission is: March 9, 1998.

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000

Attention: Murray Hogarth.

TABLE A1

WAGOO HILLS VANADIUM PROJECT
SUMMARY OF ENVIRONMENTAL FACTORS

RELEVANT FACTOR	SITE SPECIFIC FACTOR	EPA OBJECTIVE	EXISTING ENVIRONMENT	POTENTIAL IMPACT	MANAGEMENT	PREDICTED OUTCOMES
Biophysical:						
Groundwater	-	Maintain the quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Three aquifers, from 3 to 8m, 57 to 76m, and at 87m. Salinity ranges from 2000-2500mg/L in the upper aquifer, to 14000mg/L in the lower.	Preliminary investigation indicate that groundwater extraction from the proposed borefield will cause a drawdown effect of the local water table of 5 to 10 m. A detailed investigation of groundwater supply is currently being undertaken.	Prepare a Water Management Plan and monitoring programme. Provision for water supply for stock and domestic water supply in the event of water resource being affected by project.	Water resource will be maintained by proposed management practices.
Pollution Management:						
Dust/Fumes	Vanadium dust/fumes	Ensure that the dust/fume levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements (including Section 51 of the Environmental Protection Act, 1986) and acceptable standards.	Mine-site and plant area consists of sparsely vegetated semi arid area. Significant potential for high background dust levels in strong winds.	Given the remote nature of the site (nearest residence > 4 km away) there should be minimal impact. Vanadium bearing dust will be closely controlled to prevent off-site impacts.	Best practice dust and fume management will be adopted in accordance with DME recommendations . The measures will be fully described in the air emissions section of the EMP prior to works approval being finalised.	Vanadium dust and particulate levels will be controlled to meet occupational health standards of 0.05mg/m^3 of respirable dust per eight hour day on- site and the requirements of the DEP off-site.
Particulates/ 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.	The existing site is a remote virtually un-populated semi-arid area. The air environment is virtually unaffected by development.	The distance of the mine-site from the nearest residence and the workers accommodation should mitigate against any adverse impacts on amenity.	Dust suppression techniques will be employed as described in the 1992 PER, including water sprays on stockpiles and roads, plant dust control measuring and rehabilitation of disturbed areas.	Dust suppression and management practices from guidelines will ensure statutory requirements. EPA objectives are met both on-site and off-site.
Gases	SO_2, NO_x, CO and ammonia.	Ensure that gaseous emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act, 1986 (all reasonable and practicable measures are taken to minimise discharge).	Presently no sources of atmospheric emissions other than minor contributions from stock grazing and transport.	The distance of the plant from the station and accommodation minimises the likelihood of unacceptable impacts on health. SO_2, NO_2 and ammonia are irritant gases which can affect health and damage vegetation if concentrations exceed standards.	Preparation of an atmospheric modelling programme of principal atmospheric contaminants, and monitoring programme to the satisfaction of the DEP. Use of best available technology to minimise emissions. Low sulfur content coal to be used to minimise SO_2 emissions.	Acceptable standards and requirements of Section 51 of the Environmental Protection Act, 1986 met.
Greenhouse Gases	-	Ensure that greenhouse gas emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act, 1986 (all reasonable and practicable measures are taken to minimise greenhouse gas discharge).	Presently no greenhouse gas emissions.	Greenhouse gas emissions such as CO_2 will be produced as a result of fuel usage at the Process Plant.	Process Plant incorporates efficient design features to minimise greenhouse gas emissions. Greenhouse Gas EMP to be prepared.	The CO_2 emissions when using natural gas as the fuel source have been estimated at 91 875 TPA and the CO_2 emissions using a combination of diesel, butane and coal have been estimated at 148 394 TPA. Other greenhouse emissions will be negligible.
Groundwater Quality	-	Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993), and the NHMRC/ARMCANZ Australian Drinking Water Guidelines - National Water Quality Management Strategy.	A groundwater exploratory hole intersected three aquifers, contained in calcrete, palaeochannel alluvial sediments and bedrock with salinities of 2500mg/L, 8850mg/L and 14000mg/L respectively.	Leachable sodium salts from calcine tailings will be managed via a lined calcine tailings dump and drainage extraction system, for recycling of liquor into the production process. Groundwater extraction has the potential to affect groundwater levels. The hydrocarbon and chemical storage areas may also have a potential impact on groundwater. Other potential impacts to be investigated via a Water Management Plan.	A Water Management Plan and monitoring programme will be prepared prior to works approval. The borefield will be designed and managed to minimise drawdown effects. Provision for water supply for stock and domestic water supply in the event of water resource being affected by project.	No significant impact on groundwater quality.
Groundwater Quality	Solid Waste	Wastes should be contained and isolated from groundwater and surface surround.	As above.	Groundwater quality is unlikely to be affected by the proposal due to the use of a lined tailing dump for calcine tailing (containing leachable sodium). There will be a domestic waste land-fill on site which will require management to minimise the affect on the groundwater.	Design and installation of a lined tailings dump for the extraction of leachable sodium salts from calcine tailings. Landfill will meet DEP/WMD requirements.	No significant impact on groundwater quality.
Social Surroundings:						
Public Health and Safety	Risk and Hazard	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.	Population density in the vicinity of the mine-site is extremely low. The nearest residence (Windimurra Station) is located 4 km south-east of the process plant, and the next residence is located approximately 20 km from the proposed plant.	As a result of the nature of the process no significant impacts are predicted.	Undertake a qualitative risk assessment of public health and safety to ensure compliance with the DEP's individual risk criteria and DME criteria prior to commissioning. In addition, the proponent will establish a contingency plan for all hazardous reagents and products in the event of an accident resulting in spillage of any hazardous material.	Requirements of EPA and DME achieved via development and implementation of appropriate contingency plan and risk assessment.
Public Health and Safety	Road Traffic	Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.	The major transport routes from the Port of Geraldton to Mount Magnet, and to Fremantle Port are sealed highways and are the principal existing haulage routes for mining/heavy haulage vehicles. Access between Mount Magnet and mine-site via unsealed road.	Unsealed access road between Mount Magnet and mine-site may require periodical maintenance/grading.	Transportation EMP to be undertaken prior to commissioning. All relevant coded and standards for transport of dangerous goods to be met.	Road traffic management achieves adequate level of service and safety and achieves Main Roads Western Australia requirements.

TABLE A2

Note:
1. Commitments in italics are new or altered

WAGOO HILLS VANADIUM PROJECT
SUMMARY OF COMMITMENTS

COMMITMENT	OBJECTIVE	ACTION	TIMING	TO WHOSE REQUIREMENT	MEASUREMENT/COMPLIANCE CRITERIA
1. Vegetation Clearing 1-1) Minimise clearing of land consistent with safe and efficient operations.	Minimise the disturbance and clearing of vegetation.	Ensure site activities are carried out in such a way as to minimise the disturbance to vegetation.	Construction and commissioning phase.	The Proponent	Project documentation by site manager.
2. Weeds 2-1) Develop a management strategy to minimise the spread of Saffron Thistle. This strategy will be developed in consultation with the Department of Agriculture.	Minimise the spread of the Saffron Thistle.	Prepare management strategy in consultation with Agriculture WA.	Works Approval	DEP	Submission of Management Strategy.
3. Fire 3-1) Maintain strict fire control procedures.	Prevent fire and implement management procedures.	Prepare and implement fire control and management procedures.	All phases of project.	The Proponent	Implementation of fire control measures.
4. Rehabilitation 4-1) Design and rehabilitate all waste dumps in consultation with the Department of Minerals and Energy and in accordance with the "Guidelines for Waste Dump Design and Rehabilitation" of that Department. 4-2) Rehabilitate the surrounds of the vanadium mine site and the process plant and village areas at the Windimurra following decommissioning of the project. 4-3) Prepare specific proposals for site decommissioning in the event of termination of the project and implement those proposals after review and approval of the relevant Government Agencies at the time.	To rehabilitate disturbed areas and to prepare and implement a decommissioning plan.	Prepare a Decommissioning Management Plan. This plan shall address: 1. removal or, if appropriate, disposal on-site of plant and infrastructure; 2. rehabilitation of all disturbed areas to agreed final land use(s); and 3. identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.	Commissioning phase.	DEP	Preparation of Decommissioning Management Plan.
5. Groundwater 5-1) Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water and Rivers Commission. 5-2) Undertake to guarantee continuity of stock water if changes in groundwater levels, caused by the Project, adversely affect pastoral activities. 5-3) Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water. 5-4) Design the tailings dams in consultation with the Department of Minerals and Energy and in accordance with the "Guidelines for the Preparation of the New Tailings Dams" of that Department. 5-5) Implement measures in the process plant to conserve water. *5.6) The proponent will prior to commencing construction develop a water management p to the satisfaction of the EPA on advice from the Water and Rivers Commission which demonstrates that the borefield will operate in a sustainable manner.* *5.7) The proponent will manage calcined tailings by utilising a lined* *5.8) tailings dump fitted with a drainage extraction for the return of leachate to the process, in addition to management practices such as continual wetting to avoid dust production, and rehabilitation.*	To ensure groundwater supplies remain available to the Pastoral Lessee and to assess the quality of groundwater.	Prepare and undertake water quality and quality monitoring programme. Design tailings dam in accordance with applicable guidelines. Implement water conservation measures.	Works Approval	DEP	Submission of water quality monitoring Programme to the of the Water and Rivers Commission.
6. Surface Water 6-1) Prepare drainage management plans for the vanadium mine and process plant at Windimurra in consultation with the Department of Minerals and Energy.	To ensure surface water drainage is managed to protect the environment.	Prepare drainage management plans for the vanadium mine and process plant.	Works Approval	DEP	Submission of Drainage Management Plan.
7. Dust 7-1) Ensure that vanadium dust is controlled to below limits established in the Mines Regulations Act 1946 and Regulations, by incorporating dust extraction and collection equipment in the process plant. 7-2) Develop an effective operator training and awareness program to ensure that the process plant is well operated and any potential occupational health problems are quickly identified and are rectified immediately. *7.3) An EMP will be prepared prior to construction commencing which provides detailed design information on dust control systems. The will be prepared to the satisfaction of the EPA on the advice of the Pollution Prevention Division. Other design features or management techniques which*	To maintain the amenity of nearest Pastoral Lessee and fulfil occupational health and safety requirements for workers.	Prepare and implement an Environmental Management Plan for control and management of dust. Plant and mine site sources of dust will be controlled using best practice management techniques.	Works Approval	DEP.	Submission and implementation of Dust EMP. Compliance with appropriate criteria and regulations.

minimise the possibility of airborne vanadium dust or fume are: *7.4) All process areas are sealed with impermeable floors and bunded.* *7-5) The calcined tailings dump is continuously wetted to prevent wind blown dust.* *7-6) PMA will develop a Spill Management Plan which requires immediate clean-up of spills with any contaminated materials or soils being recycled through the process.* *In order to protect the health of employees a comprehensive health and safety plan will be developed for the site which will address the following issues:* *7-7) Frequent occupational monitoring of airborne vanadium levels within works areas.* *7-8) Regular personal air sampling of employees working in areas with potential exposur vanadium.* *7-9) Regular health assessment and urine tests for employees.* *7-10) Provision of, and training in the correct use of personal protective equipment.* *7-11) A comprehensive training program in the hazards associated with vanadium for all employees.* *7-12) Strict segregation of mess and meal break areas from process areas with clear procedures to ensure that contaminated protective clothing cannot enter mess areas.*					
8. Emissions 8-1) Submit final designs details of exhaust stacks and exhaust cleaning devices prior to construction for approval by the EPA as part of the Environmental Management Programme. 8-2) Submit a detailed composition of the coal to the EPA and Department of Minerals and Energy to assist in designed management plans. *8-3) Undertake modelling of principal atmospheric contaminants prior to plant construction.* *8-4) Implement atmospheric monitoring programme.* *8-5) Prepare a Greenhouse Gas management plan.*	To ensure that all gaseous emissions and ground level concentrations are within established criteria, via modelling and monitoring studies.	Prepare Greenhouse Management Plan. Undertake a modelling study of the principal atmospheric emissions, and an atmospheric monitoring programme.	Works Approval	DEP	Compliance with appropriate criteria.
9. Transport/Packaging/Storage 9-1) Develop a transportation management and contingency plan to ensure that the transportation of hazardous materials is undertaken safely. A driver training program will be incorporated into the plan and will include regular review of driver awareness. Similarly, the integrity of transportation equipment will be monitored on a regular basis. The transportation management and contingency plan will be developed in consultation with the Explosives and Dangerous Goods Division of the Department of Minerals and Energy and the Western Australian Hazardous Materials Emergency Management Scheme (WAHMEMS). 9-2) Submit a final design of the storage facility for the sodium salt reagent at Windimurra to the Department of Minerals and Energy and the EPA for approval as part of the Environmental Management Program prior to the construction of the process plant. 9-3) Ensure that all handling, packaging and road transport of inputs to the process plant and products from that plant comply with the requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail and the Dangerous Goods (Road Transport) Regulations 1983 and amended Regulations 1988. *9-4) Undertake maintenance of the unsealed access road to the plant site on an as needs basis, such as periodical road grading.*	To ensure hazardous materials are handled and transported safely and that contingency measures are in place in the event of a spill.	Prepare a transport management plan and contingency plan, including driver training programme.	Works Approval.	DEP & DME	Submission of transport management plan and contingency. Compliance with applicable guidelines and regulations.
10. Workforce 10-1) Prohibit domestic pets in the project area as a condition of employment. 10-2) Restrict off-road driving and prohibit hunting by employees as a condition of employment.	To avoid disturbance of local wildlife.	Implementation of restrictions on off-road vehicles in the vicinity of the mine-site.	During all phases of the project.	The Proponent	Compliance with employment conditions.

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5. Ore Processing Methodology.

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APPENDICES

1. Ministerial Conditions (dated 16 September 1992).

2. Consolidated Proponent Commitments (EPA Bulletin 878, January 1998).

3. EPA Guidelines.

4. Recommended practices for the control of Vanadium dust, Department of Minerals and Energy.

5. Climatic and Wind Rose Data, Mt Magnet.

6. List of Potential Vertebrate Fauna at Windimurra.

1. INTRODUCTION

1.1 Background

In 1991, Precious Metals Australia (PMA) referred to the Environmental Protection Authority (EPA) a proposal to develop a vanadium mine and process plant at Wagoo Hills, approximately 80 km south-east of Mt Magnet and an associated coal quarry at Mingenew. The EPA determined that these proposals should be formally assessed and PMA subsequently prepared a Public Environmental Review (PER) which described the environmental issues associated with the mine, process plant, and proposed coal quarry (Alan Tingay & Associates and PMA, 1992). The PER was released for public review in January 1992.

Following the public review period, the EPA published an assessment report on the proposals (EPA, 1992). The report recommended to the Minister for the Environment that the mine and process plant on Windimurra Station, and the coal mining operation at Mingenew, be approved subject to conditions relating to the use of groundwater, drainage management, dust management, noise, blasting operations, and other matters. The Minister for the Environment approved the proposals on 16 September 1992 pursuant to provisions of the Environmental Protection Act, 1986.

Shortly after this, the world vanadium pentoxide price declined from approximately US$2.30/lb to a low of approximately US$1.30/lb by mid 1993 largely as a result of substantial sales by Russia. This new price was less than the estimated cost of production of vanadium pentoxide from Windimurra. Therefore, PMA decided not to proceed with the project in accordance with the original schedule.

In late 1995, the world price rose above US$2.00/lb and after some fluctuations, climbed steadily to between US$3.00 and US$4.00/lb in 1997, i.e. two to three times the 1993 price. As the world market for vanadium recovered, PMA reviewed the project and decided to proceed to implementation. The company therefore engaged key project management personnel who formerly operated a similar project in South Africa. A review of the feasibility study for the project has recently been completed, with a number of modifications proposed to the original project in order to ensure that the project complied with the objective of utilising best available practice in the field of vanadium pentoxide processing.

Condition 9-1 of the approval issued by the Minister for the Environment in 1992 requires that the project be substantially commenced within five years otherwise the approval will lapse and be void. PMA therefore, has made an application to the Minister for the Environment under the provisions of Section 46 of the Environmental Protection Act, 1986 that the environmental approval be extended for a further period of two years. The EPA has recommended that this period of extension be granted (EPA Bulletin 878, 1998).

The review of the feasibility study identified a number of modifications to the original 1992 proposal. These changes affect the mine plan, coal source and processing of the ore. The changes reflect improved technology and efficiency

of operation and will lead to increased production, energy efficiency, energy conservation and significant improvements in both environmental and occupational health and safety performance. A summary of the key characteristics of the project is provided in Table 1.1.

TABLE 1.1

KEY CHARACTERISTIC TABLE FOR THE WAGOO HILLS VANADIUM PROJECT

Element	Description
Life of mine production.	15 years, based upon proven resource, inferred resource considerably greater.
Size of ore body.	34 million tonnes.
Area of Tenement.	988 hectares
Area of disturbance.	120 hectares.
Ore mining rate.	2.28 million tonnes per year.
Product.	Fused flake vanadium pentoxide, V_2O_5
Nominal rate of product.	7200 tonnes per year.
Tailings volume	1.5 to 1.7m tpa.
Water supply.	Nearby groundwater borefield.
Fuel supply.	Option 1; Coal, LPG and Diesel. Option 2; Natural gas.
Truck movements.	Largest transportation requirement is for coal, at 3 to 4 trucks per day.

A summary of the environmental factors of the project are presented in Table A1. The regional location and the mine-site and groundwater borefield is shown in Figures 1 and 2 respectively.

The stated nominal rate of product may vary (within the range indicated) due to factors such as variations in throughput of ore and process efficiency. In the event of production rates increasing significantly, then PMA will seek the appropriate environmental approval.

As a result of the modifications to the original proposal, and recent developments in environmental standards since 1992, the conditions listed in the approval issued by the Minister for the Environment require updating.

This report is an application under Section 46 of the Environmental Protection Act, 1986 for an amendment of the Ministerial conditions, as contained in the 1992 Ministerial Statement. The report provides a description of the changes to the original proposal and developments in environmental standards. This will provide the basis for the Minister for the Environment to set appropriate updated conditions.

It is possible that a foreign investor will be involved in the project, and if this occurs, Foreign Investment Review Board involvement will be required. A final decision in this regard will be made during the second or third quarter of 1998.

1.2 Environmental Approval

Following the public review period of the 1992 Public Environmental Review, the EPA published an assessment report on the proposals (EPA, 1992). The report recommended to the Minister for the Environment that the mine and process plant on Windimurra Station, and the coal mining operation at Mingenew, be approved subject to conditions relating to the use of groundwater, drainage management, dust management, noise, blasting operations, and other matters. The Minister for the Environment approved the proposals on 16 September 1992 pursuant to provisions of the Environmental Protection Act, 1986. The Ministerial Conditions which the proposal is subject to (Appendix 1), fall into the following categories:

- Proponent Commitments
- Implementation
- Water Resources
- Non-Vanadium Dust Levels
- Noise Limits
- Blast Limits
- Decommissioning
- Proponent
- Time Limit on Approval
- Compliance Auditing and Procedure

The first Ministerial Condition states that PMA will fulfil the commitments made in the PER and subsequently included in the Environmental Protection Authority Bulletin 633 (refer to Appendix 1 of this document). Proponent commitments are made in the following categories.

- Weeds
- Rehabilitation
- Land Use
- Groundwater
- Surface Water
- Noise
- Dust

PMA acknowledges that certain of the conditions in the existing approval should be updated in accordance with changes to environmental regulations and guidelines which have occurred since the approval was granted in 1992. These involve for example, noise levels for which new draft regulations have been published, and atmospheric emission standards.

Following a Section 46 application for a two year time-limit extension, the EPA issued its recommendations and presented a list of recommended Ministerial Conditions and the proponents consolidated commitments (Bulletin 878, EPA, 1998). The revised and updated set of proponent commitments are contained in Appendix 2. These revised conditions will completely replace the conditions issued by the Minister in response to the 1992 PER.

This Section 46 application represents an extension and improvement of the original 1992 proposal and it is PMA's view that the new proposal significantly reduces the environmental impacts associated with the proposal.

The new proposal introduces a number of efficiencies and improvements to the process which will result in direct environmental benefits. These include:

- Improved energy efficiency which reduces fuel requirements and greenhouse gas emissions.
- Better quality imported coal which removes the need for the Mingenew coal mine and potentially reduces atmospheric emissions.
- The possibility of natural gas firing which will further reduce greenhouse gas emissions and would allow other users in the region, including Western Power, to use natural gas instead of diesel fuel with the consequent environmental benefits.
- Improved process efficiency which reduces mining volumes, tailings production and reagent use.
- A lined calcined tailings dump which ensures soluble vanadium is retained in the process and prevented from entering the groundwater system.
- Improved process design in the areas in which vanadium pentoxide is produced and handled to ensure that potentially hazardous vanadium pentoxide dust and fumes are maintained below statutory emission levels.

The upgraded throughput for this proposal involves an increased requirement for groundwater. Groundwater extraction requirements have increased from 1.1 million cubic metres per year to 2.4 million cubic metres per year. The extraction of groundwater at the higher rate will be managed to prevent any adverse environmental impact as the groundwater is extracted from a deep aquifer. Previous investigations have confirmed that this aquifer is capable of yielding 3 million cubic metres of water per year on a sustainable basis.

Proponent commitments are summarised in Table A2.

2. THE EXISTING ENVIRONMENT AT WINDIMURRA

2.1 Climate

The features of the climate at Windimurra which are most relevant to this environmental assessment are rainfall, as it affects surface drainage and groundwater recharge, and wind patterns as these affect the dispersion of atmospheric emissions and dust. Run-off from rainfall is also affected by evaporation which in turn is largely determined by temperature. Rainfall, temperature and evaporation at Mt Magnet which is the nearest weather recording station, are contained in Appendix 5.

The Mt Magnet area is in the semi-arid zone of Western Australia and rainfall is typically low with an annual average of 235mm from more than 90 years of recorded data. Summer and winter are the wettest seasons with monthly averages from 16mm (April) to 32mm (June). Generally, very little rainfall occurs from September to December inclusive.

The average number of rain days in each month is also low and indicates that the overall pattern is one of occasional but locally significant falls.

A study of the maps prepared by the Institute of Engineers of Australia for rainfall and run-off for the area shows that the following storms may be expected at Mt Magnet (Table 2.1).

TABLE 2.1

MT MAGNET RAINFALL AND RUN-OFF

Storm Duration (hrs)	Return Interval (years)	Amount (mm/hr)
1	2	16
12	2	26
72	2	0.65
1	50	35
12	50	8
72	50	2.2

The data indicate that a maximum storm of 12 hours duration producing 312mm of rain may be expected every two years. This information indicates the importance of planning for water control on the waste dumps, on the walls of the tailings dam and in the control of run-off from the site.

In contrast to rainfall, temperatures and evaporation in the area are relatively high. Average monthly maxima exceed 30°C from November to March inclusive and daily maxima often exceed 40°C. Average evaporation in these months exceeds 270mm and generally 300mm.

In autumn and spring average monthly maxima temperatures are above 23°C and evaporation exceeds 100mm while in winter the average maxima

temperatures are about 20°C and evaporation ranges from about 75mm to 100mm.

The wind patterns for Mt Magnet are illustrated by wind roses (Appendix 5) which show morning and afternoon wind directions and speed. In the morning north-easterly winds predominate especially during summer with easterlies and south-easterlies also frequent. Winds from the west including north and south-westerlies are much less frequent. The easterly winds are of variable intensity but the westerlies tend to be relatively light with speeds of 1 to 20km/hr.

In the afternoon the most frequent winds are south-easterlies with easterlies and north-easterlies also common wind directions. Again, summer winds dominate the annual pattern. In general the easterly winds are light with speeds of 1 to 10km/hr. Westerlies (predominantly south-westerlies and westerlies) are more frequent than in the morning and range in speed from light to moderate (31km/hr and greater).

There is very little wind from the north and north-west, i.e. across the project area toward Windimurra Station.

2.2 Physical Features

The physiography of the Windimurra region falls into the "salinaland" category of Jutson (1950). The terrain is generally flat and drainage is entirely internal with the formation of salt pans to the east of Windimurra Hills. The elevation of the mine and plant area averages from 450 to 470m ASL.

The main physiographic components of the project area are:

- The Hawkstone Ridge area, where the orebody is located,
- The Windimurra Hills, and
- The clay and calcrete flats between and surrounding these areas.

The Hawkstone Ridge area consists of a low lateritic ridge which forms a breakaway over the kaolinised titano-magnetite horizon. Total relief along the orebody is approximately 20m. The orebody is characterised by a magnetite scree covered area on the eastern side of this ridge which trends in a north north-westerly direction. The surface of the orebody is generally 10m below the highest point on the ridge and mining activity will generally be to the east of this point.

The Windimurra Hills are the only significant rock outcrop in the area. These north-south trending strike ridges mostly comprise large boulders of gabbroic rock at high angles of repose.

The extensive flats surrounding the Windimurra Hills consist of smectite (montmorillonite) clays which, due to their shrinking and swelling properties have formed "gilgai" or "crab hole" country. The flats to the east of Windimurra Hills are largely covered by a layer of rubbly calcrete.

The soils on the Hawkstone Ridge and flat areas have been significantly eroded in many places and the exposed roots of dead mulga trees indicate a 3 to 5cm soil loss.

The main physiographic components of the project area can be further subdivided into 7 distinct landforms as follows:

- Hills and rocky outcrops - with a prominent mantle of heavily weathered cobbles and pebbles, lateritic platforms and steep grades towards the summit. Soils are skeletal though sandy belts occur with depths to 25cm.
- Less highly weathered hills with gabbro - hills with lower internal relief than above and with substantially less weathering, grades are lower and footslopes trend to the drainage plain. Soils are skeletal.
- Abrupt ridge-like hills (Windimurra Hills).
- Gravel covered slopes.
- Drainage plains marginal to hills - footslopes and gently sloping plains broken with insize drainage. Soils are sandy loams with gravel and stone inclusions to 20cm.
- Central drainage flats - broad usually unincised zones of surface water flows with drainage flats. Soils are shallow sandy loams over hardpan with cracking clay soils in the drainage areas.
- Sloping plains flanking the Hawkstone Ridge on the east.

2.3 Hydrology

Surface Water

The project area is located on slightly elevated ground which means that run-off from rainfall will be conveyed away from the site in local drainage channels. Most of the drainage runs in an easterly direction into depressions and clay pans along the south-western margin of an alleviated paleodrainage. Here it apparently evaporates or infiltrates as no major drainage channel or other means of water transport from the claypans is evident.

Regionally, the project area is adjacent to a surface water sink which is part of a paleodrainage that used to run north-westwards then west and south-westwards towards an elongate lake system south of Challa Homestead.

Groundwater

The main body of groundwater near the project area is contained in the alluvium of a paleodrainage located to the east of the mine and process site. Minor amounts of groundwater have also been encountered in bedrock.

The alluvium of the paleodrainage is calcreted sand and silt at the surface, underlain by clay and sand to depths of about 80m. A test hole drilled in the alluvium determined that the water table is 3m below ground surface and that the upper aquifer (of ferricrete-calcrete and basal quartz grit) extends from the water table to 8m depth. This aquifer is underlain by plastic clays from 8m to 57m depth which are considered to be impermeable. A lower alluvial aquifer of sand with clay lies between 57m and 76m depth. Weathered and fractured gabbro bedrock, which was drilled to depths of 87m also contains groundwater.

Test bores indicate that groundwater salinity increase with depth with salt content ranging from 2000-2500mg/l TDS in the upper aquifer, to 14 000mg/l TDS in the lower bedrock. Sampling of stock bores/wells in the paleo-channel has yielded groundwater salinities of between 1700-8600mg/l TDS all from the upper aquifer. This is not fit for human consumption. Stock such as sheep may consume water up to 14 000 mg/l TDS.

The area of the aquifers has not been precisely determined at this stage but it is considered that they are at least 12km in length and 2km in width.

Yields from the test bores range from 200-480m^3/day depending on depth but yields from production bores are expected to be higher than this. It is considered that there is a large margin of safety in the capability of the paleo-channel aquifer to yield the required water supply for the process plant and other project needs.

The gabbro bedrock contains small quantities of groundwater with salinity 900-1300mg/l TDS and it is considered that shear zones and quartz reef cutting the bedrock in the area might yield useful quantities for human use.

2.4 Vegetation and Flora

The principal project area at Windimurra lies within the Eremaean Botanical Province. This botanical Province is divided into 'regions' and 'sub-regions' and Windimurra lies within the Barlee Sub-region which is part of the Murchison Region (Beard, 1976). Mulga (*Acacia aneura*) is the predominant vegetation of the Eremaean Botanical Province and the basic vegetation type occurring on the lease area is Mulga Shrubland and Mulga Low Woodland.

The understorey component of these Mulga Shrublands and Woodlands has been modified due to a long history of stock grazing. The Department of Conservation and Land Management (CALM) has advised that *Grevillea inconspicua* is the only known Rare Flora species in the vicinity of the Mining Lease. Four plant species are on the Priority Flora List prepared by CALM for the region but none of these are expected to occur at the site since they grow on sandplains and waterlogged flats which are not present on the Mining Lease.

A search of the WA Herbarium Specimen Database revealed that the species *Acacia Inceana* is known to occur south of the Mining Lease but has not been found on the Mining Lease.

The dominant vegetation types in terms of the landforms described in Section 2.2 are as follows:

- Hills and rocky outcrops, less weathered hills with gabbro, and abrupt ridge-like hills - stunted mulga (*Acacia aneura*) with *A. ramulosa* and *A. grasbyi* in the tree layer and *Ptilous obovatus, Thryptomene inconspicua , Grevillia inconspicua, Solanum lasiophyllum* and *Eremophila* species in the Shrub layer. The ground flora consists of sparse annual herbs and grasses in season.

- Drainage plains marginal to hills - open mulga with Casuarina and other Acacia species over *Eremophila forrestiana* and other *Eremophila* species with Blue Bush (*Maireana* species) and *Sida* species with annuals.

- Central Drainage Flats - mulga with other Acacia species including *A. tetragonophylla* and *Pittosporum phylliraeoides* and other *Eremophila* species, *Ptilotus obovatus* and *Solanum lasiophyllum* on shallow hardpan soils, and *Maireana pyramidata* (*Halosarcia*) on the cracking clays.

- Gravel covered slopes - groves of mulga and other shrubs and trees.

2.5 Vertebrate Fauna

Lists of amphibian, reptile and mammal species expected to be found in the general area of the mine and process plant have been compiled by reference to the literature and are provided in Appendix 6. Bird lists were compiled using data from the Western Australian branch of the Royal Australasian Ornithologists Union's (RAOU) database from the Shires of Mt Magnet and Sandstone.

The lists indicate that 2 species of amphibians, 42 species of reptiles, 51 species of birds and 19 indigenous mammals may occur in the general area. The only animal in the lists which is gazetted rare under the Wildlife Conservation Act 1950 is the Black-footed Rock Wallaby (*Petrogale lateralis*) but it is considered unlikely that this species actually occurs in the area (Appendix 6).

2.6 Heritage Sites

In 1991 for the purposes of the 1992 Public Environmental Review the Western Australian Museum advised PMA that it had no record of either archaeological or ethnographic sites in the Windimurra area. PMA subsequently commissioned a "Survey for Aboriginal sites at the Windimurra Project area, Mt Magnet" completed by Quartermaine Consultants. This survey found that there are two archaeological sites of moderate to low archaeological significance located near the proposed pit. PMA has restated its previous undertaking that the sites will not be disturbed during mining. However, in the event of any proposed changes to the project which has the potential to impact on either site, an application under Section 18 of the Aboriginal Heritage Act 1972 will be made.

There are no known sites of significance in the area in terms of European heritage.

2.7 Native Title

The Mining Lease M 58/178 was granted prior to the Native Title Act, 1993 and therefore will not be affected by Native Title claims.

2.8 Adjacent Land Use

The lessees of the Windimurra Pastoral Lease live at Windimurra Homestead 4km to the south of the proposed mine site. The location of the project and the homestead are shown in Figure 1. The next nearest dwelling is some 20km away and the nearest town (Mt Magnet) is 80km west of the project area.

The pastoral range consultant engaged to advise PMA, considers that the project will have little impact on the carrying capacity of the pastoral lease and will cause only minor disruption to pastoral activities. The project area covers some 120 ha which represents less than one twentieth of 1% of the total area of the pastoral lease. A study of rangeland conditions made in 1975 indicated that the Salt Bush and Blue Bush communities were in fair to good condition with some depletion of the perennial Salt Bush vegetation. Observations made by the pastoral consultant in 1992 suggest that the situation has not changed significantly between 1975 and 1992, although the shrub layer has been depleted. The area of the mine and the process plant is mostly covered by surface scree and only a small part of this could be considered potential grazing land.

The carrying capacity of the various landforms in and around the project area as identified in Section 2.2 are as follows:

- Hills and rocky outcrops, less weathered hills, and abrupt ridge-like hills - 1SSU (Small Stock Unit) to 18ha.
- Drainage plains marginal to hills, and gravel covered slopes - 1SSU to 19ha, and
- Central drainage flats - 1SSU to 10ha.

Using the carrying capacities listed above, the Mining Lease (988ha) is estimated to have a carrying capacity of about 50SSU. The actual project area will affect less than a third of this area.

As there is no permanent water in the project area, most stock water is produced from bores. Two small dams, one well to the north of the pit area and the other in the central drainage flats do not depend for their total replenishment from run-off from the hills, but gather water from the run-off closer to their location. A hydrological assessment by Rockwater Pty Ltd also indicates that run-off from the project area is not likely to be significant or cause any environmental problems.

3. THE PROPOSED PROJECT

3.1 Wagoo Hills Mine Plan

The following information updates the information detailed in the "Mine Plan" and "Project Benefits Philosophy" sections of the 1992 PER. The regional location and minesite & groundwater borefield plan are shown in Figure 1 and 2 respectively. Figure 3 shows tenement holdings as of October 1997.

A revised ore reserve has been determined at Windimurra in accordance with the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves (1989). A resource of 34 million tonnes of free diggable oxidised ore averaging 0.57% V_2O_5 has been delineated to date.

A conceptual mining plan has been developed for the excavation of ore at a nominal rate of 2.3 million tonnes per year for extraction of vanadium pentoxide. However, the actual mining rate may vary over a range from 1.5 - 3 million tonnes per year, depending on ore grades and market conditions. The comparable figure proposed in the 1992 PER was 1.45 million tonnes per annum. Over the lifetime of the mine, the pit dimensions and mine design remain the same as stipulated in the 1992 PER. The proven ore reserve is sufficient to ensure a mine life of fifteen years, although the inferred resource would allow a mine life of up to 100 years. Expected initial production level for vanadium pentoxide from the project is 7,200 tonnes per annum which is approximately 12% of current world demand. Although the proposed vanadium pentoxide level has increased some 95% over that proposed in the 1992 PER (3700 tpa), this increase in production is to be achieved by only a 57% increase in mining rate demonstrating the significantly improved efficiency of the proposed vanadium pentoxide extraction process.

The vanadium-bearing ore will be excavated at Wagoo Hills by conventional earth moving machinery in an open cut mining operation. It is considered possible to extract the majority of the ore using an excavator and bulldozer but occasionally the use of minor surface blasting may be required to remove the calcrete cover.

It is anticipated that the total construction cost of the processing plant will be in the order of 94 million Australian dollars, most of which will be expended within Western Australia. Export income over the life of the project will exceed 1.0 billion dollars on current vanadium prices.

The project will directly employ an estimated 500 people during the design and construction phase and 100 people during the operational phase.

3.2 Mingenew Coal Project

The 1992 PER detailed the quarrying of coal from the Mingenew coal deposit. Subsequent tests on the quality of this coal have determined it to be economically and environmentally unsuitable for the proposed process.

As an alternative, PMA now propose to import high grade, low sulphur coal from either Indonesia or the Eastern States. This will provide environmental benefits for the proposal by reducing gaseous emissions levels from the stacks. The coal will be shipped to the Port of Geraldton and then transported by road to Wagoo Hills (refer to Section 3.7). All information relating to the Mingenew Coal Project detailed in the 1992 PER is therefore now no longer applicable.

PMA intend to use coal to fire the rotary kiln but this may change to natural gas pending the outcome of negotiations between PMA and energy suppliers.

Should the utilisation of natural gas be adopted by PMA then this would involve the construction of a spur line from the Dampier to Bunbury transmission pipeline to the Wagoo Hills site. The necessary approvals for construction of this pipeline would be referred separately to the EPA and does not form part of this Section 46 application.

3.3 Ore Processing

3.3.1 Methodology

The following information updates that supplied in the 1992 PER in the "Ore Processing" section. In line with PMA's objective of utilising best available practice in the processing of vanadium pentoxide, modifications to the extraction process have been proposed in order to improve process efficiency, tailings management and occupational health management. These changes reflect increased production and significant improvements on environmental performance. In order to improve project financial viability, the process plant will now produce 7200 tpa of product in fused flake V_2O_5 compared to the previous capacity of 3700 tpa. However, improvements in process efficiency mean that the plant will mine proportionally less ore and use proportionately less fuel and chemical reagents thereby providing distinct environmental benefits. Tables 3.3.2 and 3.7.3 illustrate the reduction in chemical reagent and fuel use.

The new plant layout and process is summarised below and diagrammatically in Figures 4 and 5 respectively.

The processing plant is located immediately adjacent to the mine site. Mined ore will be trucked from the pit to a dump pad and feed hopper associated with the primary crusher. The close coupled nature of mine and plant mean that only a small stockpile of run-on mine ore will be stored adjacent the primary crusher. Ore from the mine is initially fed into a Primary Jaw Crusher. The primary crusher is equipped with dust extraction and air extracted from the crusher is directed to a wet scrubbing unit to control particulates. The crushed material is conveyed into a semi autogenous grinding (SAG) mill where further size reduction takes place and process water is added.

Vanadium in the ore exists in solid solution within the magnetite. The first stage of the process involves the recovery of vanadiferous magnetite from the ore.

The finely ground ore slurry is pumped to wet drum magnetic separators and then gravity fed to a wet high intensity magnetic separation circuit. The recovery of vanadium in magnetite by use of magnetic separators is approximately 70% as compared to 50% for the process detailed in the 1992 PER which utilised gravity separation.

Combined tailings (waste streams) generated in the magnetite production plant are directed to the tailings thickeners where process water is recovered to be recycled. The tailings from this part of the process are inert as the vanadium is retained in an insoluble form and are pumped to the tailings dam.

Magnetite concentrate is conveyed from the beneficiation area of the plant to a storage shed in the roasting area of the plant. This storage facility represents the only substantial stockpile in the plant. The magnetite concentrate is produced as a wet filter cake containing some 8% moisture. The moist nature of the filter cake, together with the protection provided by the storage shed will minimise the potential for wind blown dust. The magnetite concentrate is then weighed and conveyed to the calciner where it is mixed with sodium oxalate and sodium sulphate.

Vanadium exists in magnetite in a trivalent form in solid solution within the magnetite crystal lattice. In order to convert the contained vanadium to into a water soluble form, the magnetite must first be oxidised at high temperature and then reacted with a suitable sodium salt.

The calciner is a cylindrical rotary kiln in which the magnetite concentrate and process reagents are mixed and heated to provide optimum conditions for chemical reactions to occur which produce sodium vanadate. The calcined material is discharged from the hot end of the kiln. The air, steam and combustion gases from the kiln pass through a wet venturi scrubber and cyclone separator before being discharged to atmosphere. The wet scrubber reduces particulates and any water soluble acid gases before the gases are discharged to the atmosphere.

The main chemical reactions occurring in the calciner are described by the following equations:

1. Oxidation of magnetite.

   $2Fe_3O_4 + 1/2\ O_2 \rightarrow 3Fe_2O_3$

2. Oxidation of vanadium by magnetite.

   $V_2O_3 + O_2 \rightarrow V_2O_5$

3. Decomposition of sodium salts.

   Sodium oxalate

   $Na_2C_2O_4 + 1/2O_2 \rightarrow Na_2O + 2CO_2$

Sodium Sulphate

$Na_2SO_4 \rightarrow Na_2O + SO_3 \rightarrow\leftarrow Na_2O + 1/2O_2 + SO_2$

4. Formation of sodium vanadate.

$V_2O_5 + Na_2O \rightarrow 2NaVO_3$

The calcine material which discharges the kiln is conveyed to the quench mill where it is quenched with a flow of recycled sodium vanadate liquor. This quenching action causes the dissolution of the sodium vanadate that is present in the hot calcined material. The water vapour which is evolved from the quench mill is scrubbed to remove particulates before atmospheric discharge.

The slurry from the quench mill is discharged to an agitated leach tank, then passes through a filtration system which washes the calcined solids and removes vanadium-rich liquor. Washed calcined tails are discharged to the calcined tailings dump (Figure 6). The calcined tailings dump is built and operated as a heap leach with solution drainage piping placed over impermeable high density polyethylene. Solution that drains out is collected in a sump and transferred by a pump back to the leach section of the plant. The continuous wetting of the dump with water reduces any possible windborne dust emissions. This process of continuous leaching continues until all soluble vanadium has been leached from the dump. At this stage, each completed tailings cell will be rehabilitated to DME requirements.

The vanadium-rich liquor from the leach section is pumped from the recycle tank to desilication tanks where sulphuric acid and aluminium sulphate is added before agitation. The liquid is then filtered to remove insoluble aluminosilicates which are discharged to the calcined tailings dump. The pregnant liquor filtrate is concentrated using an evaporator. Concentrated pregnant liquor is cooled then fed into agitated ammonium metavanadate (AMV) precipitation tanks. Caustic soda and ammonium sulphate are added resulting in the crystallisation of insoluble AMV. The remaining liquid is removed to a "barren liquor" storage tank and the slurry to a settling tank. Membrane filtration of the AMV solids removes further liquid. Liquor from the "barren liquor" storage tank is transferred to evaporation ponds which are lined with impermeable, high density polyethylene liners. Natural evaporation will result in the crystallisation of contained ammonium and sodium salts which may subsequently be harvested and recycled back into the process. The proponent is still investigating whether the recycling of these salts is feasible. If the salts contained in the barren liqor storage tanks cannot be recycled, then the tanks will be sealed with an impermeable polyethylene cap and rehabilitated.

The wet AMV filter cake is fed into the AMV flash drier which is powered by natural gas or LPG. Exhaust gases are emitted to the atmosphere via a baghouse to remove AMV particulates. The dry AMV powder is fed into the deammoniator in which the AMV will be thermally decomposed to produce vanadium pentoxide powder. The deammoniator is powered by natural gas or LPG and draws in air to assist with the oxidation reaction. Off-gas is passed through a wet scrubber to remove any residual solids, which are returned to

returned back to the process. Due to the catalytic nature of vanadium pentoxide, the ammonia within the deammoniator breaks down to form $N_2(g)$ and $H_2(g)$, thus minimal ammonia discharge should occur.

The main chemical reaction which occur in the deammoniator are described by the following equations.

1. Decomposition of AMV

   $2NH_4VO_3 \rightarrow V_2O_5 + 2NH_3 + H_2$

2. Catalytic decomposition of ammonia (under conditions in the de-ammoniator).

   $2\ NH_3 \rightarrow N_2 + 3\ H_2$

3. Reduction of vanadium pentoxide

   $V_2O_5 + H_2 \rightarrow V_2O_4 + H_2O$

4. Oxidation of vanadium (4) oxide

   $V_2O_4 + 1/2\ O_2 \rightarrow V_2O_5$

If excess ammonia is detected in the deammoniator off-gas then sulphuric acid is added to the scrubber unit of the deammoniator to produce ammonium sulphate (in solution) which is then recycled into the process.

Hot vanadium pentoxide powder is discharged from the deammoniator and transferred into the fusion furnace. Here the vanadium pentoxide powder is melted using a natural gas or LPG flame. Combustion gases evolved from the fusion furnace are ducted into the deammoniator wet scrubber where particulates are removed and recycled back into the process. The molten vanadium pentoxide discharges onto a flaking wheel which produces vanadium pentoxide flakes, approximately 1-3mm in thickness. The flakes are then discharged into drums or bulk bags. A number of dust extraction points are provided around the deammoniator, furnace, flaking and flake handling facilities.

3.3.2 Process Plant Reagents

The process detailed in Section 3.3.1 requires differing quantities and in some cases new varieties of reagents than those detailed in the 1992 PER. The main differences and the reasons for changed quantities are summarised in Table 3.3.2.

TABLE 3.3.2

PROCESS PLANT REAGENTS

Reagent	Form	Former Usage (t/day)	Revised Usage (t/day)	Comments
Flocculant to aid filtering and setting of solids (polyacrylamide)	Liquid or Solid	0.06 to 0.12	0.06 to 0.12	Process more efficient therefore no increase in use (even with production increase).
Aluminium Sulphate $Al_2(SO_4)_3.14H_2O$	Solid	-	0 to 3.0	Required for the process, In 1992 Aluminium Sulphate was planned to be produced on site.
Alumina (Al_2O_3 . $2H_2O$)	Solid	0 to 3.0	-	In 1992 Aluminium Sulphate was unavailable thus Alumina was required to produce this reagent on site.
Sulphuric Acid (H_2SO_4)	98% Solution	12 to 18	8 to 10	Process more efficient therefore no increase in use (even with production increase).
Ammonium Sulphate $(NH_4)_2\ SO_4$	Dry Solid	8 to 12	35 to 40	Increase in production rate and changes to process necessitate more reagent.
Sodium Hydroxide (NaOH)	50% Solution	0 to 1.0	0 to 1.5	Increase in production rate and changes to process necessitate more reagent.
Sodium Oxalate or Sodium Sulphate $Na_2C_2O_4$ or $NaSO_4$	Slurry/ Solid	41 to 68.5	68.5 to 90	Increase in production rate and changes to process necessitate more reagent.

3.4 Raw Materials

The increased production rate, changes in processing and in coal source have resulted in differing quantities and qualities of required raw material. The information in Table 3.7.3 provides the revised quantities, qualities and transportation methods of raw materials for the project.

3.5 Tailings

The revised tailings volume will consist of 1.5 to 1.7mtpa residue from the process plant, as compared to 1.3 to 1.5mtpa quoted in the 1992 PER. Of the 2,280,000 tonnes of material mined, approximately 7200 tonnes is extracted as vanadium pentoxide and approximately 1,630,000 tonnes is discharged to the tailings dam principally in the same form as mined. The location of this dam is shown in Figure 2.

In line with the philosophy of best available practice, it is now proposed to dispose of calcined tailings, which contains a small percentage of soluble sodium salts, into a lined calcine tailings dump within the process plant. Approximately 0.65mtpa (~ 250, 000m^3) will be deposited in the lined tailings dump. The purpose of lining the calcine tailings dam is to prevent the possible leaching of soluble sodium salts into groundwater. The incorporation of a lined calcine tailings dam represents a significant environmental improvement on the 1992 PER. The lining will be high density polyethylene which is a very durable and impermeable membrane. Drainage pipes will be installed on the liner so that leachate can be drawn out and returned into the process cycle.

3.6 Groundwater

The process plant is expected to require around 6,400m^3/day (2.34 x10^6m^3/yr) of water compared to 3,000m^3/day previously reported in the 1992 PER.

Water will be supplied from the same borefield as stipulated in the 1992 PER. However, the borefield will now comprise 13 bores producing 500m^3/day rather than the five bores producing 600 to 700m^3/day previously quoted (PER, 1992a).

Hydrogeological testing undertaken indicated that the aquifer could sustainably yield in excess of 3 x 10^6m^3/yr of water and further work is currently under way to confirm that this is the case.

Bores will be screened to ensure that water is extracted from the deep aquifer located approximately 70m below surface level.

3.7 Transportation of Inputs and Outputs

3.7.1 Coal

Coal is likely to be the fuel source for the kiln, however, natural gas may be utilised. Assuming that coal will be used as the fuel source, then coal will be transported through the Port of Geraldton and then by truck to Wagoo Hills. It is envisaged that the truck configuration will be either:

- "B-Double", or
- Road Train (double trailer combination), or
- Road Train (rigid prime mover & two trailers).

The trailers will be either "sidetipping", "belly dumpers" or "back tippers". The trucking operation will be continuous with an average of two or three trucks per day undertaking the journey from the Port of Geraldton to the process plant. The trucking contractor will comply with all transport regulations laid down by the WA Department of Minerals and Energy, local Shires through which the transport route passes and requirements of Main Roads Western Australia.

On arrival at the plant, the coal will be stockpiled in an open air stockpile. Approximately seven days supply of coal (1000 tonnes) will be held on-site. Dust control for the coal stockpile will be managed with sprinkler systems.

3.7.2 Chemical Transportation

The transportation of chemicals will be by the same routes and methodology detailed in the 1992 PER. Summaries are presented below.

Sodium Oxalate Reagent

Sodium oxalate will be transported from production sites south of Perth in single trailers via main roads to the Apple Street Roadtrain Assembly Yard at Middle Swan, where they will be assembled into roadtrains (double configuration) for haulage to the process plant. Most of this transport will be on the Great Northern Highway. The reagent is classified as hazardous (due to its toxic properties) and therefore will be safely transported in purpose-built trailers as discussed in the PER. Each trailer will be capable of containing 20t to 27t of material.

Other reagents - Hazardous Goods

Other hazardous goods that will be transported to site will be sulphuric acid and caustic soda. These are chemicals that are currently transported in bulk tankers throughout Western Australia in very large tonnages and transport to the process plant will be in accordance with current WA Department of Minerals and Energy requirements.

Non-Hazardous Goods

The non-hazardous goods; diesel, flocculant, aluminium sulphate and ammonium sulphate will be transported in either bulk transport trailers of liquid containers in accordance with current WA Department of Minerals and Energy requirements for transportation of goods of this nature in Western Australia.

Final Product- Vanadium Pentoxide Fused Flake

Vanadium pentoxide (fused form) has no UN number and is not listed in the Dangerous Goods Initial Response Guide (Standards Australia, Standards New Zealand, 1996). Vanadium pentoxide fused flake will be packaged into 250kg steel drums or 1000kg bulkabags (according to customer requirements) and back-hauled to a depot in Perth where it will be containerised prior to transfer to the Port of Fremantle for export.

3.7.3 Transportation Routes and Truck Frequencies

Figure 7 shows the transportation routes to and from the mine site. Transportation of coal will be from the Port of Geraldton, and the final product will be transported to the Port of Fremantle. Various reagents will be transported via the Great Northern Highway to the mine-site.

A summary of the estimated vehicle frequencies for each raw material is presented in Table 3.7.3. The number of truck movements, approximately 2-4 per day on the Geraldton to Mt Magnet Highway, and 2-4 per day on the Great Northern Highway are not significant when compared to existing truck numbers on these roads.

3.8 Natural Gas

PMA is currently investigating the possible use of natural gas for the project. If this proves feasible, a spur line will be constructed from the Perth-Dampier pipeline. The construction of the pipeline, should this option proceed, would be the subject of a separate referral to the DEP for environmental approval.

PMA considers that natural gas would provide significant environmental benefits for both this proposal and the surrounding region and is hopeful that current negotiations regarding bringing the natural gas pipeline to the plant will be successful.

This report has been prepared on the assumption that coal/diesel/LPG will be the primary fuels but data is presented showing the improved air emissions which would derive from using natural gas. PMA seeks approval for the use of coal/diesel/LPG or natural gas as a fuel source for the plant but recognises a separate referral and assessment would be required before approval could be granted for the construction of the spur line.

TABLE 3.7.3

RAW MATERIAL QUANTITIES AND SOURCES FOR THE WAGOO HILLS PROJECT

Raw Material	Previous Annual Requirement (PER, 1992)	Previous Annual Requirement per ton of product	Annual Requirement	Requirement per ton of product	Source	Distance to Windimurra	Form of Material	Trucks per Year
Coal	30,000 to 70,000t	8.1 to 18.9t	30,000 to 45,000t	4.2 to 6.2t	Geraldton	425km	Bulk	430-1000
Diesel Fuel	6 to 10 million litres	1622 to 2703 litres	15 to 17 million litres	2080 to 2340 litres	Geraldton	425km	Bulk, liquid	225 - 260
Sulphuric Acid	4,400 to 6,500t	1.2 to 1.8t	3000t to 4300t	0.4 to 0.6t	Kwinana	690km	Bulk, liquid	120-170
Ammonium Sulphate	3,000 to 5,000t	0.8 to 1.4t	12,000 to 15,000t	1.7 to 2.1t	Kwinana	690km	Bulk, granular	220-270
Aluminium Sulphate	1000t as $Al_2O_3 . 3H_2O$	0.3t	0 to 1,000t	0 to 0.15t	Kwinana	690km	Bulk, powder	0-18
Sodium Oxalate or Sodium Sulphate	15,000 to 25,000t	4.0 to 6.7t	25,000 to 40,000t	3.5 to 5.6t	Kwinana, Wagerup, Pinjarra, Worsley	700-800km	Bulk, wet, filter cake	460-740
Butane or LPG	360 to 550t	0.10 to 0.15t	550 t to 750 t	0.08 t - 0.10 t	Kwinana	690km	Bulk, liquid	20 - 30
Sodium Hydroxide	0 to 400t	0 to 0.1t	0 to 1,000t	0 to 0.1t	Kwinana	690km	Bulk, liquid	0-40
Flocculant	20 to 40t	5 - 11 kg	20-40t	3 - 6 kg	Kwinana	690km	Powder	*
Natural Gas		-	1570 - 1930 Tera Joules	0.2 - 0.3 TJ	Northwest shelf	-	Gas	Pipeline

*Note: The small shipments of flocculant will be transported on trucks bringing other materials (such as spares) to the site.

4. ENVIRONMENTAL CONSIDERATIONS

4.1 Introduction

The previous section provides an update of the information detailed in the "Mine Plan" and "Project Benefits Philosophy" sections of the 1992 PER. This section considers the potential impacts of site development on factors that are considered relevant by the EPA. These factors are extracted from the guidelines issued by the EPA, which are included in Appendix 3.

PMA acknowledges that conditions in the existing approval will be updated in accordance with changes in environmental regulations and guidelines which have occurred since the approval was granted in 1992. This involves for example, noise levels for which new regulations (31st January 1998) have come into effect, and atmospheric emission standards.

In addition, the recently completed feasibility study recommended certain changes to the Wagoo Hills Vanadium Project as originally proposed in 1992. These changes include the elimination of the Mingenew Coal source, increased rates of production, improved tailings management, improved processing efficiency, improved control of vanadium dust, and modifications to optimise the process plant design.

A summary of the relevant environmental factors as identified in the EPA guidelines is provided in Table 4.1 below. Each proponent commitment presented in the remainder of this section is numbered for easy reference and is presented in tabular form in Table A2.

TABLE 4.1

RELEVANT ENVIRONMENTAL FACTORS AND CORRESPONDING EPA OBJECTIVES

PRELIMINARY ENVIRONMENTAL FACTOR	ENVIRONMENTAL OBJECTIVE	PROPOSED MANAGEMENT OF ENVIRONMENTAL FACTOR
Biophysical;		
Groundwater Quantity	Maintain the quantity of groundwater so that existing and potential uses are protected.	Prepare Water Management Plan and monitoring programme. Managed under the Rights in Water and Irrigation Act 1914.
Pollution Management;		
Dust/Fumes (Vanadium)	To ensure that dust generated by the proposal does not adversely impact upon welfare and amenity or cause health problems.	Dust suppression techniques detailed in Section 4.3, to achieve the requirements of Section 51 of the Environmental Protection Act, 1986, and other acceptable standards.
Particulates/Dust	Protect the surrounding land uses	Dust suppression techniques

	such that dust emissions will not adversely impact upon their welfare and amenity.	detailed in Section 4.4, to achieve the requirements of Part V of the Environmental Protection Act, 1986 and in accordance with the Land Development Sites and Impact on Air Quality guidelines (DEP, November 1996).
Gases	Ensure that gaseous emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986.	Preparation of atmospheric modelling and monitoring, and use of best available technology to achieve the requirements of Section 51 of the Environmental Protection Act, 1986.
Greenhouse Gases	Ensure that greenhouse gases meet acceptable standards.	Prepare Greenhouse gas EMP and incorporate efficient design process plant features, to the requirements of Section 51 of the Environmental Protection Act, 1986.
Groundwater Quality	Maintain or improve the quality of groundwater to ensure existing and potential uses are protected.	Prepare Water Management Plan and water quality monitoring programme, to the requirements of the draft WA Guidelines for Fresh and Marine Waters, NHMRC/ARMCANZ Australian Drinking Water Guidelines- National Water Quality Management Strategy.
Groundwater Quality, Solid Waste	Wastes should be contained and isolated from groundwater and surface water.	Installation of a lined storage area for mine-site residue which contains leachable sodium. Extraction system will remove sodium for return to the process.
Social Surroundings:		
Public Health and Safety, Risk and Hazard.	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.	Undertake a qualitative risk assessment (HAZOP and HAZAN study) to meet the EPA's criteria for individual fatality risk off site and the DME's requirement in respect of public safety.
Public Health and Safety, Road Traffic.	Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.	Prepare Transportation EMP prior to commissioning, to meet the requirements of Main Roads Western Australia.

4.2 Groundwater Quantity

EPA Objective

Maintain the quantity of the groundwater so that existing and potential uses, including ecosystem maintenance, are protected, consistent with the regulation of groundwater extraction under the Rights in Water and Irrigation Act 1914.

Policy Context

Groundwater extraction management consistent with the Rights in Water and Irrigation Act 1914.

Potential Impacts and Management

Groundwater drawdown caused by operation of the borefield has the potential to deplete water supplies obtained from stock bores or wells and if excessive may affect vegetation. This effect of the drawdown on the surrounding environment will depend on the distance between the borefield and the stock bores, the depths of the stock bores below the water table and the amount of borefield draw on the upper aquifer. Groundwater extraction is most likely to occur from the paleodrainage channel, at approximately 70m depth. Preliminary investigations suggest that a local cone of depression of the groundwater of around 5 to 10 metres will develop within the deep aquifer of the PMA borefield. Drawdown will decrease as the distance from the borefield increases. The extent of groundwater drawdown is currently being investigated by Rockwater Pty Ltd, by field studies and numerical modelling of the aquifer.

Investigations undertaken to date suggest that the thick layer of clay separating the surface aquifer from the deeper aquifer which is being used as a resource for the project, acts effectively as an aquiclude. Thus the extraction of water from the deep aquifer is expected to have minimal impact on the surface aquifer and as a result there will be no significant environmental impacts associated with the extraction of groundwater.

The borefield has been previously assessed by Rockwater (Rockwater, 1991a and 1991b). Rockwater (1991b) concluded that a $3x10^6$ m^3/yr could be sustainably extracted. Rockwater have been commissioned by PMA to conduct a further study to ascertain acceptable pump rates at the borefield. The necessary approval for groundwater extraction will form part of a separate submission for a groundwater extraction licence to be submitted to the Water and Rivers Commission.

Commitment

7) Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water and Rivers Commission.

8) Undertake to guarantee continuity of stock water if changes in groundwater levels, caused by the Project, adversely affect pastoral activities.

9) Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water.

10) Design the tailings dams in consultation with the Department of Minerals and Energy and in accordance with the "Guidelines on the Safe Design and Operating Standards for Tailings Storages" of that Department.

11) Implement measures in the process plant to conserve water.

12) The proponent will prior to commencing construction develop a water management plan to the satisfaction of the EPA on advice from the Water and Rivers Commission which demonstrates that the borefield will operate in a sustainable manner.

13) The proponent will manage calcined tailings by utilising a lined tailings dump fitted with a drainage extraction for the return of leachate to the process, in addition to management practices such as continual wetting to avoid dust production, and rehabilitation.

14) All significant storages of hazardous material will be located above ground on bunded areas.

4.3 Vanadium Dust/Fumes

EPA Objective

Ensure that the dust/fume levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements (including Section 51 of the Environmental Protection Act, 1986) and acceptable standards.

Policy Context

Vanadium dust should be managed under Section 51 of the Environmental Protection Act, 1986 to meet the objectives specified in the EPA guidelines. The Department of Minerals and Energy also provides recommended practices for the control of vanadium dust (Appendix 4).

Potential Impacts and Management

Vanadium dust was identified by the EPA in the 1992 assessment as a key issue.

Inhalation of vanadium-bearing dusts may occur during roasting and leaching of the ore and during drumming or bagging operations. In addition the potential exists for exposure when spills of material arising from leaching and

precipitation operations are allowed to dry out and become resuspended in the atmosphere.

A comprehensive evaluation of the health risks of exposure to vanadium was undertaken by a task group of the World Health Organisation (WHO, 1988) A summary of these health risks can be found in Table 4.3.

TABLE 4.3

REPORTED HEALTH EFFECTS FOLLOWING INHALATION OF VANADIUM (after WHO, 1988)

Vanadium Pentoxide concentration (mg/m3)	Reported Symptoms
0.01 - 0.04	May cause some irritation. No impairment of lung function
0.1	Cough with increased production of mucous
0.5	Reversible decrease in Forced Vital Capacity (FVC)
~1-10	Non-specific effects, such as headaches, nausea, weakness, ringing in the ears and palpitation
5-150	Irritation of the nose and respiratory tract.

Regulation 8.10(5)(0)of the Mines Regulation Act specifies a standard purity (occupational exposure standard) for vanadium of 0.05 mg/m^3 as respirable dust. This is consistent with the Threshold Limit Value - Time Weighted Average (TLV - TWA) of 0.05mg/m^3 (as V_2O_5) for an eight hour work day recommended by the American Conference of Government Industrial Hygienists (Hewson, 1992). This standard is applicable for workers within the plant boundary.

The DEP has indicated that the limit for vanadium pentoxide likely to be applicable to the project is $1.19x\ 10^{-3}$ mg/m^3 V_2O_5 respirable dust/fumes. The limit will be applicable to residences and therefore applies to ground level concentrations, outside of the project boundary.

Advice has been sought from the Department of Minerals and Energy in respect of current practices and limits for vanadium dust management. The Department of Minerals and Energy in Hewson (1992) offer ten recommendations for dust control in a new vanadium processing plant (see Appendix 4). These recommendations fall into a number of main categories of management, summarised as follows;

(1) Vanadium bearing material (eg. stockpiles), be managed by containment of process and the use of dust suppression or containment techniques during handling.

(2) Implementation of a high standard of housekeeping throughout the plant.

(3) Management and cleaning of filtration and collection systems.

(4) Plant design to minimise the need for routine use of protective equipment.

(5) Encouraging a high standard of personal hygiene of workers.

PMA has adopted the recommendations as the basis for implementing dust control in the plant.
The nature of the process is such that vanadium is not released from the magnetite ore matrix until after the calcination stage and so the normal nuisance or inert dust and particulate control measures and standards are applicable to all stages of the plant prior to calcination. Whilst it is contained in the magnetite ore, vanadium is largely inert and not available in biological terms.

After leaving the calciner, the vanadium concentrate is immediately quenched and wetted and is handled as wet slurry or fluid through all stages of the process to the belt filter immediately prior to the AMV flash drier. At all subsequent stages, the vanadium rich materials are handled in fully enclosed systems which are equipped with dust extraction and bag filters to ensure that vanadium levels are maintained at extremely low levels. This approach is taken not only to protect the environment and for occupational health reasons but also because vanadium pentoxide is a valuable commodity and PMA wishes to maximise recovery from the process.

PMA has recently employed two senior engineers from the South African vanadium industry. These personnel were responsible for the design, commissioning and operation of Rhombus Vanadium, the latest vanadium pentoxide plant to be built in the world. As such, these personnel have been able to provide PMA with invaluable information relating to the processing of vanadium pentoxide and methods of improving occupational health and their practical advice has been incorporated into the process design of the vanadium pentoxide handling areas.

Commitment

16) Ensure that vanadium dust is controlled to below limits established in the Mines Safety and Inspection Act 1994, by incorporating dust extraction and collection equipment in the process plant.

17) Develop an effective operator training and awareness program to ensure that the process plant is well operated and any potential occupational health problems are quickly identified and are rectified immediately.

18) An EMP will be prepared prior to construction commencing which provides detailed design information on dust control systems. The will be prepared to the satisfaction of the EPA on the advice of the Pollution Prevention Division.

19) All process areas are sealed with impermeable floors and bunded, to permit ready clean-up of spillages, which are potential dust sources.

20) The calcined tailings dump is continuously wetted to prevent wind blown dust.

21) PMA will develop a Spill Management Plan which requires immediate clean-up of spills with any contaminated materials or soils being recycled through the process.

33) In order to protect the health of employees a comprehensive health and safety plan will be developed for the site which will address the following issues:

- Frequent occupational monitoring of airborne vanadium levels within works areas.
- Regular personal air sampling of employees working in areas with potential exposure to vanadium.
- Regular health assessment and urine tests for employees.
- Provision of, and training in the correct use of personal protective equipment.
- A comprehensive training program in the hazards associated with vanadium for all employees.
- Strict segregation of mess and meal break areas from process areas with clear procedures to ensure that contaminated protective clothing cannot enter mess areas.

The process design and occupational health procedures described above have been proven to be effective through experience with a similar plant operating in South Africa. The Windimurra plant incorporates significant design elements which will ensure a higher level of performance for this plant.

4.4 General Dust

EPA Objective

Ensure that 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.

Policy Context

Management under Part V of the Environmental Protection Act, 1986 and in accordance with the Land Development Sites and Impact on Air Quality Guidelines (DEP, November 1996).

Potential Impacts and Management

The issue of dust was covered in detail in the 1992 PER and this information is still relevant. It should be re-iterated that the nearest station homestead is some 4km from the site and the next nearest residence is of the order of 20km from the site. The accommodation village is located approximately 2.5km north-east of the tailing dump and processing plant. Compliance with Part V of the Act and the 1996 DEP Guideline will therefore be readily achievable. As detailed in the PER, standard dust suppression procedures will be employed at the mine to reduce dust emissions. These include water sprays on stockpiled materials, watering of roads in dry conditions, and the minimisation of exposed areas of soil by early implementation of rehabilitation as required by the Department of Minerals and Energy.

Within the plant, the following dust control measures will be adopted:

- The primary crusher is equipped with a wet scrubber and dust extraction;
- Through most of the intermediate stages of the process, feed stocks and process materials are handled as liquids or slurries.
- All potential points of emission to the atmosphere are fitted with fume or dust extraction with exhaust gases directed to wet scrubbers or bag filters.
- The calciner off gases are directed to a wet venturi scrubber and particulate separator.
- There are no significant stockpiles of materials associated with the plant except for the magnetite concentrate stockpile which is enclosed in building.

As a result of these measures and the strict controls over vanadium dust and fume, the plant will meet the EPA objectives for dust and particulate control. In addition, the very remote nature of the area mitigates against a significant off-site impacts from airborne particulates.

Detailed design information on dust control equipment will be submitted as part of the works approval submission to verify that the wet scrubbers and bag filtration units are capable of meeting the EPA's objectives for particulate emissions.

Commitment

16) Ensure that vanadium dust is controlled to below limits established in the Mines Safety and Inspection Act 1994, by incorporating dust extraction and collection equipment in the process plant.

17) Develop an effective operator training and awareness program to ensure that the process plant is well operated and any potential occupational health problems are quickly identified and are rectified immediately.

4.5 Atmospheric Emissions

EPA Objective

Ensure that gaseous emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act, 1986 (all reasonable and practicable measures are taken to minimise discharge).

Policy Context

Gaseous emissions shall be managed under Section 51 of the Environmental Protection Act, 1986 and in accordance with the Draft National Environmental Protection Measure and Impact Statement for Ambient Air Quality, 21 November 1997.

Potential Impacts and Management

In terms of the receiving environment, the nearest residence to the project area is Windimurra Station, approximately 4km to the south east of the process plant. Population density in the vicinity of the process plant is extremely low, with the next nearest residence located 20km from the process plant. The workforce village is located approximately 2km north west of the process plant, and will be subject to Occupational Health and Safety standards.

The purpose of this section is to detail the atmospheric emissions and control measures to ensure compliance with standards. This information is supplied as an update, and in addition to, the information and commitments given in the 1992 PER.

The process plant will generate atmospheric emissions from the following sources:

- Rotary Kiln,
- Quench Mill,
- AMV Flash Drier,
- Deammoniator,
- V_2O_5 Fusion Furnace, and
- The Power Plant.

The main atmospheric emissions and sources are summarised in Table 4.5.a.

TABLE 4.5a

PRIMARY ATMOSPHERIC SOURCES AND EMISSIONS

Source	Process	Potential Atmospheric Emissions
Rotary Kiln	Burning of coal and possibly natural gas.	CO_2, NO_x, SO_x, particulates.
Power Plant	Burning of natural gas/diesel, chemical reaction.	CO_2, NO_x, SO_x, particulates.
Quench Mill	Quenching of calcine material.	H_2O, particulates.
AMV Flash Drier	Burning of natural gas.	CO_2, NO_x, SO_x, particulates.
Deammoniator	Burning of natural gas, chemical reaction.	CO_2, CO, NO_x, SO_x, NH_3 particulates.
V_2O_5 Fusion Furnace	Burning of natural gas.	CO_2, NO_x, SO_x, particulates.

The principal atmospheric emissions from the process plant will be oxides of nitrogen, carbon dioxide, water and sulphur dioxide. The fuel source for the kiln (gas or coal) is yet to be finalised. This impending decision and the finalising of some of the plant components has resulted in no modelling of atmospheric emissions data having been undertaken to date.

PMA is committed to minimising atmospheric emissions to the lowest practicable levels to ensure compliance with all relevant emission guidelines, and the conditions set by the EPA. As part of this commitment PMA will undertake modelling of the principal atmospheric contaminants prior to plant construction. In addition PMA will make use of best available technology, such as employing low nitrogen oxide burners, to achieve compliance. Prior to commencement PMA will prepare a monitoring program to the satisfaction of the DEP.

The DEP has provided informal advice on the limits which are likely to be applicable to the project for vanadium and ammonia. The DEP indicates that the likely limit for ammonia is 5.95×10^{-1} ppm. However, no ammonia will be produced due to the redesigned deammoniator converting ammonia into N_2 and H_2. The likely limit for vanadium pentoxide is 1.19×10^{-3} mg/m^3 V_2O_5 respirable dust/fumes.

The following sections (4.5.1 to 4.5.5) detail the ambient air quality guidelines which will be adhered to for the principal gaseous emissions (CO, SO_2 NO_2 and particulates). A summary of the proposed standards and goals for the principle atmospheric pollutants are presented in Table 4.5.b.

TABLE 4.5b

PROPOSED STANDARDS AND GOALS FOR ATMOSPHERIC POLLUTANTS, NEPC, 21 NOVEMBER 1997

Pollutant	Unit	Averaging Time	Maximum Concentration	Goal (10 year) maximum allowable exceedences
Carbon Monoxide	ppm	8 hours	9.0	1
Nitrogen Dioxide	ppm	1 hour 1 year	0.125 0.03	1 0
Sulphur Dioxide	ppm	1 hour 1 day 1 year	0.20 0.08 0.02	1 1 0
Particulates (as PM_{10})	$\mu g/m^3$	1 day	50.0	5

4.5.1 Ammonia and Carbon Monoxide

The EPA's guidelines have identified CO, NH_3, SO_2 and NO_x as significant gases. As a result of plant design changes there are now no significant sources of carbon monoxide (CO) and ammonia (NH_3). No CO will be produced because the combustion processes and chemical reactions occur under controlled conditions with excess oxygen. Emissions of ammonia will be minimised due to the redesign of the deammoniator, and also due to the natural catalytic properties of V_2O_5 which will break down ammonia into nitrogen (N_2) and hydrogen (H_2) gas, as described in section 3.3.1.

4.5.2 Nitrogen Dioxide

The EPA has not yet set limits and standards for nitrogen dioxide emissions under an Environmental Protection Policy (EPP). Therefore, the guideline of the National Health and Medical Research Council for the one hour averaging period for residential areas has been adopted for the purposes of the present proposal. This guideline states that the $320\mu g/m^3$ level is not to be exceeded more than once a month in residential areas. For the longer averaging periods in residential areas, the World Health Organisation (1987) and USEPA (1977) limits have been adopted. These are $150\mu g/m^3$ for the 24 hour average and $100\mu g/m^3$ for the annual average respectively.

4.5.3 Particulates

Consideration of particulates is included primarily due to the possibility that coal will be used as the kiln fuel source. The burning of coal has the potential to release high levels of particulates into the atmosphere. In recognition of this PMA will be installing a scrubbing system to remove particulates.

The Clean Air Society of Australia and New Zealand (1994) has ambient air quality standards based on average particulate sizes. The use of scrubbers will ensure these standards are adhered to.

In other process areas where gaseous emissions occur, the gases will be passed through either bag filters or wet scrubbers in order to ensure that the relevant emissions levels are attained.

4.5.4 Sulphur Dioxide

The Environmental Protection Act, 1986 does not specify maximum air quality objectives throughout Western Australia. However, the EPA has promulgated two Environmental Protection Policies (EPPs) for atmospheric pollutants for the Kwinana and Kalgoorlie areas. The EPA uses the Kwinana EPP standards and limits as guidelines for the assessment of new industrial projects (where there are no existing sources) and for existing industrial plants which are seeking approval for modifications (Environmental Protection Authority, 1992b). These standards and limits, which are for sulphur dioxide and particulates only will be used for the Wagoo Hills Project.

In the Kwinana EPP, a limit is defined as "a concentration not to be exceeded" and a standard is defined as "a concentration which it is desirable not to exceed". The standard is interpreted as the value which the ground level concentration must be below for 99.9% of the time. For one hourly averages this equates to the 9th highest hourly value predicted during a year being less than the standard.

The standards and limits for sulphur dioxide used in the EPP for the Kwinana policy area are summarised in Table 4.5.4. The standards and limits for industrial estates will be adhered to within the project boundary and residential limits will apply outside the project boundary.

TABLE 4.5.4

STANDARDS AND LIMITS FOR SULPHUR DIOXIDE

Area	Averaging Period	Standard ($\mu g/m^3$)	Limit ($\mu g/m^3$)
Industrial Estate	1 hour	700	1400
	24 hour	200	365
	Annual	60	80
Residential	1 hour	350	700
	24 hour	125	200
	Annual	50	60

Section 4.5.5 below summarises the stack emission rates for the gases of concern identified in the EPA guidelines. The figures quoted in the tables for sulphur dioxide represent the emissions derived from the combustion of sulphur contained in fuels. The proponent is investigating the possibility of recycling sodium and ammonium salts from the barren liqor tank through the calciner. This will result in increased sulphur dioxide emissions from the calciner stack but the actual level will depend on a final equilibrium being reached in the process circuit and cannot be calculated at this time.

The recycling of salts from the barren liqor tank is occurring in South African vanadium plants at present but the results in terms of sulphur dioxide emissions are not yet available. If the recycling of sodium and ammonium salts from the barren liqor tank proves to be feasible then detailed calculations of sulphur dioxide emissions will be presented in the gaseous emissions EMP. Modelling results will be presented to confirm that the calciner scrubber efficiency and the final design stack height will ensure that ground level sulphur dioxide concentrations meet the design criteria specified in Table 4.5.4.

4.5.5 Stack Emission Concentrations

Guidelines for maximum concentrations of emissions from stacks and vents may also apply to industrial plants in addition to guidelines for ground level concentrations of emissions.

The relevant guidelines for emission concentrations proposed for the Wagoo Hills Vanadium Project are those defined by the National Guidelines for Control of Emission of Air Pollutants from New Stationary Sources, by the Australian Environment Council/National Health and Medical Research Council. A summary of the standards follows (Table 4.5.5.a);

TABLE 4.5.5a

STANDARDS FOR NEW STATIONARY SOURCES

Pollutant	Standard Applicable to;	Standard
Solid particles	industrial plant, fuel burning equipment.	0.25 gm^{-3}
Acid gases	-	0.4 gm^{-3}
Nitric acid or oxides of nitrogen	Steam Boilers, for liquid and solid fuels, general industry.	0.5 gm^{-3}
Carbon Monoxide	Any trade, industry or process other than cement manufacture, brick manufacture and stationary industrial diesels.	1.0 gm^{-3}
Vanadium and vanadium compounds	Any trade, industry or process.	10 mg. m^{-3}
Sulphur Trioxide	Any trade, industry or process, other than sulphuric Acid plants.	0.1 gm^{-3}

The proponent will endeavour to design the plant so that emissions from all stacks and vents in the process plant will be designed to be below these guidelines. This will be achieved by use of scrubbers and employing best available technology such as low nitrogen oxide burners. If this is not possible, computer modelling will be undertaken to ensure that the criteria specified in Table 4.5.4 for ground level concentrations are met at all times.

TABLE 4.5.5b

SUMMARY OF FUEL BASED ATMOSPHERIC EMISSIONS FROM THE WAGOO HILLS VANADIUM PROJECT USING NATURAL GAS AS THE FUEL SOURCE

Source	Fuel used	Consumption / year	CO g/s	Ammonia g/s	SO_x g/s	NO_x g/s
Power station	natural gas	21,749,000 m^3/yr	Nil	Nil	0.06	0.82
Rotary kiln	natural gas	25,042,000 m^3/yr	Nil	Nil	0.07*	0.84
AMV flash drier	natural gas	233,000 m^3/yr	Nil	Nil	0.0	0.006
Deammoniator	natural gas	467,000 m^3/yr	Nil	Trace**	0.0	0.016
V_2O_5 Fusion Furnace	natural gas	233,000 m^3/yr	Nil	Nil	0.0	0.006
TOTAL		47,724,000	Nil	Trace**	0.0	1.69

Note; gas volumes are given as Normal (N) atmospheric and temperature conditions.

* In the event of sulphate being recycled back into the process, then the emission rate is likely to increase.

** considerably less than 1 g/s.

TABLE 4.5.5c

SUMMARY OF FUEL BASED ATMOSPHERIC EMISSIONS FROM THE WAGOO HILLS VANADIUM PROJECT USING A FUEL SOURCE OTHER THAN NATURAL GAS

Source	Fuel used	Consumption / year	CO g/s	Ammonia g/s	SO_x g/s	NO_x g/s
Power station	diesel	16,703,000 litres/yr	Nil	Nil	3.58	31
Rotary kiln	coal	35,600 tonnes/yr	Nil	Nil	11.3*	17.6
AMV flash drier	LPG	175,00 kg/yr	Nil	Nil	0.0	0.009
Deammoniator	LPG	349,000 kg/yr	Nil	Trace**	0.0	0.016
V_2O_5 Fusion Furnace	LPG	175,000 kg/yr	Nil	Nil	0.0	0.009
TOTAL			Nil	Trace**	14.8	48.97

Note; gas volumes are given as Normal (N) atmospheric and temperature conditions.

* In the event of sulphate being recycled back into the process, then the emission rate is likely to increase.

** considerably less than 1 g/s.

4.5.5 Monitoring

PMA will undertake modelling of the principal atmospheric contaminants prior to plant construction. PMA will endeavour to make use of best available technology. Prior to commencement PMA will prepare a monitoring program for air emissions to the satisfaction of the DEP.

4.6 Greenhouse Gas Emissions

EPA Objective

Ensure that greenhouse gas emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986 (all reasonable and practicable measures are taken to minimise greenhouse gas discharge).

Policy Context

Managed under Section 51 of the Environmental Protection Act, 1986.

Potential Impacts and Management

The only significant greenhouse gas produced by the Wagoo Hills Vanadium Project will be carbon dioxide. As PMA has not yet made a final decision on the source of fuel for the project the total CO_2 emissions have been calculated using both the fuel options (coal and gas). The CO_2 emissions when using natural gas as the fuel source have been estimated at 91 875 TPA and the CO_2 emissions using a combination of diesel, butane and coal have been estimated at 148 394 TPA. Other greenhouse emissions will be negligible.

The sources of carbon dioxide emissions will be:

- power station
- rotary kiln
- AMV flash drier
- deammoniator
- V_2O_5 fusion furnace

Details of the sources and volumes of CO_2 emissions are provided in Table 4.6a and Table 4.6b.

TABLE 4.6a

SUMMARY OF CO_2 EMISSIONS FROM THE WAGOO HILLS VANADIUM PROJECT USING NATURAL GAS AS THE FUEL SOURCE

Source	Fuel used	Consumption / year	CO_2 t/yr
Power station	natural gas	21,749,000 m^3/yr	42,166
Rotary kiln	natural gas	25,042,000 m^3/yr	46,079
AMV flash drier	natural gas	233,000 m^3/yr	429
Deammoniator	natural gas	467,000 m^3/yr	859
V_2O_5 Fusion Furnace	natural gas	233,000 m^3/yr	429
TOTAL		47,724,000 m^3/yr	**89,961**

Note; gas volumes are given as Normal (N) atmospheric and temperature conditions.

TABLE 4.6b

SUMMARY OF CO_2 EMISSIONS FROM THE WAGOO HILLS VANADIUM PROJECT USING A FUEL SOURCE OTHER THAN NATURAL GAS

Source	Fuel used	Consumption / year	CO_2 t/yr
Power station	diesel	16,703,000 litres/yr	45,165
Rotary kiln	coal	35,600 tonnes/yr	77,015
AMV flash drier	LPG	175,00 kg/yr	531
Deammoniator	LPG	349,000 kg/yr	1,059
V_2O_5 Fusion Furnace	LPG	175,000 kg/yr	531
TOTAL			**124,301**

As the estimated life span of the project is 15 years the total CO_2 emissions from the project is estimated at 1,378,125 tonnes if the fuel source is natural gas and 2,225,910 tonnes if the fuel source is a combination of diesel, coal, and LPG.

In 1994 the total human-related emissions of carbon dioxide in Australia were estimated at 409 MTPA. Based upon the data presented in Tables 4.6a and 4.6b, the total greenhouse gas emissions arising from the vanadium project will account for approximately 0.02% of Western Australia's per annum greenhouse gas emissions if natural gas is adopted as the fuel source, and 0.03% if coal/diesel/LPG is adopted.

The EPA has adopted the following provisional policy on greenhouse gases:

a) proponents are required to calculate the greenhouse gas emissions associated with their proposal,

b) proponents are required to estimate the international offsets achieved by implementation of their proposal,

c) proponents are required to indicate the "no regrets" measures adopted to reduce greenhouse gas emissions, and

d) proponents should enter into a voluntary agreement with the state which includes annual estimation of greenhouse gases, commitments to implement "no regrets" measures and approaches to abate greenhouse gas emissions and enhance sinks.

PMA will adhere to the EPA policy on greenhouse gases and will undertake the specified work.

Commitments

22) Submit final designs details of exhaust stacks and exhaust cleaning devices prior to construction for approval by the EPA as part of the Environmental Management Programme.

23) Submit a detailed composition of the coal to the EPA and Department of Minerals and Energy to assist in designed management plans.

24) Undertake modelling of principal atmospheric contaminants prior to plant construction.

25) Implement atmospheric monitoring programme.

26) Prepare a Greenhouse Gas management plan.

4.7 Groundwater Quality

4.7.1 Maintenance of Groundwater Quality

EPA Objective

Maintain the quality of the groundwater so that existing and potential uses, including ecosystem maintenance, are protected.

Policy Context

Management consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993), and the NHMRC/ARMCANZ Australian Drinking Guidelines- National Water Quality Management Strategy.

Potential Impacts and Management

There are several potential sources of groundwater contamination, including leachable sodium salts from the calcine tailings dump, on-site drainage and on-site waste disposal. The majority of the crushed ore will not present a risk to the environment as process chemicals will only be added to the extracted magnetite ore component. The remainder of the ore will therefore be disposed

on-site without risk of leachable chemicals. The disposal of calcine wastes requires management due to the presence of leachable sodium salts, and a lined and managed calcine tailings dump will be utilised, as discussed in section 4.7.2.

Within the process plant, bulk storage of hazardous materials such as fuels and reagents will be in above ground storage tanks. Storage areas will be bunded to contain any spills.

Domestic waste will be disposed on-site in a landfill designed and operated to the satisfaction of the DEP.

PMA undertakes to prepare drainage management plans (including stormwater management) for the mine site and process plant, in consultation with the Department of Minerals & Energy.

Commitment

7) Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water and Rivers Commission.

9) Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water.

10) Design the tailings dams in consultation with the Department of Minerals and Energy and in accordance with the "Guidelines on the Safe Design and Operating Standards for Tailings Storages" of that Department.

12) The proponent will prior to commencing construction develop a water management plan to the satisfaction of the EPA on advice from the Water and Rivers Commission which demonstrates that the borefield will operate in a sustainable manner.

13) The proponent will manage calcined tailings by utilising a lined tailings dump fitted with a drainage extraction for the return of leachate to the process; in addition to management practices such as continual wetting to avoid dust production, and rehabilitation.

14) All significant storages of hazardous material will be located above ground on bunded areas.

15) Prepare drainage management plans for the vanadium mine and process plant at Windimurra in consultation with the Department of Minerals and Energy.

4.7.2 Groundwater and Solid Waste Management

EPA Objective

Wastes should be contained and isolated from groundwater and surface surrounds.

Policy Context

Management consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993), and the NHMRC/ARMCANZ Australian Drinking Guidelines-National Water Quality Management Strategy.

Potential Impacts and Management

The calcined waste tailings dump will be managed to remove leachable sodium salts for return to the process. The calcined tailings dump will be permanently wetted down to assist with sodium salt removal and avoid dust production. Individual dumps are constructed on the basis of storing one years production of calcined tailings and are approximately 120m x 120m x 20m (benched) in dimensions. Once a dump is full then calcine is directed into an adjacent constructed dump. The original dump is continued to be wetted to continue the process of leaching. After a period of time the concentration of salts measured in the leachate reduces to a negligible amount and the dump is then rehabilitated with topsoil and planted with local species of vegetation. The network of drainage pipes and transfer pumps is maintained for areas of rehabilitated calcine tailings in order to collect (and return to the process) leachate resulting from rainfall.

It should be emphasised that this approach not only represents a significant improvement on the procedure detailed in the 1992 PER but also represents the current world's best practice in dealing with calcine tailings.

The fine tailings rejected in the magnetite separation stage will be directed to a conventional tailings dump after thickening. This tailings dump will be designed to facilitate recycling of process water. In addition, the dam will be rehabilitated in a manner which minimises the impacts of any stored salts on the surrounding environment.

Commitments

7) Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water and Rivers Commission.

8) Undertake to guarantee continuity of stock water if changes in groundwater levels, caused by the Project, adversely affect pastoral activities.

9) Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water.

10) Design the tailings dams in consultation with the Department of Minerals and Energy and in accordance with the "Guidelines on the Safe Design and Operating Standards for Tailings Storages" of that Department.

11) Implement measures in the process plant to conserve water.

12) The proponent will prior to commencing construction develop a water management plan to the satisfaction of the EPA on advice from the Water and Rivers Commission which demonstrates that the borefield will operate in a sustainable manner.

13) The proponent will manage calcined tailings by utilising a lined tailings dump fitted with a drainage extraction for the return of leachate to the process, in addition to management practices such as continual wetting to avoid dust production, and rehabilitation.

14) All significant storages of hazardous material will be located above ground on bunded areas.

4.8 Public Health & Safety/Transportation

4.8.1 Risk and Hazard

EPA Objective

Ensure that risk is managed to meet the EPA criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.

Policy Context

Off-site risk is managed in accordance with the EPA criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.

Potential Impacts and Management

While the plant uses quantities of hazardous materials, no significant off-site risk will be present due to the remote location of the mine-site and storage of relatively small quantities of materials.

The transport of all hazardous materials will be carried out in accordance with the provisions of the Explosives and Dangerous Goods Act 1983 and the Australian Code for the Transport of Dangerous Goods by Road and Rail. All transport will be by contractors with proven experience in the handling and transport of hazardous goods by road in Western Australia.

PMA will undertake a qualitative risk assessment of public health and safety to ensure compliance with the DEP's individual risk criteria and DME criteria. In

addition, PMA will establish a contingency plan for all hazardous reagents and products in the event of an accident resulting in spillage of any hazardous material. This contingency plan will be established in accordance with the Western Australian Hazardous Materials Emergency Management Scheme. The Police Department of WA is responsible for the planning, training and functioning of this scheme.

Commitments

27) Develop a transportation management and contingency plan to ensure that the transportation of hazardous materials is undertaken safely. A driver training program will be incorporated into the plan and will include regular review of driver awareness. Similarly, the integrity of transportation equipment will be monitored on a regular basis. The transportation management and contingency plan will be developed in consultation with the Explosives and Dangerous Goods Division of the Department of Minerals and Energy and the Western Australian Hazardous Materials Emergency Management Scheme (WAHMEMS).

28) Submit a final design of the storage facility for the sodium salt reagent at Windimurra to the Department of Minerals and Energy and the EPA for approval as part of the Environmental Management Program prior to the construction of the process plant.

4.8.2 Transport

EPA Objective

Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.

Policy Context

The maintenance of access roads and road traffic management will be undertaken in accordance with the requirements of Main Roads Western Australia.

Potential Impacts and Management

As discussed in section 3.7.3, the increase in vehicle movements on the Great Northern Highway and the Geraldton to Mt Magnet Highway due to the project is considered to be insignificant. The plant site access road between Mt Magnet and the plant is an unsealed road and may require periodical maintenance such as grading.

Commitment

29) Ensure that all handling, packaging and road transport of inputs to the process plant and products from that plant comply with the requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail and the Dangerous Goods Regulations 1992.

30) Undertake maintenance of the unsealed access road to the plant site on an as needs basis, such as periodical road grading.

4.9 Noise Management

EPA Objective

The EPA objective for noise management is not stated in the EPA Guidelines (Appendix 3), as noise is not identified as a significant environmental factor for the vanadium project.

Policy Context

Noise management will be undertaken to satisfy the requirements of the DEP Noise Regulations, dated 31 October 1997, under the Environmental Protection Act 1986. Noise management within the project area will be managed in accordance with Occupational Health and Safety requirements.

Potential Impacts and Management

Noise from the mine site and processing plant is unlikely to be significant due to low density of noise sensitive premises in the vicinity of the plant, with the nearest residence located 4 km south east of the plant (Windimurra Station).

Commitments

Not applicable.

5. PUBLIC CONSULTATION

The original vanadium pentoxide proposal was made available for public comment in 1992 for a period of eight weeks. The current report is made available for a two week public comment period. It is the intention of PMA to invite comment from specific parties such as those listed below;

1) Government departments including:

   Department of Minerals and Energy, Water and Rivers Commission, Ministry for Planning, Aboriginal Affairs Department, Department of Conservation and Land Management, Department of Resources and Development, Health Department of Western Australia, Main Roads Western Australia, Mid West Development Commission and Geraldton Port Authority.

2) Local government authorities:

   Shire of Mt Magnet.

3) Others:

   Station Owner, Windimurra Station.
   Conservation Council of Western Australia.

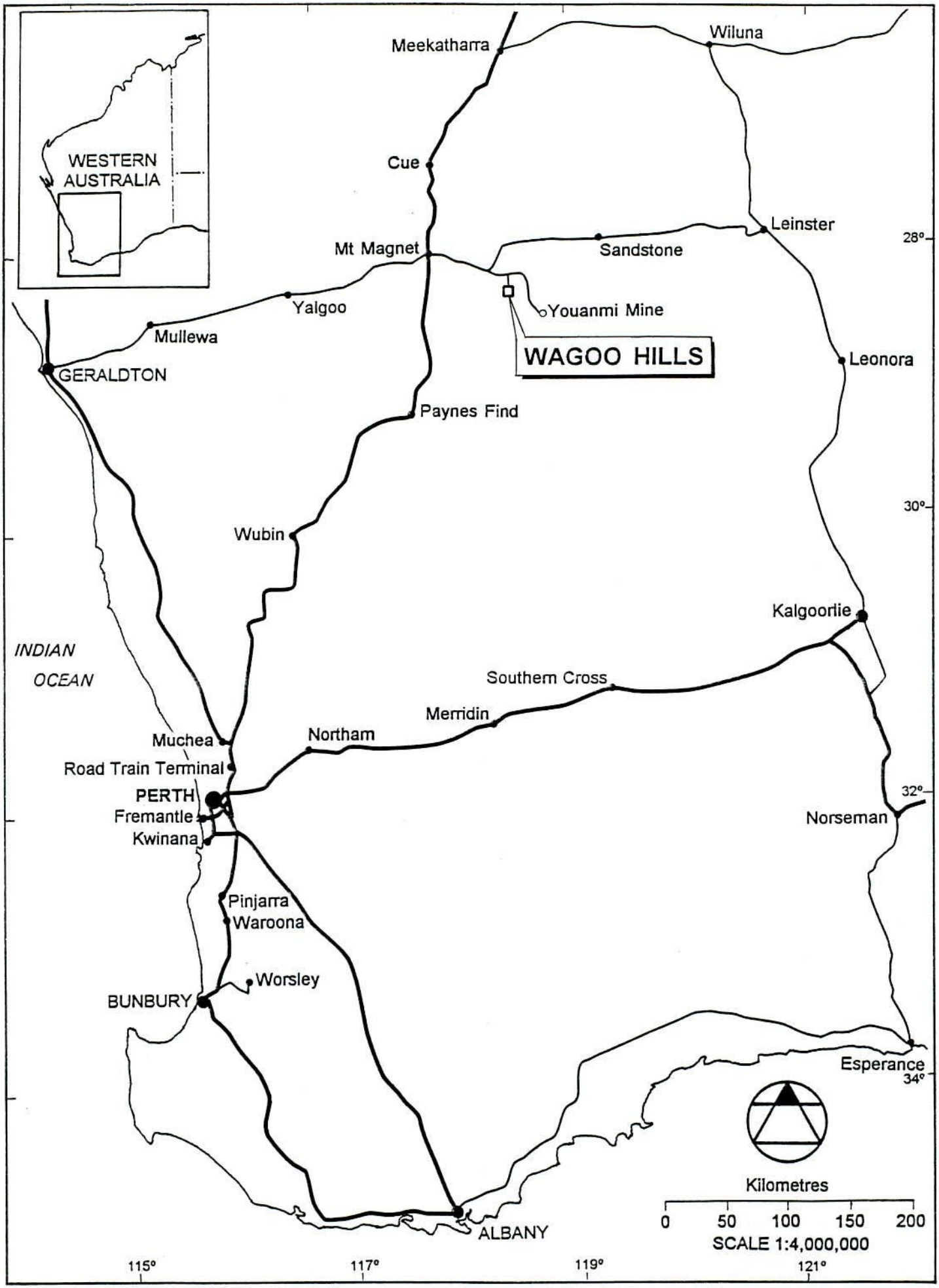
DISCLAIMER

This report has been prepared on behalf of, and for the exclusive use of, our client, and is subject to and issued in accordance with the agreement between the client and Alan Tingay & Associates. Alan Tingay & Associates accepts no liability or responsibility whatsoever in respect of any use of or reliance upon this report by any third party.

As part of our Quality System, documents are checked then approved prior to distribution.

Document Reference:	JG372 Report No: 98/03
Project Number:	97068
Draft:	Final
Checked:	N. Davies
Approved:	N. Davies
Date:	20/02/98

FIGURES



DRAWN BY: GLM 27-1-98 CHECKED BY: JG 18-2-98

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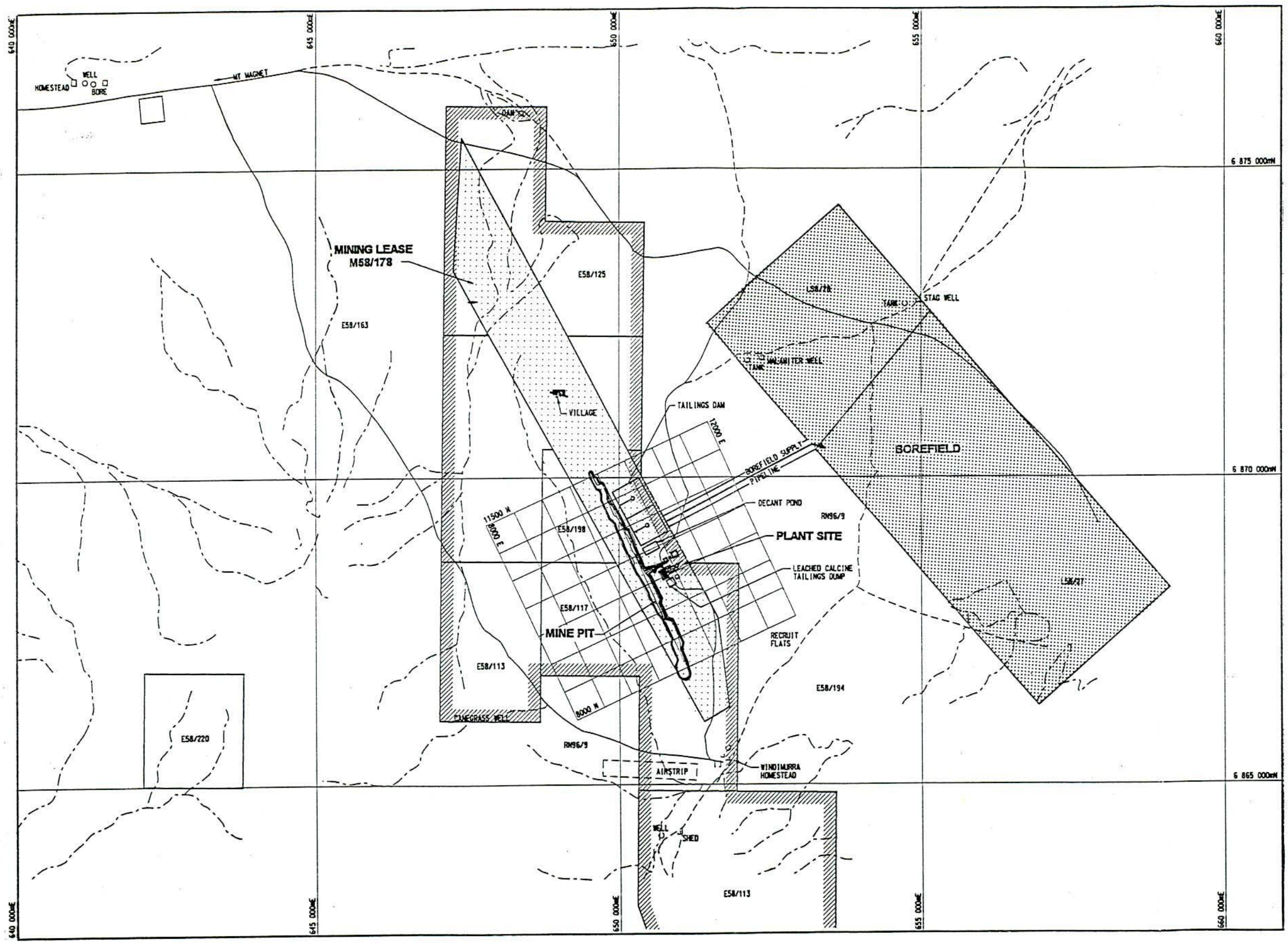
ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
REGIONAL LOCATION
FIGURE 1



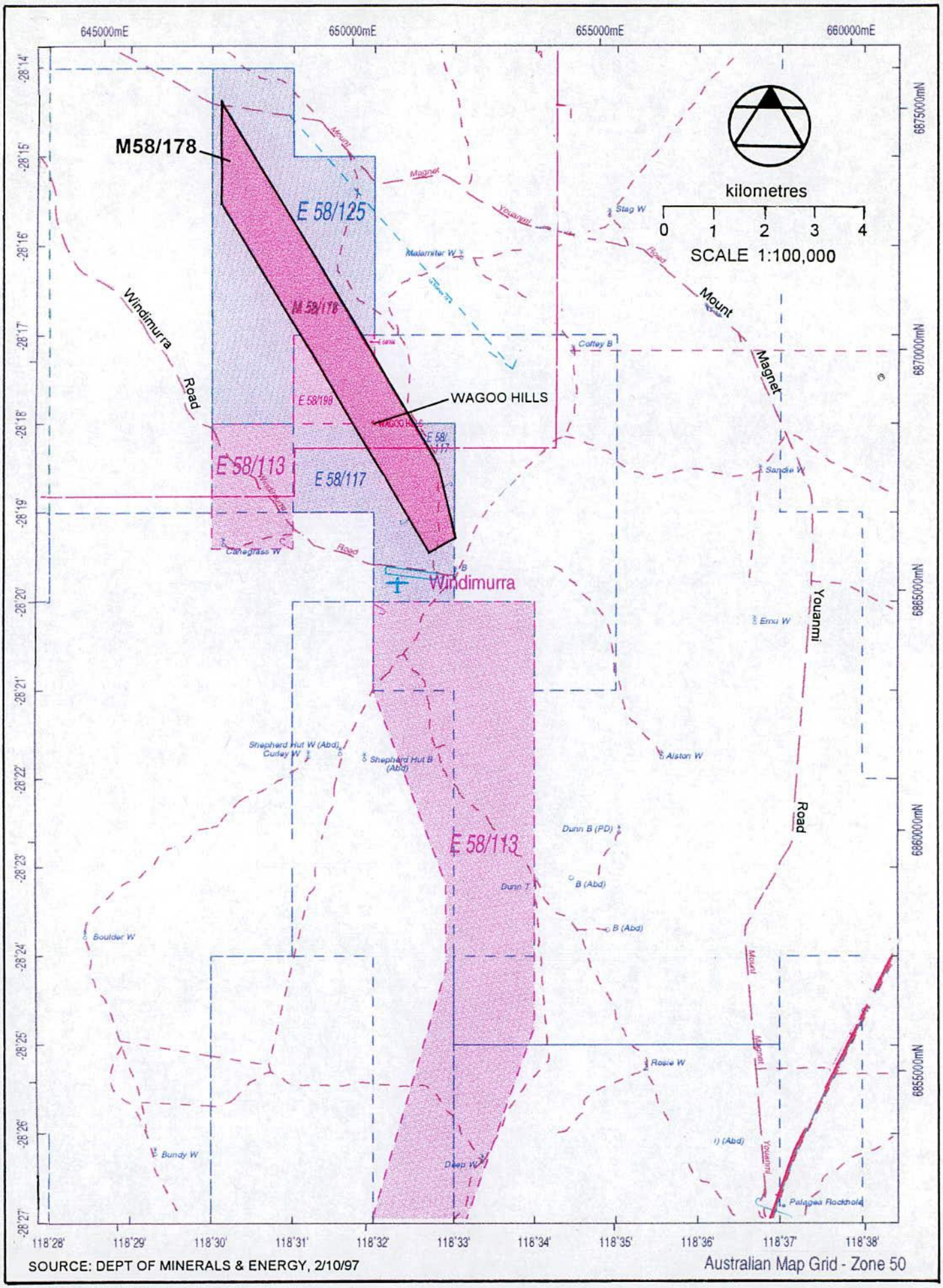
DRAWN BY: PB 23.1.98 CHECKED BY: JG 18-2-98

97068

SOURCE: SIGNET ENGINEERING PTY LTD 14/1/97

ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
MINESITE & GROUNDWATER BOREFIELD
FIGURE 2



SOURCE: DEPT OF MINERALS & ENERGY, 2/10/97

Australian Map Grid - Zone 50

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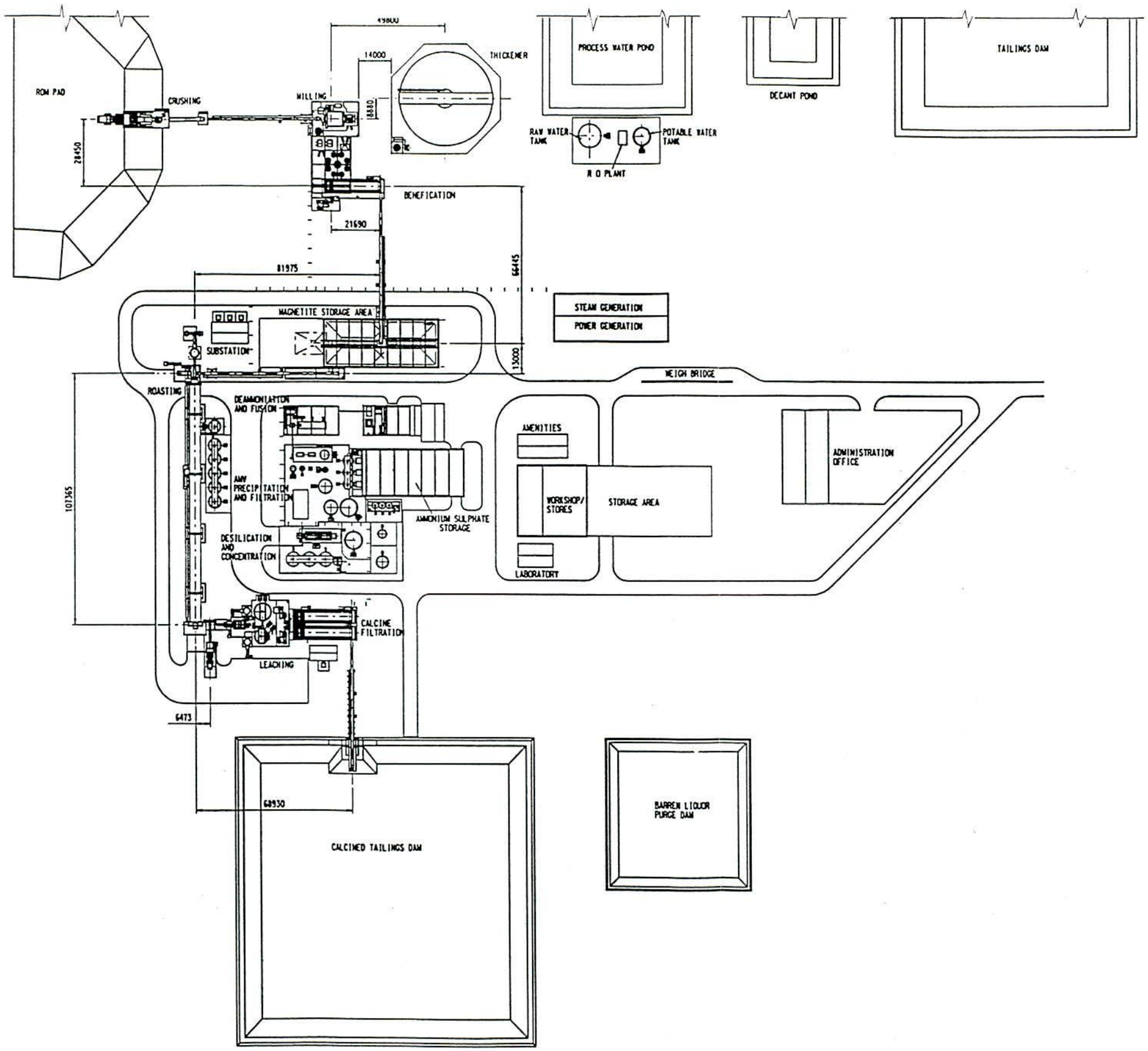
ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
TENEMENT MAP
FIGURE 3



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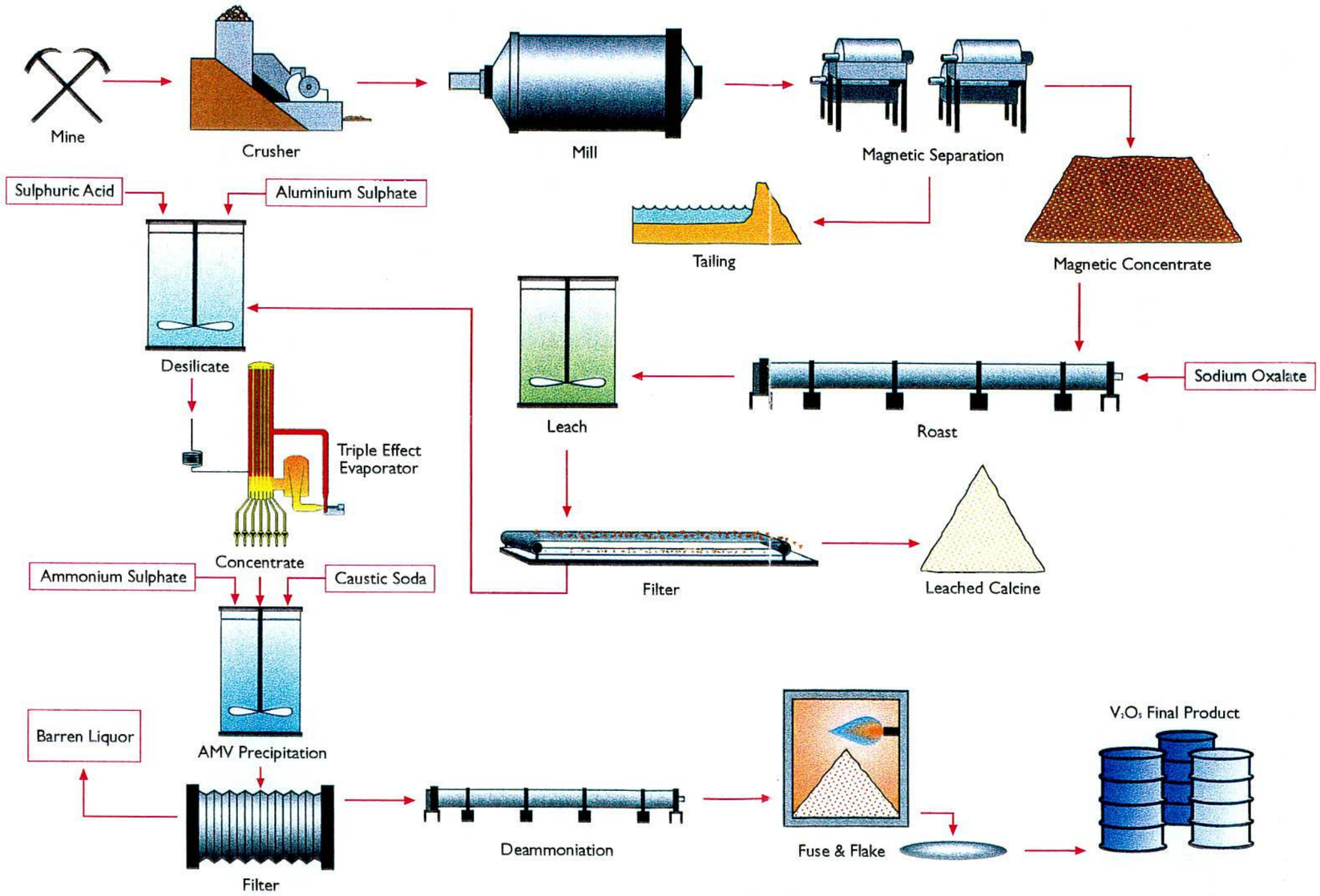
SOURCE: SIGNET ENGINEERING PTY LTD 1/97

ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
PLANT LAYOUT
FIGURE 4

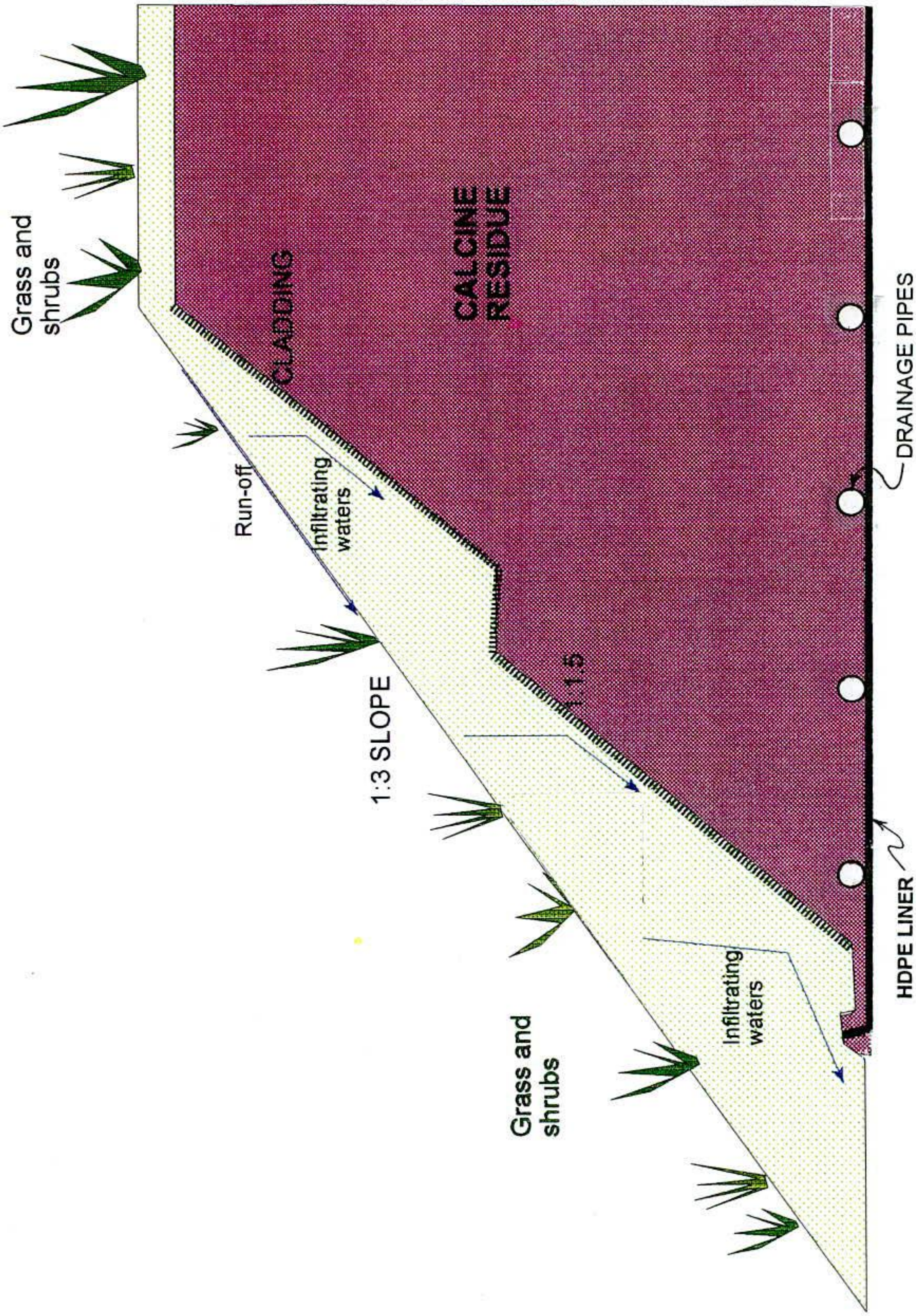


WAGOO HILLS (WINDIMURRA)
VANADIUM PROJECT
ORE PROCESSING METHODOLOGY
FIGURE 5

SOURCE: PRECIOUS METALS AUSTRALIA OCTOBER, 1997

97068 DRAWN BY: GLM 15-10-97 CHECKED BY: JG 18-2-98

ALAN TINGAY & ASSOCIATES



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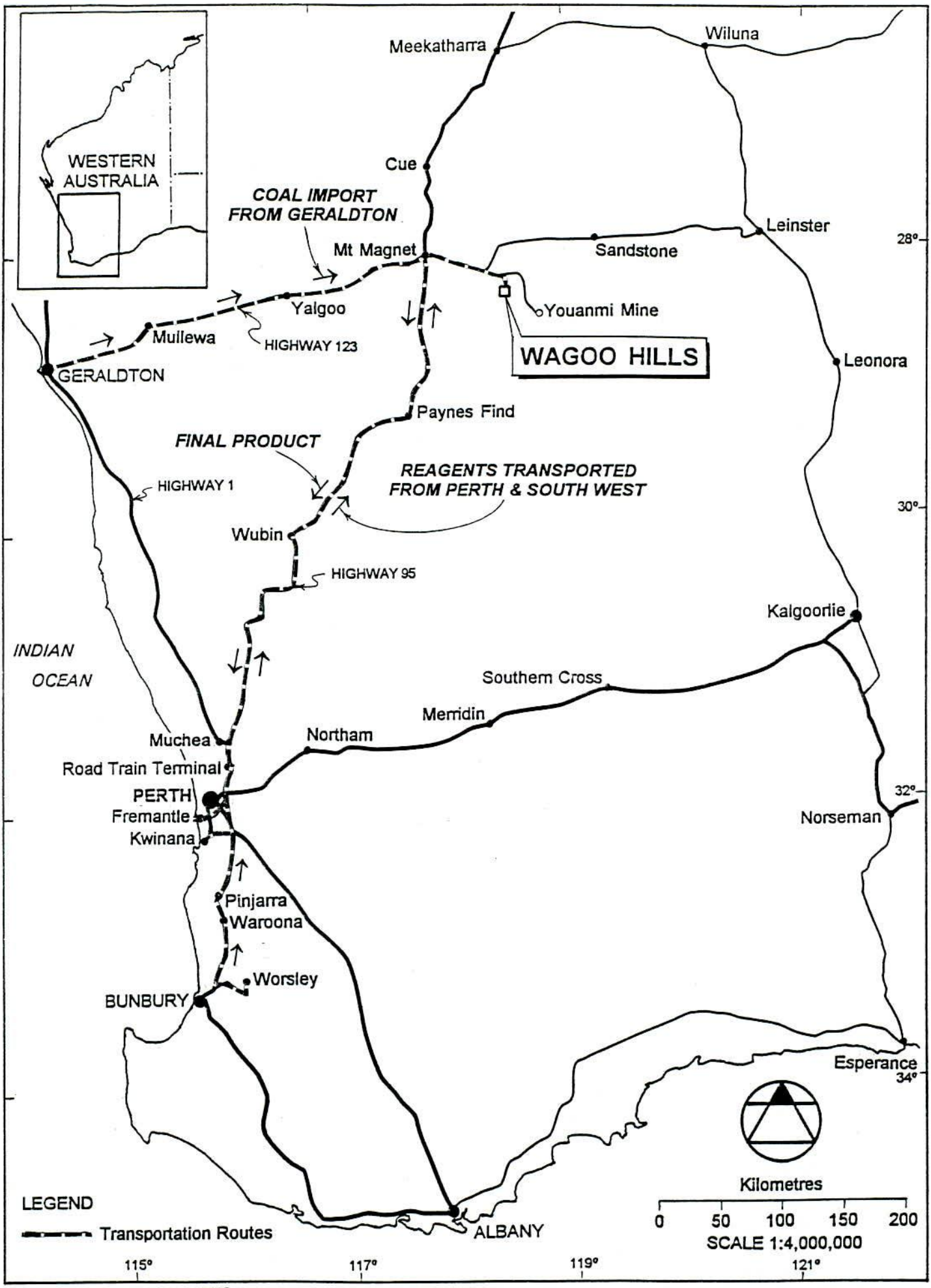
SOURCE: STASS ENVIRONMENTAL

ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
LINED CALCINE TAILINGS DUMP
FIGURE 6



DRAWN BY: GLM 27-1-98 CHECKED BY: ND 19-2-98

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ALAN TINGAY & ASSOCIATES

WAGOO HILLS (WINDIMURRA) VANADIUM PROJECT
TRANSPORTATION ROUTES
FIGURE 7

APPENDIX 1

MINISTERIAL CONDITIONS
(DATED 16 SEPTEMBER 1992)

Ass # 653

Bull # 633

State # 283

WESTERN AUSTRALIA
MINISTER FOR THE ENVIRONMENT

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

WAGOO HILLS VANADIUM PROJECT & MINGENEW COAL PROJECT (653)

PRECIOUS METALS AUSTRALIA LIMITED

This proposal may be implemented subject to the following conditions:

1 **Proponent Commitments**
The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made in the Public Environmental Review and subsequently and included in Environmental Protection Authority Bulletin 633 as Appendix 1 (A copy of the commitments is attached).

2 **Implementation**
Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 **Water Resources**
Development and operation of the Wagoo Hills Vanadium Project should not adversely affect surface and ground water resources on Windimurra Station. If such resources are adversely affected, stock and domestic water supplies of appropriate quality and quantity are to be supplied to Windimurra Station.

3-1 Prior to construction at the Wagoo Hills site, the proponent shall prepare water management plans referred to in commitments 5.1 to 5.4 and 6.1 for the Wagoo Hills Vanadium Project, in consultation with the Water Authority of Western Australia, the Department of Agriculture and the Department of Mines, to the requirements of the Environmental Protection Authority.

These plans shall:
1. address surface water flows affected by the project;
2. outline a groundwater monitoring programme to determine whether there has been any contamination arising from the operation of the minesite or process plant and associated tailings dam;

Published on

17 SEP 1992

3. make provision for suitable water supplies for stock and domestic purposes on Windimurra Station if existing supplies are adversely affected by the project; and
4. specify responsibility for monitoring, auditing of performance and compliance with the plans.

3-2 The proponent shall subsequently implement the plans required by condition 3-1.

4 Non-vanadium Dust Levels

The Wagoo Hills Vanadium Project and the Mingenew Coal Project should not cause excessive levels of non-vanadium dust.

4-1 The proponent shall not cause short term levels of non-vanadium bearing dust at residential premises near the Wagoo Hills Vanadium Project to exceed 1000 microgrammes per cubic metre (ug/m^3), measured continuously over 15 minutes.

4-2 The proponent shall not cause short term levels of non-vanadium bearing dust at residential premises near the Mingenew Coal Project to exceed 1000 microgrammes per cubic metre (ug/m^3), measured continuously over 15 minutes.

5 Noise Limits

The noise generated by the vanadium mine and process plant at Wagoo Hills and the coal mine and stockpile area at Mingenew should be kept within environmentally acceptable levels.

5-1 The proponent shall ensure that the noise emissions from the Wagoo Hills Vanadium Project do not cause or contribute to noise levels in excess of:

- 40 dB(A) between 10.00 pm and 7.00 am:
- 45 dB(A) between 7.00 pm and 10.00 pm on any day, and between 7.00 am and 7.00 pm on Saturday, Sunday and any gazetted public holiday; and
- 50 dB(A) between 7.00 am and 7.00 pm Monday to Friday inclusive, but excluding gazetted public holidays;

as measured at the nearest affected noise-sensitive premises.

Where the combined level of the noise emissions from the project and the normal ambient noise exceeds the levels specified above, this condition will be considered to be contravened only when the noise emissions from the site are determined to be dominant and significantly influencing the measured noise levels.

5-2 The proponent shall ensure that noise emissions from the Wagoo Hills Vanadium Project do not include tonal or impulsive components or other characteristics which make the noise more annoying than it would be in their absence.

5-3 The proponent shall conduct noise surveys and assessments at the Wagoo Hills site in consultation with the Environmental Protection Authority.

5-4 The proponent shall ensure that the noise emissions from the Mingenew Coal Project do not cause or contribute to noise levels in excess of:

- 40 dB(A) between 10.00 pm and 7.00 am:
- 45 dB(A) between 7.00 pm and 10.00 pm on any day, and between 7.00 am and 7.00 pm on Saturday, Sunday and any gazetted public holiday; and

- 50 dB(A) between 7.00 am and 7.00 pm Monday to Friday inclusive, but excluding gazetted public holidays;

as measured at the nearest affected noise-sensitive premises.

Where the combined level of the noise emissions from the project and the normal ambient noise exceeds the levels specified above, this condition will be considered to be contravened only when the noise emissions from the site are determined to be dominant and significantly influencing the measured noise levels.

5-5 The proponent shall ensure that noise emissions from the Mingenew Coal Project do not include tonal or impulsive components or other characteristics which make the noise more annoying than it would be in their absence.

5-6 The proponent shall conduct noise surveys and assessments at the Mingenew site in consultation with the Environmental Protection Authority.

6 Blast Limits

Blasting operations at the Wagoo Hills Vanadium Project and Mingenew Coal Project should not produce excessive air pressure levels.

6-1 The proponent shall ensure that blasting operations at the Wagoo Hills Vanadium Project are undertaken such that:

- the air-blast over-pressure level generated by any blast does not exceed 125 dB (peak linear); and
- no more than one in any ten consecutive blasts results in an air-blast over-pressure level greater than 120 dB (peak linear);

as measured at the nearest affected noise-sensitive premises.

6-2 The proponent shall ensure that blasting operations at the Wagoo Hills Vanadium Project only occur between the hours of 9.00 am and 5.00 pm Monday to Saturday inclusive.

6-3 The proponent shall ensure that blasting operations at the Mingenew Coal Project are undertaken such that:

- the air-blast over-pressure level generated by any blast does not exceed 125 dB (peak linear); and
- no more than one in any ten consecutive blasts results in an air-blast over-pressure level greater than 120 dB (peak linear);

as measured at the nearest affected noise-sensitive premises.

6-4 The proponent shall ensure that blasting operations at the Mingenew Coal Project only occur between the hours of 9.00 am and 5.00 pm Monday to Saturday inclusive.

7 Decommissioning

The satisfactory decommissioning of the Wagoo Hills Vanadium Project and the Mingenew Coal Project, the removal of the plants and installations and the rehabilitation of the sites and their environs is the responsibility of the proponent.

7-1 At least six months prior to the decommissioning of each project, the proponent shall prepare a decommissioning and rehabilitation plan.

7-2 The proponent shall implement the plans required by condition 7-1.

8 Proponent

These conditions legally apply to the nominated proponent.

8-1 No transfer of ownership, control or management of the proposal which would give rise to a need for the replacement of the proponent shall take place until the Minister for the Environment has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.

9 Time Limit on Approval

The environmental approval for the proposal is limited.

9-1 If the proponent has not substantially commenced each project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the projects have been substantially commenced. Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the five year period, further consideration of the proposal can only occur following a new referral to the Environmental Protection Authority).

10 Compliance Auditing

In order to ensure that environmental conditions and commitments are met, an audit system is required.

10-1 The proponent shall prepare periodic "Progress and Compliance Reports", to help verify the environmental performance of each project, in consultation with the Environmental Protection Authority.

Procedure

The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Bob Pearce, MLA
MINISTER FOR THE ENVIRONMENT

16 SEP 1992

APPENDIX 2

CONSOLIDATED PROPONENT COMMITMENTS, (EPA BULLETIN 878, JANUARY 1998)

Schedule 1

Proponent's Consolidated Environmental Management Commitments

April 1992

WAGOO HILLS VANADIUM PROJECT & MINGENEW COAL PROJECT (653/1146)

Precious Metals Australia Limited

The Proponent undertakes to fulfil the following commitments in accordance with the applicable State laws and regulations and with the standards and procedures agreed with the State.

1. Vegetation Clearing

1.1 Minimise clearing of land consistent with safe and efficient operations.

2. Weeds

2.1 Develop a management strategy to minimise the spread of Saffron Thistle. This strategy will be developed in consultation with the Department of Agriculture.

3. Fire

3.1 Maintain strict fire control procedures.

4. Rehabilitation

4.1 Design and rehabilitate all waste dumps in consultation with the Department of Mines and in accordance with the "Guidelines for Waste Dump Design and Rehabilitation" of that Department.

4.2 Rehabilitate the surrounds of the vanadium mine site and the process plant and village areas at Windimurra following decommissioning of the project.

4.3 Prepare specific proposals for site decommissioning in the event of termination of the project and implement those proposals after review and approval of the relevant Government Agencies at the time.

5. Groundwater

5.1 Design and implement a monitoring programme of groundwater levels and water quality in the borefield and other bores in the vicinity of the project area at Windimurra before operational start and to the satisfaction of the Water Authority of WA.

5.2 Undertake to guarantee continuity of stock water if changes in groundwater levels, caused by the Project, adversely affect pastoral activities.

5.3 Guarantee to provide the Pastoral Lessee with a potable water supply if the project adversely affects his current source of fresh water.

5.4 Design the tailings dams in consultation with the Department of Mines and in accordance with the "Guidelines for the Preparation of the New Tailings Dams" of that Department.

5.5 Implement measures in the process plant to conserve water.

6. Surface Water

6.1 Prepare drainage management plans for the vanadium mine and process plant at Windimurra in consultation with the Department of Mines.

7. Dust

7.1 Ensure that vanadium dust is controlled to below limits established in the Mines Regulations Act 1946 and Regulations, by incorporating dust extraction and collection equipment in the process plant.

7.2 Develop an effective operator training and awareness program to ensure that the process plant is well operated and any potential occupational health problems are quickly identified and are rectified immediately.

8. Emissions

8.1 Submit final design details of exhaust stacks and exhaust cleaning devices prior to construction for approval by the EPA as part of the Environmental Management Programme.

8.2 Submit a detailed composition of the coal to the EPA and Department of Mines to assist in designed management plans.

9. Transport/Packaging/Storage

9.1 Develop a transportation management and contingency plan to ensure that the transportation of hazardous materials is undertaken safely. A driver training program will be incorporated into the plan and will include regular review of driver awareness. Similarly, the integrity of transportation equipment will be monitored on a regular basis.

The transportation management and contingency plan will be developed in consultation with the Explosives and Dangerous Goods Division of the Department of Mines and the Western Australian Hazardous Materials Emergency Management Scheme (WAHMEMS).

9.2 Submit a final design of the storage facility for the sodium salt reagent at Windimurra to the Department of Mines and the EPA for approval as part of the Environmental Management Program prior to the construction of the process plant.

9.3 Ensure that all handling, packaging and road transport of inputs to the process plant and products from that plant comply with the requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail and the Dangerous Goods (Road Transport) Regulations 1983 and amended Regulations 1988.

10. Workforce

10.1 Prohibit domestic pets in the project area as a condition of employment.

10.2 Restrict off-road driving and prohibit hunting by employees as a condition of employment.

APPENDIX 3

EPA GUIDELINES

Department of Environmental Protection

Head Office:
Westralia Square
141 St Georges Terrace
Perth, Western Australia 6000
Tel (08) 9222 7000 Fax (08) 9322 1598
http://www.environ.wa.gov.au

Postal Address:
PO Box K822
Perth, Western Australia 6842

Mr N Beckingham
Senior Environmental Scientist
Alan Tingay & Associates
21 Howard Street
PERTH WA 6000

Your Ref
Our Ref 85/91
Enquiries Murray Hogarth

Dear Mr N Beckingham

WAGOO HILLS VANADIUM PROJECT & MINGENEW COAL PROJECT - PROJECT CHANGES (1184)

Further to our earlier discussions regarding the above proposal, please find enclosed the final guidelines for preparation of the proponent's document.

Should you need any further information please contact Murray Hogarth on 9222 7139 in the first instance.

Yours sincerely

M Hogarth

for K J Taylor
DIRECTOR
EVALUATION DIVISION

29 January 1998

Enc

Environmental Protection Authority
Guidelines

WAGOO HILLS VANADIUM PROJECT & MINGENEW COAL PROJECT — PROJECT CHANGES

(Assessment Number 1184)

Part A	Specific Guidelines for the preparation of the Section 46 environmental review document
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 map
Attachment 4	Air Quality and Air Pollution Modelling Guidelines

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.

Part A: Specific Guidelines for the preparation of the Section 46 environmental review

1. The proposal

Precious Metals Australia Limited wishes to modify aspects of the Wagoo Hills Vanadium Project and Mingenew Coal Project which was assessed by the Environmental Protection Authority in 1992. The proposed project areas are indicated on the attached plan (Attachment 3). A description of the currently approved proposal and the proposed changes are described below.

Approved proposal

Wagoo Hills Vanadium Project

This consists of a proposed vanadium mining and processing operation 80 km south-east of Mt Magnet. Vanadium pentoxide ore would be mined via open-cut mining of a pit 150 m wide by 35 m deep, which would be extended 200 m each year over the 30 year life of the mine. 1.45 million tonnes per annum of ore would be processed at the adjacent processing plant and the resulting 3700 tonnes per annum of vanadium product transported to Fremantle for export. Infrastructure to support the operation would include an accommodation village, process water supply, and roads.

Mingenew Coal Project

This consists of development of a small coal quarry 20 km north-east of Mingenew to supply coal to the Wagoo Hills Vanadium Project for use in the process plant as a source of energy. The quarry is expected to supply 30000 - 70000 tonnes of coal to the Wagoo Hills Vanadium Project each year.

Proposed changes

Precious Metals Australia Limited wishes to increase the rate of mining and processing at the Wagoo Hills mine from 1.5 Mtpa (million tonnes per annum) to 2.28 Mtpa. In addition, the proponent also wishes to make changes to the proposed method of ore processing.

The proponent also wishes to abandon the proposed Mingenew Coal Project and instead satisfy the Wagoo Hill Project's energy requirements from imported coal shipped through the port of Geraldton, or use natural gas.

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

2. Environmental factors relevant to this proposal

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	
Factor	**Site specific factor**	**EPA objective**	**Work required for the environmental review**
BIOPHYSICAL			
Groundwater		Maintain the quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Detail of increased water requirements for mining, processing, and other associated operations (including dewatering). Assessment of the implications this may have on regional groundwater. Proposed measures to manage impacts.
POLLUTION MANAGEMENT			
Dust/fumes	vanadium dust/fumes	Ensure that the dust/fume levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements (including Section 51 of the Environmental Protection Act 1986) and acceptable standards.	Estimate quantities and concentrations of vanadium emissions which will be generated by the project. Comparison of estimates with relevant standards and limits. Proposed measures to minimise vanadium emissions. (Refer also to the *Air Quality and Air Pollution Modelling Guidelines* contained in Attachment 4)

Particulates / 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.	Estimate quantities and concentrations of particulate emissions which will be generated by the project, in particular, the process plant. Comparison of estimates with relevant standards and limits. Proposed measures to minimise emissions of particulates. (Refer also to the *Air Quality and Air Pollution Modelling Guidelines* contained in Attachment 4)
Gases	SO_2, NO_x, CO, and ammonia	Ensure that gaseous emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986 (all reasonable and practicable measures are taken to prevent or minimise discharge).	Estimate quantities and concentrations of all gaseous emissions which will be generated by the project, in particular, the process plant. Comparison of estimates with relevant standards and limits. Proposed measures to minimise emissions. (Refer also to the *Air Quality and Air Pollution Modelling Guidelines* contained in Attachment 4)
Greenhouse gases		Ensure that greenhouse gas emissions meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986 (all reasonable and practicable measures are taken to prevent or minimise greenhouse gas discharge).	Detail of potential sources of greenhouse gases and estimates of the quantities of these gases produced annually.

Groundwater quality		Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) [and the NHMRC / ARMCANZ Australian Drinking Water Guidelines - National Water Quality Management Strategy].	Detail of water requirements for the mining, processing, and other associated operations. Detail of the drainage and fate of water used/pumped. Assessment of the implications this may have on local and regional groundwater quality. Proposed measures to manage impacts.
	solid waste	Wastes should be contained and isolated from groundwater and surface surrounds.	Detail of the composition and storage of all solid wastes, in particular, various tailings streams from the processing plant. Assessment of the implications this may have on local and regional groundwater quality. Proposed measures to manage impacts.
SOCIAL SURROUNDINGS			
Public health and safety	risk and hazard	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.	Description of the types, quantities, and methods of transport for various reagents and products of the processing plant, in particular, any hazardous goods. Assessment of the implications this may have on public health and safety. Proposed measures to manage impacts.

Public health and safety	road traffic	Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements..	Description of the transport requirements for the mine and processing plant, including those associated with importing coal. Assessment of the implications this may have on public health and safety. Proposed 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).....6

Distributed by the proponent to:

Government departments

- Department of Minerals and Energy.....2
- Water and Rivers Commission.....1
- Ministry for Planning 1
- Aboriginal Affairs Department 1
- Department of Conservation and Land Management.....2
- Department of Resources Development.....1
- Health Department of Western Australia 1
- Main Roads Western Australia.....1
- Mid West Development Commission 1
- Geraldton Port Authority 1

Local government authorities

- Shire of Mingenew 1
- Shire of Mt Magnet.....1

Libraries

- J S Battye Library 3
- The Environment Centre.....2
- Geraldton Public Library 2

Other

- Conservation Council of WA 1
- members of the public who have recently made submissions on this project to the EPA (list to be provided by the DEP) 2

3.2 Available for public viewing

- J S Battye Library;
- Geraldton Public Library; and
- Department of Environmental Protection 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 will co-ordinate, on behalf of the EPA, relevant government agencies and the public in providing advice about environmental matters during the assessment of the environmental review for this proposal.

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. It should be noted that the environmental review will form the legal basis of the Minister for the Environment's approval of the proposal and therefore the environmental review 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. 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 programme, 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 develop and implement an Environmental Management System appropriate to the proposal consistent with the principles outlined in the AS/NZS ISO 14000 series, including provisions for accountability review and a commitment to continuous improvement.

The key components which should be included in environmental review documentation, depending on the scale of the proposal, are environmental management:

- policy;
- resources budget;
- programme;
- plan(s);
- training programme;
- monitoring programme;
- contingency plan(s); and
- improvement plan(s).

Documentation on the relevant components should be proportional with the scale of the proposal and the potential environmental impacts. If appropriate, the documentation can be incorporated into a formal environmental management system and provision made for periodic performance review. Public accountability is a principle that should be incorporated into the approach on environmental management.

The environmental management programme is the key document that should be appropriately defined in an environmental review. The environmental management programme should provide plans to manage the relevant environmental factors, define the performance objectives, outline the operational procedures and outline the monitoring and reporting procedures which would demonstrate the achievement of the objectives.

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

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 could be presented in the form of a table as follows:

Table 1: Key characteristics (example only)

Element	Description
Life of project (mine production)	55 months
Size of ore body	682 000 tonnes
Area of disturbance	100 hectares
Ore mining rate • maximum • average	 • 200 000 tonnes per year • 160 000 tonnes per year
Background gamma radiation levels • maximum • average	 • 0.52 µGrey per hour • 0.16 m 0.08 µGrey per hour
Water supply • source • maximum hourly requirement • maximum annual requirement	 • Yarloop borefield, shallow aquifer • 180 cubic metres • 1 000 000 cubic metres
Heavy mineral concentrate transport • truck movements (maximum)	 • 75 return truck loads per week

[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.

The key characteristics table should be supplemented with figures to ensure that the proposal is clearly explained. 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.

All figures should include a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, a title and (where applicable) the date of aerial photo.

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 proposal and all 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 key 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 key 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 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 a commitment to good general management of the project. Such commitments would not normally be included in the list appended to the statement. The EPA expects that the proponent will audit these commitments by internal processes. Though the DEP would not subject the less significant environmental commitments to routine audit, it may periodically request that compliance with these commitments be demonstrated, so as to verify satisfactory environmental performance in the proponent's implementation of the proposal.

With the implementation of continuous improvement, the procedures to implement the commitments may need to be changed. These changes can be made in updates to the environmental management plan, whilst ensuring the objective is still achieved.

Once the proposal is approved, changes to the commitments constitute a change to the proposal and should be referred to the DEP.

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

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

Commitment (Who/What)	Objective (Why)	Action (How/Where)	Timing (When)	Whose advice	Measurement/ Compliance criteria
1. XYZ Mining will develop a rehabilitation plan	to protect the abundance, species diversity, geographic distribution and productivity of the vegetation community types 3b and 20b	by limiting construction to a small area (10 ha) of Reserve 34587 and rehabilitating the area	before construction	CALM, NPNCA	fences built; species distribution and density consistent with vegetation community types 3b and 20b
2. XYZ Mining will minimise dust generation	to maintain the amenity of nearby land owners	by preparing and implementing a Dust Control Plan which meets EPA Dust Control criteria	before the start of construction phase	preparation: DEP; implementation: Shire	Letter from Shire submitted with Performance and Compliance Report.

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

Draft commitments which are not in a format that can be audited will not be accepted by project officers for public review documentation. Proponents will be assisted to revise inadequate commitments.

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.

APPENDIX 4

RECOMMENDED PRACTICES FOR THE CONTROL OF VANADIUM DUST, DEPARTMENT OF MINERALS AND ENERGY

RECOMMENDED PRACTICES FOR THE CONTROL OF VANADIUM DUST, DEPARTMENT OF MINERALS AND ENERGY.

(1) Stockpiles containing <5% V_2O_5 should be appropriately contained (e.g. by use of bundling or storage bins) and the containment system should incorporate measures to ensure the suppression or containment of dust during handling and transfer operations. Dry process materials containing >5% V_2O_5 should be stored in sealed bins and transferred to the process by enclosed and ventilated conveyors or elevators.

(2) Dried out surface deposits of pregnant liquor solutions may also pose an inhalation risk. Process engineering should be such to minimise the occurrence of spillage's (eg. enclosing reaction vessels, thickeners, and incorporating monitoring equipment and alarms to indicate full capacity, equipment failure, mal-functions). Vessels containing vanadium rich solutions should be suitably bunded and the floors (eg. epoxy coated concrete) should be sloped with adequate drainage to a single sump which permits the return of floor washing to the process. Procedures should be implemented to limit the spread of vanadium contamination and to ensure regular washing down/clean-up of spillage's.

(3) A high standard of housekeeping should be fostered through out the plant and regular clean-up campaigns should be implemented. To the extent practicable, all clean up should be by washing spilt material to sumps. Vacuuming systems may be required near the fusion furnace and drumming station areas. Shovelling, sweeping or blowing or dry vanadium bearing materials should not be permitted.

(4) Unit processes involved in the refining of vanadium salts should be isolated, enclosed and ventilated and, to the extent practicable, operated remotely. This is particularly important from the deammoniation stage onwards since the vanadium is in a highly concentrated form (>75% V_2O_5). Close attention should be paid to dust and fume extraction around the fusion furnace. Automatic re-feeding systems should be incorporated to handle spillage's of material in the vanadium production circuits.

(5) Procedures should be implemented prior to maintenance work to ensure that residual vanadium contamination is removed and there are no hazardous fumes or gases (eg. NH_3, SO_2) present in the workplace environment.

(6) All collected dust, fumes and gases should be cleaned via appropriate filtration and/or scrubbing systems prior to emission to the atmosphere. Collected solids from the dust extraction system should be transferred (directly) to sealed bins or bulkabags prior to disposal. Appropriate procedures should be implemented for the cleaning or maintenance of the dust collection system.

(7) The design and the operation of the plant should be such that to the extent practicable, workers are not required to wear respiratory

protection devices or protective clothing on a routine basis. Where respirators are required, they should be properly maintained, employees should be trained in their correct fitting and use, and management should ensure that appropriate procedures are adhered to.

(8) Control, rest and crib rooms should be provided which are sealed to prevent ingress of airborne contamination and which have a filtered air supply.

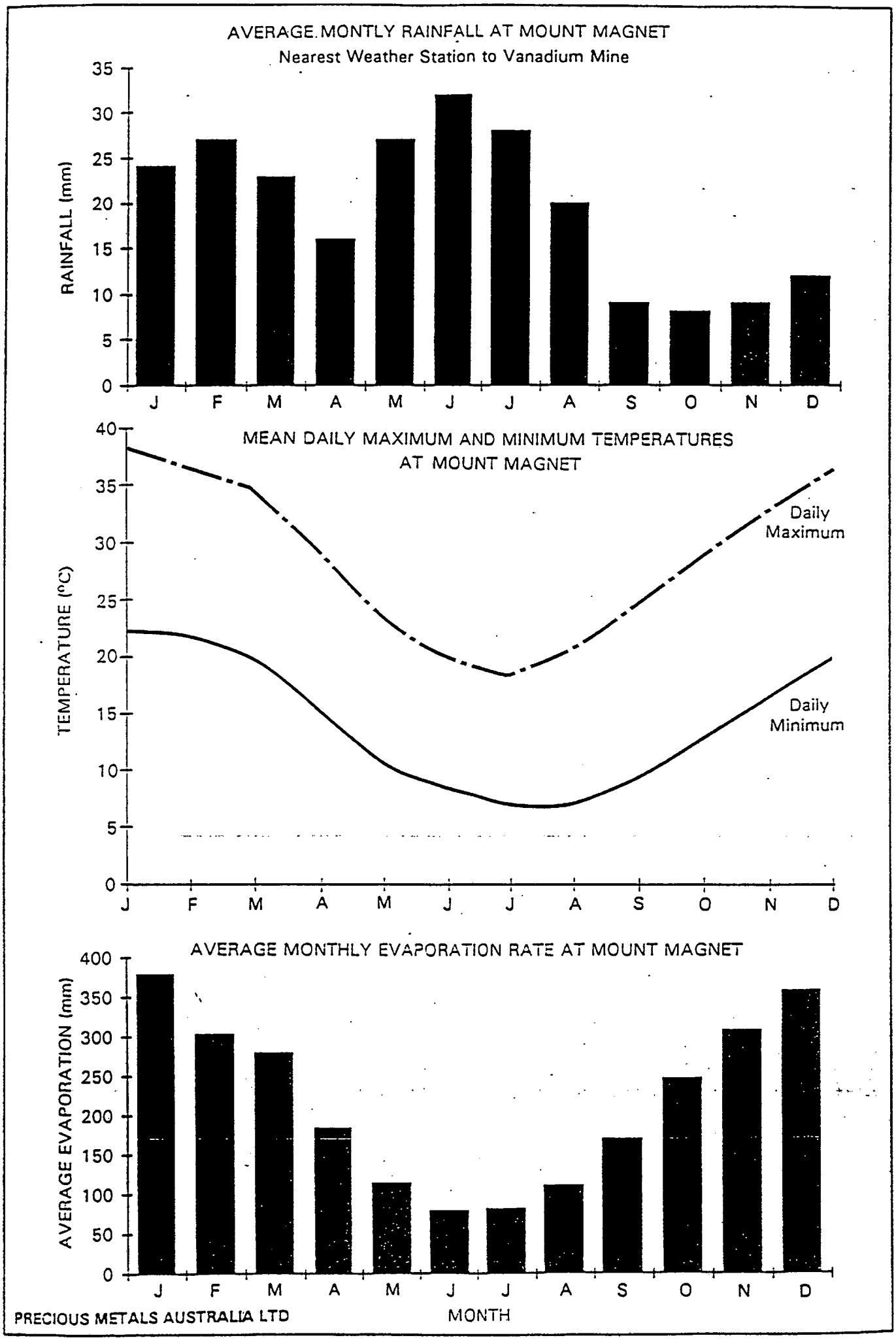
(9) A good attitude to personal cleanliness should be fostered amongst vanadium plant workers (eg. washing hands before eating or drinking, showering after shift).

(10) Workers involved in vanadium production should have their work clothes provided and laundered on site.

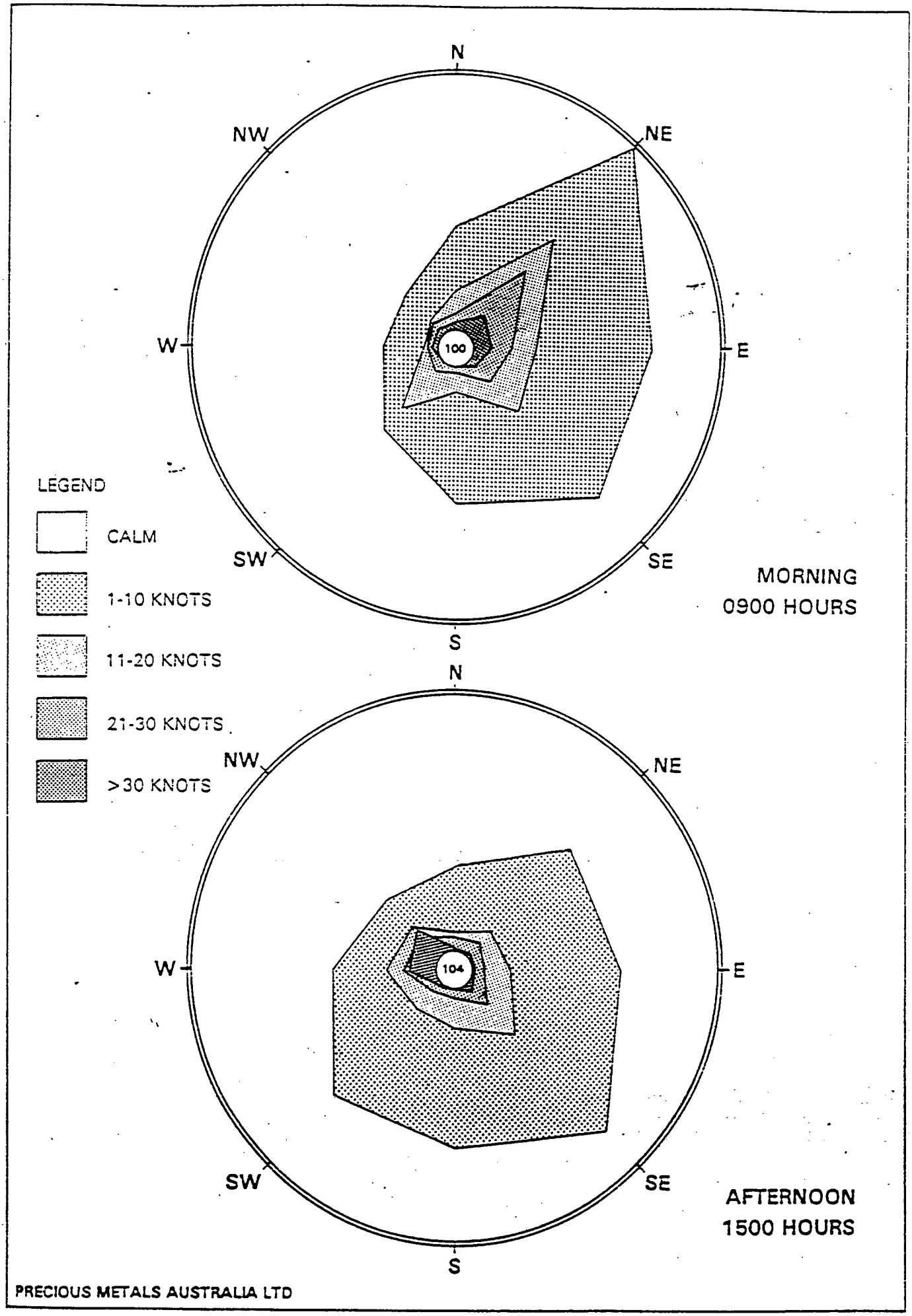
While many of the above measures can be provided for in plant design, it is important to that engineering control measures are properly operated and maintained to assure their continual effectiveness. This will require appropriate monitoring (eg. alarms, operational procedures and worker training.

APPENDIX 5

CLIMATIC AND WIND ROSE DATA, MT. MAGNET



WEATHER DATA FOR MT MAGNET



WIND ROSES FOR MT MAGNET

APPENDIX 6

LIST OF POTENTIAL VERTEBRATE FAUNA AT WINDIMURRA

LIST OF POTENTIAL VERTEBRATE FAUNA AT WINDIMURRA

AMPHIBIANS

Pseudophryne guentheri
Neobatrachus wilsordei

REPTILES

GECKOS

Diplodactylus mainii
Diplodactylus pulcher
Diplodactylus squarrosus
Gerhyra variegata

LEGLESS LIZARDS

Delma australis
Delma fraseri
Lialis burtonis
Pygopus nigriceps

SKINKS

Cryptoblepahrus carnabyi
Cryptoblepharus plagiochephlus
Ctenotus mimetes
Ctenotus schomburgkii
Ctenotus uber
Egernia depressa
Egernia inornata
Eremiascincus richardsonii
Lerista macropisthopus
Menetia greyii
Morethia obscura
Tiliqua occipitalis
Tiliqua rugosa

DRAGONS

Ctenophorus inermis
Ctenophorus reticulatus
Ctenophorus scutulatus
Pogona minor

MONITORS

Varanus caudiolineatus
Varanus eremius
Varanus gouldii
Varanus tristis

SNAKES

Aspidites ramsayi
Morelia stimsoni
Acanthophis pyrrhus
Denisonia fasciata
Furina ornata
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Rhinophochalus monachus
Vermicella bertholdi
Vermicella bimaculata
Vermicella fasciolata
Vermicella semifasciata

BIRDS

Emu
Collared Sparrowhawk
Wedge-tailed Eagle
Brown Falcon
Crested Pigeon
Galah
Port Lincoln Ringneck

Mulga Parrot
Bourke's Parrot
Pallid Cuckoo
Horsfield's Bronze-Cuckoo
White-backed Swallow
Welcome Swallow
Tree Martin
Richards Pipit
Black-faced Cuckoo-shrike
White-winged Triller
Red-capped Robin
Hooded Robin
Gilberts Whistler
Rufous Whistler
Grey Shrike-thrush
Crested Bellbird
Grey Fantail
Willie Wigtail
Chiming Wedgebill
Cinnamon Quail-thrush
White-browed Babbler
White-winged Fairy-wren
White-browed Scrubwren
Weebill
Western Gerygone
Chestnut-rumped Thornbill
Slaty-backed Thornbill
Yellow-rumped Thornbill
Southern Whiteface
Spiny-cheeked Honeyeater
White-browed Treecreeper
Yellow-throated Miner
Singing Honeyeater
White-plumed Honeyeater
White-fronted Honeyeater
Crimson Chat
Zebra Finch
Australian Magpie-lark
Black-faced Woodswallow
Little Woodswallow
Grey Butcherbird
Pied Butcherbird
Grey Currawong
Australian Magpie
Torresian Crow

MAMMALS

INDIGENOUS MAMMALS

Short-beaked Echidna
Common Dunnart
Fat-tailed Dunnart
Hairy-footed Dunnart
Wongai Ningaui
Black-footed Rock Wallaby
Western Grey Kangaroo
Common Wallaroo (Euro)
Red Kangaroo
Hills Sheathtail-bat
White-striped Mastiff-bat
Little Mastiff-bat
Greater Long-eared Bat
Lesser Long-eared Bat
Gould's Wattled Bat
Little Broad-nosed Bat
Western Broad-nosed Bat
Sandy Inland Mouse
Spinifex Hopping Mouse

INTRODUCED MAMMALS

House Mouse
Rabbit
Dingo
Fox
Feral Cat