WORKING ARRANGEMENT FOR ALCOA'S

BAUXITE MINING OPERATIONS

IN STATE FOREST

ENDORSED

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HR - Please advise!

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PART 1

1. Introduction

The "Northern Jarrah Forest Bauxite Mining Handbook" is a comprehensive introduction and explanation of bauxite mining in the Northern Jarrah forest. It is essential reading for Officers involved with bauxite mining.

This booklet has more specific objectives. "It is a summary of essential information for control of Alcoa's field operations in State Forest at Jarrahdale, Huntly, Del Park and Wagerup. The booklet has three parts: a brief description of mining; a definition of Alcoa and F.D. responsibilities in State forest and the main part, prescription for implementing these responsibilities. The first two parts are likely to remain unchanged unless new mining methods develop or Alcoa enters new agreements with the State. Prescription, on the other hand, should be updated when new research information has been produced and verified.

A co-ordinated approach between Alcoa and F.D. is required for updating and implementing prescriptions. This is important so that better use is made of information in both organisations and prescriptions represent mutually agreed, practical, and technically sound working arrangements. Working groups including representatives from Alcoa and F.D. have been nominated with responsibility for developing (where necessary) and updating prescriptions.

It is not sufficient for prescriptions to contain only technical specifications. For works programming it is important to record requirements such as timing or season when the work must be done and the resources required, men, materials and plant. Responsibility for finance must be shown where not already specified in an agreement.

2. Field Operations in Bauxite Mining

Bauxite mining follows a sequence of exploration, mining and rehabilitation. This includes a number of discrete operations:

* Exploration drilling at a spacing of 120m grid,
* Ore development drilling at spacing of 60m grid,
* Removal of marketable timber,
* Stacking and burning forest residues,
* Removal and stock piling overburden,
* Drilling and blasting caprock,
* Loading and transporting bauxite to crusher,

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* Crushing and transport to refinery,
* Rehabilitation of mined pits,
* On-going management of rehabilitated areas.

Bauxite mining is located within jarrah forest that has been treated to improve its resistance, or rehabilitate it from dieback disease.

Within the list of mining operations above, working arrangements or prescriptions are required in every case where forest values are affected, particularly spread of dieback disease. Most of these prescriptions are already operational and require only updating. A new prescription has been developed for the mining operation itself i.e. loading and transporting bauxite to the crusher. Arrangements are in hand for trial hygienic mining in Urbrae Block to develop and test this prescription.

3. Organizational Responsibilities

3.1 Forests Department

Under the provisions of the Forest Act 1918 (amended) the Forests Department is charged with the responsibility for management of State forest included in the Alcoa lease area.

In fulfilling this responsibility the F.D. aims to ensure that forest resources are managed for maximum long term social and economic benefit. To this end, the F.D. has adopted a multiple use management system therein seeking to minimise conflict with other land uses whilst having regard to overall balanced development including economic considerations. Mining is recognised as being compatible with Water Production and is permitted in Recreation, Catchment Protection, Scientific and Timber Production M.P.A.s. However, mining is not considered compatible in Conservation and Landscape M.P.A.s.

Mining is a transient land use and the F.D. is charged with ensuring it takes place with minimum deleterious effects on the forest environment and that rehabilitation is consistent with the land use needs.

3.2 Alcoa

Alcoa's responsibilities in State forest are defined in Alumina Refinery Agreement Acts (Kwinana, Pinjarra, Wagerup) and under the Wagerup ERMP.

3.2.1 Alcoa's Rights and Obligations under Refinery Acts. (Forest requirements only).

* Alcoa may remove overburden and forest produce for its own operations.

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* Alcoa will give the Conservator 6 months notice of such intentions.
* Conservator will remove millable timber from areas to be mined.
* Alcoa will dispose of overburden and forest waste so as not to damage adjacent forest.
* Alcoa will leave areas clean and tidy after mining but not necessarily on original contour.
* Alcoa will pay compensation for areas of State forest cleared for mining.
* The forest Officer in Charge (O.I.C.) may prohibit use of F.D. roads and give Alcoa directions on roads that can be used. This does not apply to roads built by the Company, Main Roads Department, or organizations other than F.D.
* Damage to F.D. roads from Alcoa's operations will be repaired at the company's expense.
* Alcoa will restore and reafforest areas destroyed by mining.
* Alcoa will comply with Bushfires Act and take precautions to prevent the spread of fire in its lease area and in adjacent areas, as directed by the O.I.C.

3.2.2 Alcoa's Undertakings Under Wagerup ERMP

Although developed as part of the Wagerup ERMP these undertakings are being applied to other minesites ie. Jarrahdale, Del Park and Huntly.

* Alcoa submits mining and management programme which specifies areas for mining and methods for mining and rehabilitation. Five year mining plans are submitted for Jarrahdale and Huntly and Del Park and 10 year mining plans for Willowdale. These are revised annually and form the basis for clearing applications for areas to be mined. Annual clearing applications are checked by O.I.C.'s and the mining operation group (see handbook) before approval is recommended to the Conservator.
* Exploration drilling is subject to stringent dieback hygiene specified by the F.D.
* Rehabilitation proposals are developed to best suit land use and include the following stages:

  Reshaping mined areas to control drainage,

  Return of topsoil,

  Contour or grade ripping,

  Establishing ground vegetation and trees with the aid of fertilizer,

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Controlling drainage and water discharge from pits.

Providing access for future forest management.

* Alcoa has undertaken to rehabilitate dieback infected forest next to its mining areas. Prescriptions have been developed and F.D. work programme is funded by Alcoa through FIRS (Forest Improvement and Rehabilitation Scheme).

* Alcoa will dismantle its facilites on termination of mining and will carry out rehabilitation measures.

PART 2

Prescriptions

The table below lists prescriptions which are necessary for Alcoa's operations in State forest. Working groups have been nominated with responsibility for developing (where necessary) and updating these prescriptions. A basis for most of these prescriptions lies in the "mining operations handbook". Many prescriptions have already been developed and in operation for a number of years. These require only updating.

Title	Objective	Working Group
Exploration and Development Drilling	Ensure dieback hygiene & minimize damage to vegetation	Convenor: OIC Jarrahdale Members: Alcoa Rep. Reg. For. Prot. North For. Mining Dwellingup For. Mining Harvey
Logging, clearing and burning	Ensure dieback hygiene, sale of MFP and proper fire control	Convenor: R/L Ops. North Members: Alcoa Rep. Snr For. Prot. North Snr For. Prot. Central
Dieback hygiene in mining	Develop hygiene mining at Urbrae	Convenor: Alcoa Rep. Members: OIC Dwellingup OIC Dwellingup Rsch Supt. North
Rehabilitation of mined pits	Update "rehab" prescriptions	Convenor: OIC Dwellingup Members: Alcoa Rep. OIC Jarrahdale OIC Harvey OIC Dwellingup Rsch Landscape Expert
Post "rehab" management of Pits	specifications for silviculture, access fire control and recreation	Convenor: R/L Planning North Members: Alcoa Rep. R/L Planning Central OIC Dwellingup Rsch I & P Rep. Snr For. Prot. North Information Branch

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FIRS	Update Specifications	Convenor: Insp Admin. North Members: Alcoa Rep. OIC Dwellingup Rsch OIC Dwellingup OIC Harvey OIC Jarrahdale

Prescriptions should include:

- Objective
- Strategy
- Technical specifications
- Works Programme Requirement
  - Timing
  - Resources
- Funding

EXPLORATION AND DEVELOPMENT DRILLING

1.0 Background on Exploration and Drilling

1.1 Phases of Exploration

Phase 1: Magnetometer Survey: remote sensing to broadly outline areas of laterization. Completed many years ago for most of Lease.

Phase 2: Exploration drilling: Drilling at 400 foot grid to prove up best areas from magnetometer survey. Done with no dieback hygiene during the 1960's. Not permitted since 1972.

Phase 3: Development drilling: firming up of ore bodies by drilling at 200ft. centres, 2-5 years in advance of mining. Dieback hygiene conditions imposed since 1976.

Phase 4: Grade Control Drilling: Final ore definition by drilling at 15m centres 6 months-2 years before mining. Hygiene restrictions according to dieback category since 1976.

Phase 5: "Fill-ins": Anomalies or areas with assay problems drilled just prior to mining.

1.2 Ore Grades

Alcoa seeks bauxite ore capable of producing an average of 31.5% alumina. The lower cut-off grade is 27.5%.

All information on ore resource and grades is in the hands of the company, as are details of the economic calculations which determine average and cut-off grade acceptability.

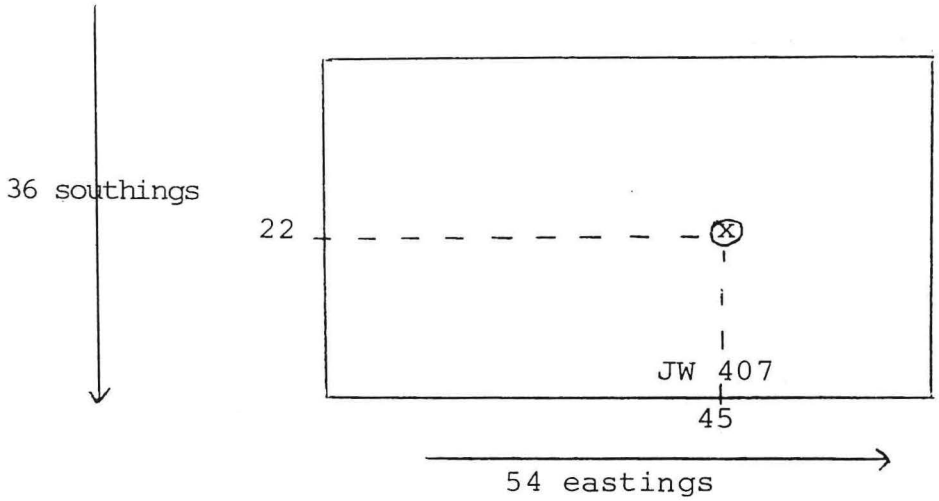
1.3 The Alcoa Mapping System

i) Imperial Map Scale was used to early 1970.

Many imperial maps are still in use. The imperial grid system comprises "squares" of 830m x 600m, with 28 "squares" to a "block", of 3,300m x 3,600m.

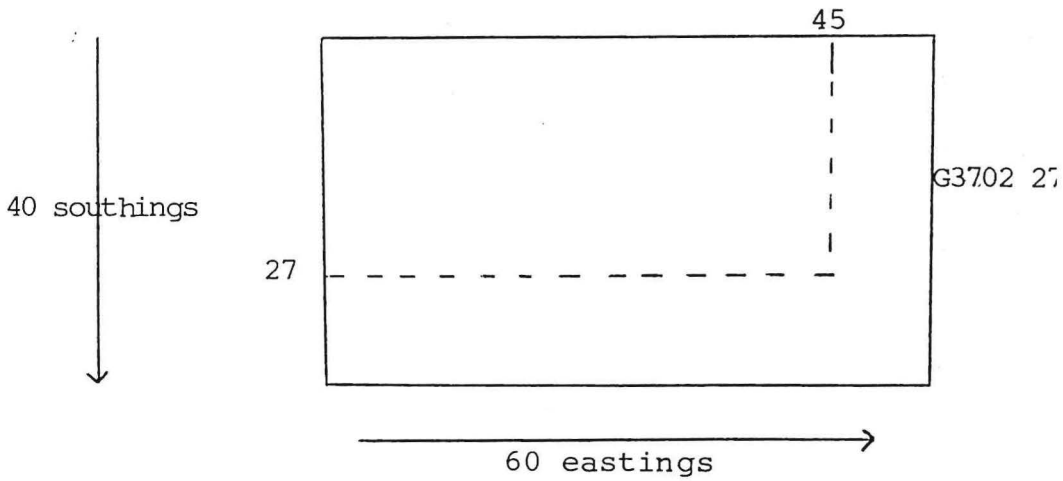
Within each "square" points are identified by southings and eastings. The southing axis has 36 digits and the eastings axis 54 digits.

For example, for square JW407, the point shown is JW407.22.45.



ii) Metric Maps are now coming into more general use.

The same grid system is used, except that 40 southings and 60 eastings are used and "Squares" are designated one letter and 2 digits, e.g.



2.0 Planning for Drilling Operations

2.1 Five Year Drilling Plan

Each July Alcoa will submit a 5 year drilling plan (1:25,000 scale) to the local office of the Forests Department.

This plan should show the broad direction of drilling over each of the ensuring 5 years. This will assist in the co-ordination of drilling and associated operations with other forest activities, particularly F.I.R.S. and prescribed burning. Without such a plan there maybe:

- destruction of dieback symptoms and the creation of false symptoms resulting in greater difficulty in disease interpretation.
- Exposure of the soil (by burning) causes hygiene difficulties under moist soil conditions.
- disturbance of pegs which have been accurately surveyed.

In addition, this plan permits commencement of Forests Department hygiene planning well in advance of the operations.

2.2 Annual Drilling Plans

By the first week of July each year Alcoa will submit proposals for the next 12 months drilling operations to the local office of the Forests Department. These should include:

i) Broadscale plans showing areas and type of drilling at 1:25,000 scale.

ii) A programme of drilling indicating Alcoa's priority for operations.

iii) Forest Officers will examine the dieback status and other forest values of the proposed drilling areas. From these considerations a hygiene strategy will be developed. (Guidelines in Section 3.2).

All dieback forest will be scheduled for moist soil operations.

The remaining area of forest programmed for drilling will be scheduled for dry and moist soil operations. The general priority for dry soil conditions will be:

ONE: Drilling areas within large continuous areas of dieback-free forest

- where, due to soil conditions maintaining clean vehicles under moist soil conditions will be difficult.
- Forests types which are likely to suffer high impact if infected with Phytophthora.

TWO: Forests types which are likely to suffer low impact if infected with Phytophthora.

- Small areas of dieback-free forest which are likely to be vulnerable to the natural spread of the disease.

It is recognised that some areas of dieback-free forest will have to be scheduled for moist soil operation subject to the appropriate hygiene (section 4).

iv) The programme for drilling operations is resolved from an amalgamation of Alcoa's priorities and the hygiene strategy. This will be returned to Alcoa within 2 weeks of the arrival of the programme if a five year drilling plan is available and 4 weeks if not.

2.3 Changes and additions to drilling operations are possible throughout the year, provided adequate notice for dieback demarcation is given.

3.0 Schedule of Operations

3.1 Dieback Interpretation and Demarcation should occur in advance of all field operations to ensure that hygiene conditions are consistantly applied to those operations.

3.2 Dieback Location Maps (1:25,000) and hygiene conditions (including access) should be forwarded to the mine site surveyor for areas of operation in the ensuing drill season. Early notification is assisted by 5 year drilling plans.

3.3 Survey and Pegging at 60m intervals permits a survey of the surface geology to accurately map the final drill layout. From this a final survey at 15m intervals occurs. At this time dieback management lines are accurately mapped onto drill layout sheets and 2 copies are forwarded to the local Forests Department.

3.4 Hygiene Conditions (access routes, points for vehicle cleanliness) are then added to the drill layout and one copy is forwarded to Alcoa's drilling supervisor.

3.5 Notification: Survey crew location is to be available at all times from the minesite security office.

Drill rig location - the local Divisional office to be notified on a weekly basis.

4.0 Environmental Controls

4.1 Dieback Hygiene

i) Objective: To carry out field operations in such a manner the risk of spreading dieback disease into dieback-free forest is minimised.

ii) Hygiene Strategy

- Dieback Categories
  - Areas of forest in which field operations are to take place will be categorised into:

    Dieback
    Suspect
    Dieback-free

    In the forest these categories will be separated by Management Lines of painted blazes on trees and will be demarcated by Forest Officers.
- Access to each category will be designated and checked by F.D. Officers.
- Field Operations will be confined separately to each category. Transfer from one category requires specific hygiene conditions.
- Cleanliness:
  - Vehicle and plant cleanliness is the basis for controlling dieback spread in the field operation. This could be achieved by:
    - Washdown with fungicide - treated water from a high pressure/low volume pump.
    - Airhose to either suck or blow by use of vacuum pump or compressor.
    - Brushing down.
- Exploration and Ore Development Operations will be permitted in:
  - Dieback forest under all conditions.
  - Suspect and Dieback-free forest only under dry soil conditions. In the event of dry season rainfall, operations may continue provided soil is not picked up by vehicles; however, support vehicles must be left outside the dieback-free boundary.

. Grade Control Operations will be permitted in:

. Dieback forest under all conditions.

. Suspect and Dieback-free forest under dry soil conditions with normal field hygiene; and during moist soil conditions with the following limitations:

. support vehicles remain outside the dieback-free boundary or on nominated hard surfaced roads.

. drill rigs do not pick up and transfer soil while operating in the drill area or travelling on access roads.

iii) Field Hygiene

. Dieback-Free Forest

. Every vehicle is to be inspected prior to entry into the area to ensure that no soil has been picked up in transit. A cleandown is required at the dieback boundary or nominated cleandown point if the vehicle is not clean.

. Each vehicle traversing an area must be continually checked to ensure that soil is not being picked up. If soil conditions deteriorate (as in Suspect and Dieback-free above) the operation must transfer to dieback forest via an approved access road.

. After drilling each hole prior to departure for the next hole the drill rig must be inspected for cleanliness. If the rig is not clean of soil, cleandown is required.

. Cleandown must take place at least once per day as a safety measure.

. Suspect Forest

. Conditions apply to field operations in suspect forest will be the same as those for dieback-free forest.

. Prior to leaving suspect forest and entering dieback-free forest vehicles are to be free of soil.

. Dieback Forest

. Cleandown between holes is not necessary.

. Do not cross moist low-lying flats or creeks.

- Prior to leaving dieback forest vehicles are to be free of soil.

- General

  - Training: Vehicle operators must be trained in hygiene principles, techniques of inspection for vehicle cleanliness and vehicle cleandown.

  - Prior to departure from the base depot all vehicles must be in a clean condition.

4.2 Rubbish

No refuse is to be left behind any field operation.

4.3 Forest Disturbance

All field operations must minimise damage and disturbance to forest vegetation.

5.0 Review

Prescription to be reviewed July 1985.

LOGGING, CLEARING AND BURNING OF MINESITES

1.0 Sequence of Events

1.1 Five year mining plan revised annually by Alcoa and submitted to Conservator September-October.

1.2 Inspection and consideration by Divisions, M.W.A. etc. Recommendation to Minister through M.M.P. Group.

1.3 Minister approves five year plan about December.

1.4 Alcoa submits two year clearing plan in March. Six months notice is required but under agreement this is extended to two years to facilitate proper planning and implementation of dieback hygiene.

1.5 The two year clearing plan is assessed by Divisions and M.O.G. and Region recommends to Conservator.

1.6 Conservator approves two year clearing plan about June.

1.7 In July Alcoa submits to Divisions a clearing schedule for next twelve months.

1.8 Agreed proposals are surveyed and demarcated in the field by Alcoa.

1.9 Divisions check areas for dieback and demarcate in the field. A plan showing dieback and dieback-free is given to Alcoa.

1.10 Divisions arrange removal of salvage sawlogs and minor forest produce.

1.11 Alcoa heaps and burns remaining debris.

1.12 The area is ready for mining.

2.0 Objectives

To carry out the sequence of events with maximum efficiency having due regard for:

2.1 Timber salvage and clearing only areas which are to be mined.

2.2 Minimising the risk of spreading dieback disease into dieback-free forest.

2.3 Minimising the risk of fire damage to surrounding forest.

3.0 Hygiene Strategy

3.1 F.D. will categorise all forest into either dieback, suspect or dieback-free. In the field and on 1:10,000 scale plans given to Alcoa, each of the three categories is indicated. In the rare cases where suspect occurs, special local arrangements should be made for marking as it should be regarded as dieback-free for entry of vehicles but dieback for exit.

3.2 Field operations will be confined to a single disease category. Transfer from one to another requires specific hygiene conditions.

3.3 Access will be defined in advance by the F.D. as shown on plan in 3.1.

3.4 The objective is to prevent infected soil movement into suspect or dieback-free forest. Vehicle and plant cleanliness is the basis for controlling soil movement and dieback spread in field operations. It can be achieved by:

- Wash-down using high pressure low volume pump.
- Airhose to either suck or blow by use of vacuum pump or compressor. (dry soil)
- Brushing down. (dry soil)

3.5 Soil Conditions

i) Dry Soil

Timber salvage, clearing and burning will be possible in all dieback categories during dry soil conditions when the probability of spread is lowest.

All plant must be clean on entry to 'suspect' or 'dieback-free' areas and on leaving dieback or suspect to travel through dieback-free forest.

ii) Wet Soil

Operations in 'dieback' are permitted providing plant is cleaned down before leaving. Operation in 'suspect' and 'dieback-free' should be avoided if possible but are permitted providing plant is clean on entry and support vehicles for all categories of dieback remain outside the boundary or on nominated hard surface roads.

iii) Hygiene requirements above apply equally to all operations by all parties involved in timber salvage and clearing of minesites.

4.0 Planning for Timber Salvage and Clearing

4.1 The sequence of planning and operational events are 1.0 - 1.12.

4.2 1:10,000 scale plans are used at all stages.

4.3 Changes to the plan are possible provided adequate notice is given to allow for dieback demarcation, timber salvage, clearing and burning.

5.0 Field Operations

5.1 General

i) Training - Vehicles and plant operators must be trained in the techniques of inspection for vehicle cleanliness, cleandown and hygiene principles.

F.D. will train Alcoa staff when required, Alcoa will train their operators.

ii) Prior to departure from the base depot all vehicles must be in clean condition.

iii) Access is to be confined to routes approved by the F.D. This is important during wet and moist soil conditions.

iv) Dieback-free Forest

Prior to entry into the above, every vehicle is to be inspected by the operator to ensure no soil has been picked up in transit. Such inspection should be monitored form time to time by both Alcoa and F.D. staff. Cleandown is required at the dieback boundary or nominated cleandown point if the vehicle is not clean.

v) Suspect Forest

The same conditions as for 'dieback-free', except prior to leaving suspect forest vehicles and plant are to be free of soil.

vi) Dieback Forest

Prior to leaving dieback forest, vehicles are to be free of soil.

5.2 Clearing Boundary Definition

i) Boundaries of proposed clearing areas are marked in the field by Alcoa using yellow

plastic tape attached to trees or stumps.

ii) Following inspection and approval of proposed clearing boundaries by local F.D. staff, Alcoa overmarks the yellow plastic tape with white paint prior to the commencement of clearing operations.

iii) When necessary, Alcoa will prepare site drainage plans for approval by M.O.G. prior to commencement of clearing.

5.3 Dieback/Dieback-free Forest Boundary Definition

i) The F.D. will reinspect dieback boundaries established for surveying and drilling operations prior to commencement of clearing operations.

ii) Dieback boundaries are established by means of yellow blazes on trees along the boundary. The yellow blazes face into the dieback infected forest and act as a warning to all machine operators that should they pass through the line they may infect dieback-free forest.

iii) Dieback boundary markings removed during timber salvage will be replaced by the F.D. Any removed during clearing will be replaced by Alcoa using yellow painted pegs. Within the pit they will also use yellow painted pegs.

iv) The agreed minimum practical unit of dieback-free forest to be segregated for hygiene in a largely dieback area is 2 hectares.

5.4 Forest Produce Removal

i) Salvage of merchantable timber on S.F. is performed by licensed private contractors under the direction of the F.D.

ii) Identical hygiene conditions apply to timber removal operations as described for clearing operations in this prescription.

iii) F.D. is to be responsible for ensuring that operators are cleaned-down when required.

iv) F.D. is to maintain the dieback boundaries during the forest produce removal phase.

5.5 Clearing Methods

i) A forest officer will inspect each clearing area prior to the commencement of clearing operations to ensure all merchantable timber has been removed.

ii) Any non-merchantable timber remaining within the cleared areas is pushed by bulldozer, heaped and burnt by Alcoa. F.D. will direct Alcoa concerning fire protection requirements.

iii) Concurrent with bulldozing operations cleared areas are raked to remove large surface rocks and tree roots. Depending upon quantity of rocks the raked material may be heaped and burnt or separately removed by loader and truck to a site approved by the F.D. using approved access.

iv) The dieback boundary is to be maintained by Alcoa during clearing operations.

v) All clearing machinery coming on site i.e. entering State forest, must be cleaned and this will be monitored by Alcoa and F.D.

vi) Any machine which is to clear dieback-free forest must be clean upon entry. Low loaders are to use F.D. nominated access and to be clean on entry to dieback-free roads and forest.

vii) Where an area contains dieback and dieback-free forest the dieback-free forest should be cleared first.

viii) Drainage and runoff from washdown points is to be provided to the satisfaction of the F.D.

Temporary drainage control is to be established during clearing on all slopes which may feed water into surrounding forest i.e. the strip at the bottom is cleared first and a small windrow of overburden built up to prevent run-off from the cleared area.

Runoff from dieback infected sections of an area to be cleared must be contained and not allowed to enter the dieback-free sections.

5.6 Burning Debris

i) The burning operations must comply with the provisions of the Bushfires Act 1954.

ii) On State forest the F.D. is responsible for prescribing the conditions, supervising the burn and retaining power of veto. On private property the same conditions apply as on any other private property.

iii) All burning is banned during the prohibited period as prescribed by the Bushfires Act 1954. e.g. Normally 15th December until 15th March for Murray Shire. F.D. will arrange necessary extensions where burning cannot be completed during the prescribed period.

iv) Heaps are to be located so that retained surrounding forest is not killed when the heaps are burnt.

v) Heaps may be burnt at any time during the

unrestricted burning period.

vi) Hygiene during pushing up of burning heaps is to be as outlined above for the clearing operations.

3.0 Review

As information becomes available prescription will be updated.

"REHAB 85"

PRESCRIPTION FOR REHABILITATION OF BAUXITE MINES IN THE WESTERN JARRAH FOREST

1. INTRODUCTION

1.1 Environmental aspects of bauxite mine planning, operations and rehabilitation in the Western Jarrah Forest are complex. Overlapping tenures and legislation are involved, together with interactions between land use and bilogical factors.

1.2 However, the complexity of the system must not deter the formulation and clear statement of objectives, strategies and most up-to-date techniques. This statement can then provide an agreed basis for review and up-date by all parties involved as well as operating guidelines for field personnel.

1.3 The first such statement of this nature in this field was titled "Rehab 80". It was produced by the Forests Department, who co-ordinated input from a range of organizations and specialist workers.

1.4 Following a period of implementation and further research and analysis, previous prescriptions are to be withdrawn and replaced by this prescription.

Rehab 85 now represents the best current "State of the Art" describing techniques to be used in bauxite mine rehabilitation in the Western Jarrah Forest.

1.5 New techniques (i.e departures from this prescription) may be introduced as research projects, so long as:

- the location and timing is approved by the Forests Department; and

- accepted research procedures for experimental design, measurement and follow-up are fulfilled.

DIEBACK HYGIENE IN MINING

1.0 Objective

To leave originally dieback-free forest in a condition in which it can be revegetated with jarrah with a high confidence in survival, and that surrounding forest will remain uninfected.

2.0 Strategy

2.1 Dieback mapping and field definition of areas; completed by Forests Department.

2.2 Alcoa then develop mine plans.

2.3 Mine plan options to be discussed with Forests Department to determine the preferred strategy which optimises cost control and hygiene management.

2.4 Interim measures applicable to the total operations:

- Washdown facilities for light and heavy vehicles will be located at the entrance to the clean operational envelope. These will be sited beyond the general vehicle car park and associated administration and crusher facilities, to limit the number of vehicles required to pass through the washdown station and the frequency of use of same by any one vehicle.

- Shedding water from pits will be critical. This requirement is complicated by a proposal to instal a pipehead dam downstream of the site in 1988-89. Preliminary discussions with Peter Moore of the M.W.A. indicate that such approach may be acceptable if the promising work at Jarrahdale on filtration of run-off progresses to a satisfactory end point over the next 4 years.

- The ideal approach on the minesite itself will be to separate clean and infected pits and the haul roads serving these, and to have separate crusher ramps receiving the 2 classes of road. Practicality of such approach will be determined when dieback mapping is completed. Cost will have a significant bearing on whether such an operational split is applied totally, partially or not at all.

- The possibility of applying different degrees of hygiene management in different sections of Urbrae Block will also be considered. This would permit examination of the levels of expenditure and hygiene management necessary to achieve varying levels of confidence in dieback control.

1.6 The prescription will be reviewed at 12 monthly intervals, at which time new strategies or techniques may be considered for incorporation.

Input for this review will be considered from the various bodies interested or involved in the rehabilitation operation and the review will be co-ordinated by the Forests Department. Any proposed changes to objectives, strategies or operational techniques should be fully documented, outlining the reasons, and detailing the data to support the proposed change, and will be subject to comment and acceptance by the appropriate government authorities, and mining company.

2. THE OBJECTIVE

An objective is a broad statement of what it is expected to achieve within known constraints.

The overall objective for rehabilitation of bauxite mines in the Western Jarrah Forest is to maximise the forest's potential by:

"Regenerating a stable forest ecosystem, planned to enhance or maintain water, timber, recreation, conservation and/or other nominated forest values".

Specific goals (not listed in order of importance since priorities may vary with designated land use) are:

2.1 Water values: to ensure that mined areas provide acceptable water quality and quantity.

2.2 Timber: to grow a forest which has the potential for eventual sawlog production.

2.3 Recreation: to maintain existing recreational values where possible and to provide increased opportunities for forest based recreational activities in accordance with Forests Department regional and divisional recreation plans.

2.4 Protection: to conserve the residual soils; to control dieback spread and to ensure unacceptable fire hazards do not accumulate.

2.5 Landscape: to create a rehabilitated landscape visually compatible with the adjoining indigenous forest.

2.6 Conservation: to recreate, in the long-term, floral faunal and soil characteristics compatible with the surrounding indigenous forest.

In seeking to meet goals for the rehabilitation of mined areas, it is important to remember that the desired end result is a multiple-use forest in which rehabilitated and natural stands are fully integrated.

3. REHABILITATION STRATEGIES

Strategies are the measures to be adopted in order to achieve the objective. These are:

3.1 The development of prescriptions for rehabilitation procedures for each mined area, in accordance with the designated land use priority and land use management plans.

3.2 The conduct of research programmes into means of improving rehabilitation procedures.

3.3 The monitoring of the regenerated areas for their capacity to sustain long-term production of the forest values listed in the objective, and

3.4 The development of remedial treatments should monitoring reveal that rehabilitation objectives are not being achieved.

4. REHABILITATION PLANNING

Rehabilitation planning occurs at two levels:

i. The first is broad-scale regional minesite planning on a 5 year time scale.

ii. The second is the detailed operational annual planning on a pit-by-pit basis.

4.1 Broad-scale Regional Planning: The mining company is required to produce each year an updated 5 year Mining and Management Plan for approval by Government. In the preparation of these plans the following aspects of regional rehabilitation are to be considered

- Land use priorities.
- The sequence of mining and rehabilitation.
- Access for mining and future management.
- Location of mine facilities.
- Dieback hygiene.
- Landscape considerations.
- Water management systems and water course protection.
- Land use priorities.
- Buffer zones for fire management purposes.
- Requirements for long-term management.

Where possible 5 year Mining and Management Plans should be drawn up in consultation with the relevant Government Departments.

This prescription deals only with Mining Operations in Water Production MPA's and Recreation MPA's. At this stage no mining is proposed for other MPA's.

4.2 Special Preliminary Planning in Recreation MPA's: Where mining is proposed in areas designated as Recreation MPA's preliminary survey and site analysis is required. Part of this work is the responsibility of the mining company and part is that of the forest officer-in-charge. However, best results will occur if a team approach is used.

Responsibility of the Company:

i. Inventory natural and cultural (i.e man-made) landscape attractions and recreational features within the mining envelope. The purpose of the inventory is to identify those attractions or features such as water bodies, large rock

outcrops, prominent view points, historical sites and existing recreation development which are considered important to the existing or potential recreational use of the area. Such attractions can be classified on the basis of various criteria such as uniqueness and opportunity for relocation elsewhere (in the case of man-made attractions).

ii. Record site vegetation types which will be cleared as a result of mining and identify any special elements worthy of special protection. Information on vegetation will be used in selecting species mixes for understorey re-seeding following mining.

Responsibility of the Forest Officer:

i. Assess the mining envelope in terms of its existing and potential significance for recreation at a regional and local level. The assessment should identify the opportunities which exist for land and water-based recreation activities, taking into account both the likely demand for such activities and the capability of the area to service those demands.

ii. Through reference to regional and divisional land use management plans, determine the area's suitability for post-mining recreation development and use (the term suitability refers to capability, modified by other land use requirements and constraints). Proposed recreation development is to be specified in terms of location, type and extent of facilities required.

iii. Decide on post-mining access requirements for recreational development and use of the area, and design the mine road network to fit these requirements wherever practicable.

iv. In consultation with Alcoa examine proposed mining plans with respect to the location, extent and timing of operations in order to identify what impact these operations will have on landscape values and recreational features as determined in the inventory stage. Where practicable, operations will be planned so as to minimise visual impacts on the landscape resulting from mining. In this regard, attention should be paid to considerations such as the size and configuration of mining pods as they relate to the character of the surrounding landscape.

4.3 Annual Operational Planning: Detailed conceptual proposals for each minepit are prepared roughly 12 months in advance of rehabilitation. (Note: When better information on proposed dates of mining for specific areas becomes available, an 18 months lead time should be aimed at).

Each detailed conceptual proposal is prepared jointly by Forests Department and mine company staff, and is to deal with the following factors:

- Pit identity (nominated by Forests Department).
- Dieback hygiene, drainage, erosion control and water management specifyng measures to be adopted from initial drilling through to completed rehabilitation.
- Treatment and Management of non-ore bodies within and adjacent to ore i.e. "islands" of unmined forest.
- Species to be used.
- Any special features to be incorporated or retained (e.g. pit walls) as part of the rehabilitated landscape.
- Internal access to pits for future forest management.
- Location of mining facilities/structures.
- Scheduling in sensitive areas.
- Rock management.

- movement, stockpiling and replacement of topsoil and overburden, in regards to dieback within the pit and downslope of the area.

- Identification of features such as permeability, slope, waste islands, rocks, state of forest downslope, wetness of pit, thin overburden, sudden slope changes etc, which may require special handling.

The conceptual rehabilitation proposal will be initialled as "Agreed To" by the local Forests Department officer-in-charge.

Contentious or unusual areas should be referred to the Mining Operations Group. This group contains representatives of the Forests, Mines and Public Works and Agriculture Departments and the Metropolitan Water Authority.

Departures from the agreed conceptual plans are sometimes desirable. This should only happen after detailed field consultation between Forests Department and company staff.

Detailed conceptual plans should be available before rehabilitation commences i.e. 1st September. This will allow for appropriate scheduling to occur.

4.4 Special Fire Protection Provision: When rehabilitation is scheduled within the boundaries of the Jarrahdale or Dwellingup Townsite Protection Plans, refer to these plans for details of tree and shrub species permitted and access required.

5. DIEBACK MANAGEMENT

Because bauxite mining and rehabilitation involves massive soil and vehicular movement under all weather conditions, together with substantial modification to natural drainage patterns in the forest, close attention to dieback hygiene is essential.

The two key management aims are:

i. to minimise the spread of infection into dieback-free forest and minesites.

ii. to manage access and drainage so as not to expand areas which favour the survival and pathogenicity of the disease.

Dieback hygiene measures are specified in detail in other prescriptions dealing with drilling, timber salvage, clearing and topsoil handling - i.e operations not dealt with in this prescription.

Other dieback control requirements which are relevant to rehabilitation are listed below in sequence as they arise.

6. PREPARATION OF PITS FOR PLANTING

6.1 When mining is completed, the earthworks required for the preparation of pits for planting will follow the sequence below:

i. Deep ripping of any portion of compacted pit floor which may be covered with greater than 0.5 metres of fill, batter material, fill from waste islands or boulders or tree trunks.

ii. Landscaping.

iii. Replacement of overburden then topsoil.

iv. Deep or shallow ripping or scarification as required.

v. Water management structures such as contour and grade banks, waterways and sumps. These structures are put in either now or any other time that is appropriate.

6.2 Landscaping: i.e pit walls battered and smoothed, shaping of waste islands, shaping of pit floor, and importing of fill. Occasional retention of pit walls may be prescribed subject to recreation plan and safety i.e perched boulders, long-term stability of cliff wall.

6.3 Overburden and topsoil: will be respread evenly over all areas to be regenerated. The distribution of this material from pit to pit will be in accordance with the following requirements:

i. minimise the amount of infected material to be carried to dieback-free areas, as detailed in the conceptual plan.

ii. minimise the movement of topsoil and overburden.

iii. move soil mainly under dry conditions, attempt to schedule soil movement during summer.

6.4 Unmined areas

Islands or inliers of low grade ore often occur within a pit. It is desirable that these areas remain undisturbed. However, there will be occasions when they are both cleared and stripped.

When this occurs either the area will be completely landscaped or the unmined caprock will be "popped" with explosives to provide planting sites and ameliorate runoff. Blasted craters will be graded level prior to respreading overburden and topsoil. To avoid bringing up rocks these areas should be scarified on contour.

6.5 Rock management

Throughout the pit preparation work, care must be taken not to import, or bring to the surface, large boulders - i.e. those whose size and density renders the future forest floor untrafficable. An active rock management programme should be in operation to avoid rocks being brought to the surface. If rocks occur in the finished surface sufficient rocks must be removed from the pit floor to allow access for future management including fire control, silviculture, and other tending or harvesting operations. This may occur before or after planting provided the objective of avoidance of soil compaction and erosion is not compromised.

6.6 Ripping

Deep ripping is required to fracture the compacted pit floor so as to facilitate root penetration, water infiltration and to provide an "anchor" for the returned topsoil, and to control the overland flow of water.

In General:

i. All of the rehabilitated areas require either contour or grade ripping.

ii. Battered banks need not be deep ripped, but must be scarified or shallow ripped. This avoids bringing up numerous rocks, but still controls erosion and prepares a seed bed.

iii. The distance between parallel riplines is to be determined by the need to ensure a continuous fracture of the compacted subsoil.

iv. The depth of deep ripping should be as deep as possible and should not be less than 1.2 metres.

v. Ripping should be done using a winged tyne to maximise subsoil fracture. Only where it is advantageous should an ordinary tyne be used for deep ripping and use of this type of tyne should be documented on the conceptual plans.

vi. In areas where public access is to be encouraged, the ground surface may be levelled during and/or following deep ripping, provided control of soil erosion within pits is not compromised.

vii. Cleared unmined areas should be scarified on contour to avoid bringing up rocks.

7. WATER MANAGEMENT

7.1 Careful water management must be considered in every phase of the operation from initial clearing and road construction through to completion of rehabilitation.

7.2 A variety of water management systems may be adopted, depending on land use priority, site, and the nature of the particular catchment or storage facility involved.

7.3 Criteria for Success: irrespective of the system which is used, it must satisfy the following basic criteria:

- there must be minimum topsoil erosion within pits,
- on proclaimed catchments the system must meet standards of stream turbidity, salinity and biological purity described by the appropriate water supply authority. Off proclaimed catchments, streams draining an area influenced by mining must not increase unduly in turbidity, chemical or biological pollution,

- there must be no long-term ponds of water lying either within or below pits or roads,
- the need for long-term maintenance must be minimal,
- peak flood levels (as prescribed by the water authorities) must not emanate from mined catchments,
- the system must be acceptable in terms of costs, aesthetics and the land use priority.

7.4 Water Management Systems

Pits can be designed/constructed so as to (i) retain and infiltrate water, (ii) discharge water or (iii) some combination of retention and discharge.

7.5 In catchments where there is need to maintain stream water quality and the forest downslope is predominantly graveyard or resistant, this will be achieved by:

i. infiltration and silt trapping in the contoured rip lines, and

ii. collection of overland flow either in a series of midslope contour banks and a pit bottom sump or by a system of grade discharge banks directing overland flow to predetermined sump areas within the pit.

iii. Each sump must have the minimum capacity to cope with the runoff from a storm of up to 10 days duration, and a recurrence interval of once in fifteen years, with the worst case temporal pattern calculated from meteorological records and mine pit characteristics. This design will be based on an accepted hydrological model.

Higher runoff capacities may be prescribed depending upon sensitivity of the area.

Stable overflow sections are to be provided so that more extreme runoff events will not cause severe erosion or damage.

iv. Where contour interceptor banks are constructed these should be established at up to 10 m vertical intervals. Such banks may not exceed 1 m in height nor have steep sides which will present an obstacle to future access. Where specified, contour interception banks must be provided with suitably constructed overflows and non-erodable spillways. Construction of these devices must be completed before the first Autumn rains.

v. Where grade discharge banks are used, these will connect to stabilized waterways which direct water to detention sumps within the pit.

vi. Sump and drain locations will be indicated on the conceptual rehabilitation plans.

Note: It is recognized that the use of a water retention system may give rise to prolonged pools or saturated zones within or just below pits, and this does not conform with one of the success criteria for water management.

7.6 In catchments where the discharge of water is prescribed so as to protect areas of forest downslope from the effects of dieback resulting from increased runoff due to mining, water management will be achieved by:

i. infiltration and silt trapping in the contoured or grade rip lines, and

ii. control of overland flow by grade banks, waterways and slow release detention ponds or filter systems.

Grade banks should be constructed so as not to erode, and to be located at least along each 10 metre vertical contour within each pit. Distance apart should depend upon site characteristics and should be such that any potential erosion is contained between two grade banks and does not create serious management problems such as accessibility, safety and loss of topsoil.

Waterways should collect water discharged from grade banks and deliver it to the discharge system.

The discharge system from the detention pond or filter system should be such that it provides for the major passageway for water, avoids long-term detrimental effects of silt and water on forest or stream vegetation, minimises forest soil erosion, and does not significantly increase turbidity levels in forest streams.

7.7 Drainage from mine access roads, haul road, mine site facilities or from pits must not flow into unmined, dieback-free forest, but must be channelled (via ponds or filters) directly into water courses.

7.8 All erosion control earthworks other than deep ripping with the winged tyne must be completed and effective before the first Autumn rains (i.e generally before 30th April each year).

Standards will be monitored and remedial action specified using an Inspection and Action Checklist (Appendix II).

8. PLANTING

8.1 Planting Layout and Design

8.1.1 As a general rule, tree species will be established as mixtures. Pure stands may be planted in localised portions of the landscape.

8.5 Selection of Tree Species for Planting: Criteria for selection of tree species to be used are:

i. Tolerance to dieback
ii. Fire resistance
iii. Capacity for roots to penetrate the compacted kaolin layer
iv. Useful timber
v. Proven longevity, and growth to maturity in the minepit environment
vi. Visual compatibility with indigenous forest
vii. Useful nectar source

There are currently no tree species with proven capacity to satisfy all these criteria. Pending continuing studies into a wide variety of species in pits and arboreta (and new aboreta establishment), the following species will be planted as random mixtures

Freely draining sites

Eucalyptus wandoo	½)	
E. laeliae	¼)	50%
E. accedens	¼)	
E. resinifera	1/3)	50%
E. maculata	2/3)	

Sites prone to temporary waterlogging

Eucalyptus patens		50%
E. saligna	½)	50%
E. diversicolor	½)	

Sumps

E. patens		50%
E. megacarpa	½)	50%
E. rudis	½)	

For freely drained sites at Huntly

E. wandoo	2/3)	30%
E. accedens	1/3)	
E. maculata		20%
E. meullerana		50%

To be planted in mixtures in the specified proportions. Where a choice is provided, can be either or both, but in the specified proportions overall

To provide greater diversity and to open the potential for jarrah and marri to re-establish on mined sites, eucalypt seeds should be included in the understorey seed mix as follows:

Freely draining sites

E. marginata	0.25 kg/1 ha clean seed
E. calophylla	0.25 kg/1 ha clean seed

Temporary waterlogging sites

E. patens	0.10 kg/1 ha clean sand
E. wandoo	0.05 kg/1 ha clean seed

8.6 Seed Sources

Species Native to W.A:
Seed to come from at least 10 provenances, each represented by at least 10 mother trees.

Eastern States Species:
Seed to come from no more than 5 collection points in existing W.A. plantations. The remaining seed (to make a total of 10 provenances per species) will be obtained from Eastern States seed stocks.

All provenances must be approved by F.D. Rehabilitation Research.

For each species, seed from all 10 provenances shall be mixed together in equal proportions before sowing in the nursery.

8.7 Fertilizer - Apply 200 grams of Monammonium phosphate per plant at the appropriate time.

Fertilizer to be placed approximately 15 cms from the base of the plant, in a spear hole or stamped depression.

8.8 Success Criterion for Planting/Fertilizer Operation - 80% survival of planted species at 9 months after planting.

Areas of 0.5 ha and above which fail to meet this criterion, to be rescheduled for replanting the next winter.

9. UNDERSTOREY ESTABLISHMENT

9.1 The aim of understorey establishment is to generate a diverse and vigorous understorey which will rapidly contribute to soil stabilization, erosion control and the build-up of soil nitrogen and organic matter. At the same time, development of fuels and fire risks should be kept to tolerable levels.

9.2 Base species for the seed mix will include the major northern jarrah forest legume species i.e. Acacia pulchella, A. celastrifolia, A. extensa, A. lateriticola, A. drummondii, A. urophylla, Kennedia coccinea and K. prostrata. These species should make up about 75% of the mixtureand be in equal proportions. A large diversity of minor jarrah forest species should make up the balance, including other nitrogen fixing species (Allocasuarina and Macrozamia spp.).

9.3 Specific species and specific mixes should be applied to particular sites e.g. waterlogging tolerant species for sumps, wildflower species for roadsides and recreation areas (See section 4.2), and species of low flammability and height for special fire management zones.

9.4 As a general rule, non-indigenous and high Phytophthora cinnamomi susceptible species should not be used.

9.5 Understorey seed mixes will be determined in advance and specified in the rehabilitation plan for each pit and for specific sites within pits.

9.6 Fertilizer - Areas to be seeded will be broadcast fertilized with 450 kg/ha of superphosphate before sowing.

9.7 Application Rate - Mixed seed will be sown at the rate of 1 kg/ha.

Seeding is to be done after ripping by ground application and to be completed by 1st June each year.

9.8 Success Criterion - 1 plant established per square metre, 9 months after sowing, as determined by stocked quadrat survey of each pit.

Areas of 0.5 ha or greater not stocked at this rate to be reseeded the following Autumn. Light scarification may be necessary to promote seed germination in areas reseeded in Year 2.

10. ROADS

10.1 The road network which remains after rehabilitation must conform to a predetermined plan. The basic planning principle is to aim for the minimum number of well surfaced, low profile roads, consistent with provision for public access and fire protection.

10.2 This plan will be drawn-up from approved 5 year mining plans, and will cater for:

i. access for mining
ii. access for rehabilitation
iii. access for future forest management

10.3 Unwanted roads will be rehabilitated by:

i. recovery of gravel for reuse elsewhere
ii. ripping and erosion control
iii. seeding and planting in harmony with surrounding forest

11. PRESCRIPTION REVIEW

Next date for review of this prescription : May, 1985.

POST RE-REHABILITATION MANAGEMENT

1.0 Introduction

Existing rehabilitation techniques have successfully achieved the establishment of suitable landscape, understorey and overstorey in bauxite minesites.

Monitoring of rehabilitation is required in conjunction with the development of remedial re-rehabilitation treatments where necessary. Bauxite Rehabilitation and Research monitoring sections are attached.

2.0 Objectives:

2.1 To monitor regenerated areas for their capacity to sustain long-term production of the forest values listed in the objectives for rehabilitation.

2.2 To develop remedial treatments should monitoring reveal that rehabilitation objectives are not being achieved.

3.0 Strategies:

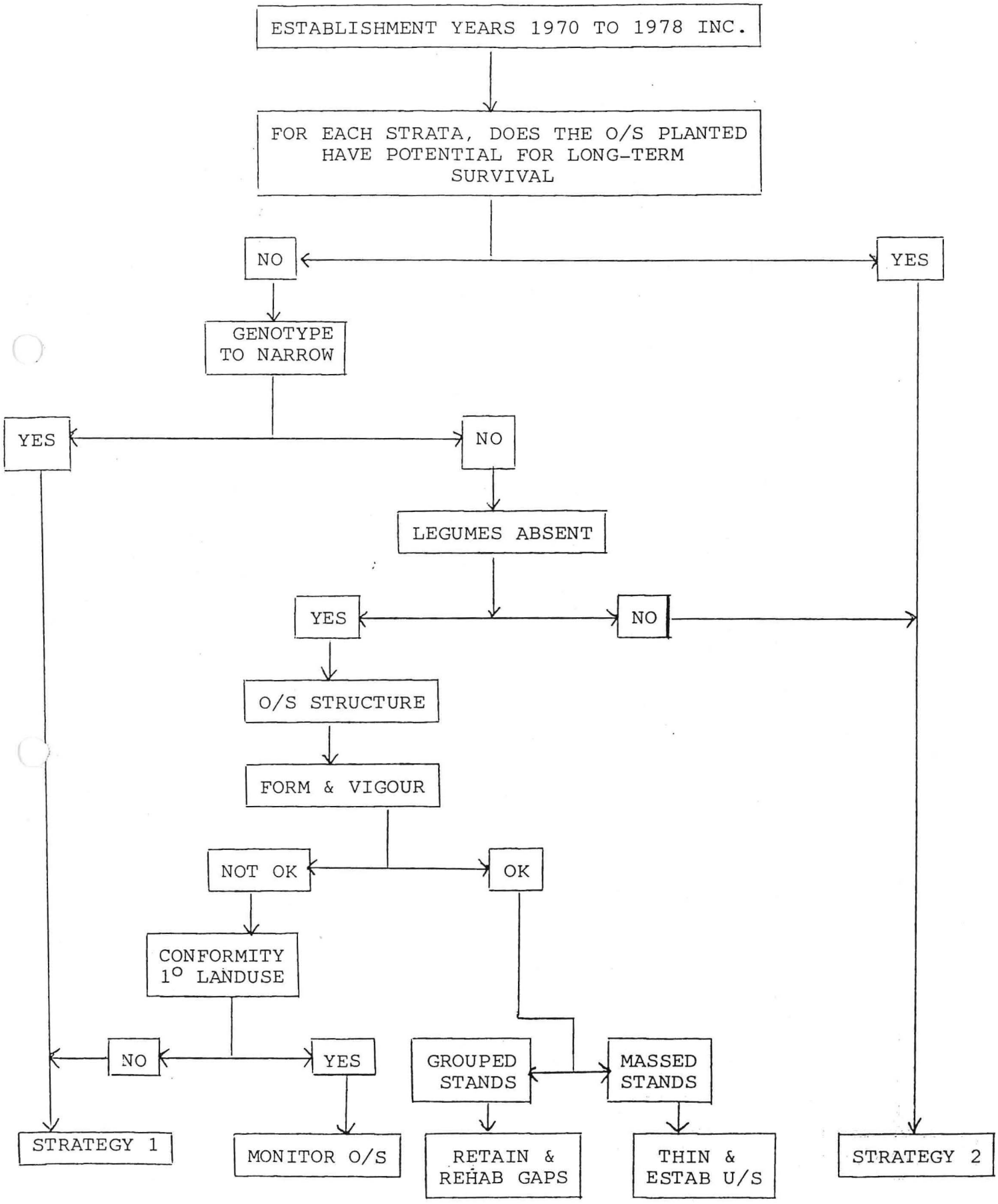
1. Stands established before 1970 do not generally match the objectives for minepit rehabilitation. Both inadequate site 'preparation' (ripping) and understorey establishment (nutrition) are observed to limit growth.

   With the exception of some stands which meet growth criteria (e.g. pit margings, limited bauxite extraction), they are to be re-treated.

2. Stands established after 1978 generally match objectives for minepit rehabilitation. Research monitoring remedial treatments, (if necessary), and ecosystem tending (silviculture, fire protection, dieback management) should maintain rehabilitation in a viable condition.

3. Residual rehabilitation between planting years 1970 and 1978 are assumed to be limited by nutrition only. Procedures for re-treatment are shown on Figure 1.

Figure 1: Procedures for evaluation of rehabilitation established between 1970 & 1978 inclusive.



BAUXITE REHABILITATION MONITORING

1.0 Objectives

To monitor the survival and extension growth of bauxite rehabilitation plantings.

2.0 Strategy

2.1 Each minesite is stratified on the basis of planting year, species, site preparation and silvicultural treatment.

2.2 Plots are established at about age 7 years and re-measured at 5 yearly intervals.

2.3 Plots yield information on basic extension growth of the best and worst stands within a strata. Recorded information includes species, dominance class, form, mortality, diameter at breast height, total height, crown break and crown radius.

2.4 Processing of the data defines the limits of growth within the pits. Interpolation between these limits in conjunction with research information on the effects of treatments will allow an informed choice of management tactics to optimise the site for a particular land use priority.

3.0 Control Systems

The Hardwood Operations Control System (H.O.C.S.) caters for the recording of information pertaining to all minesites. Information is recorded in the following systems:

3.1 H.O.C.S. System C

Prints at 1:10,000 scale:

(i) Print C2 Plots show
- I&P plots.
- strata boundaries.
- research plots.
- research stands.

(ii) Print C4 Rehabilitation shows
- print boundaries.
- section boundaries.
- rehabilitation (year, species mix and area).
- sump plantings.
- dieback rehabilitation.
- gravel pit rehabilitation

3.2 Bauxite Register

This supplements H.O.C.S. print C2 and is a written register recording details of
- clearing/mining.
- planting of tree and scrub species.
- fertilizing.
- silviculture treatments

RESEARCH MONITORING

1.0 Introduction

Existing research has focused on hydrology and tree performance studies in mined areas in high rainfall zones.

Three factors have been identified which can limit growth either within rehabilitated areas, or adjacent, unmined forest, viz.,

- nutrition, particularly the availability of nitrogen.
- the effect of high soil bulk densities on deep root penetration.
- increased soil moisture in forest areas downslope from pits and changed site susceptibility to *P. cinnamoni*.

2.0 Objective

To maintain programmes to monitor factors limiting to the development of viable ecosystems and landscapes.

3.0 Strategies

3.1 Infiltration studies of water following ripping, the development of shallow sub-surface flows and susceptibility to *P. cinnamoni*, particularly in jarrah dominant forest, outside pit margins.

3.2 Measurements of evapotraspiration from native forest and rehabilitated minesites to determine long-term changes in the hydrologic balance.

3.3 Hydrologic responses in hillslope and small catchment studies. viz.,

- streamflow responses
- groundwater responses (shallow and deep)
- streamflow componants.

3.4 Tree performance, plant nutrition, microbiology and ripping.

3.5 Monitor overstorey/understorey rehabilitation development. Important attributes are evapotranspiration, disease and fire tolerance, growth rates, biomass production, floral and faunal successional processes, nutrient cycling, aesthetics, and compatibility with multiple landuse objectives.

3.6 Intergration of treatments into ecosystems. Effects of fire and scrub management on sites.

3.7 Integration of ecosystems into whole landscapes.