BAUXITE PIT REHABILITATION

Saddleback State Forest

AGREED ARRANGEMENTS BETWEEN

WORSLEY ALUMINA PTY LTD

AND THE

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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1. PREAMBLE

The aim of this document is to outline the mechanisms by which the Department of Conservation and Land Management (CALM) and Worsley Alumina will provide for progressive mine-pit rehabilitation in State Forest areas of the Worsley Alumina Principal Mineralised Area (i.e. Saddleback, Quindanning and Marradong Forest Blocks.)

To achieve this aim, the document sets out the responsibilities of each party and develops a set of policies, objectives, strategies and review mechanisms for rehabilitation planning. These provide a framework from which a rehabilitation prescription will be prepared annually. The framework ensures that full advantage can be taken of the resources and experiences of both organizations, and that the prescription is responsive to new information from trials, research and operational experience. It is also anticipated that the regular process of review built into the mechanism will identify aspects of rehabilitation requiring trial and experimentation.

(iii) The approved ERMP contains undertakings in several technical areas:

- Surface water control
- Disease management
- Topsoil/overburden handling
- Pit-floor ripping
- Revegetation
- Fertilizing
- Maintenance of rehabilitation
- Rehabilitation research (including the Trial Rehabilitation Exercise: TRE-1)

(iv) The approved ERMP also contains a commitment to carry out biological studies, which have been and will be designed to provide data directly applicable to rehabilitation planning.

3. POLICIES AND OBJECTIVES

3.1 Land use plans in the Principal Mineralised Area

A small area within Saddleback Block is designated as a scientific study Management Priority Area. This area encompasses an hydrology research area designed to study the hydrologic impact of mining and rehabilitation. Worsley Alumina has made a specific commitment to support this study in terms of liaison with the appropriate authorities regarding the timing of mining operations in the research area.

Other specified uses for the area include conservation of flora and fauna and protection of forest values.

Current recreational use of the area is minimal and only broadscale planning has been undertaken to develop its potential. This is outlined in the Northern Region Forest Recreation Framework Plan (Forests Department, 1982). In this plan, the area falls within the Monadnock Management Unit (grouped with other Monadnocks in the eastern forest). Since these areas are best suited to non-motorised, low-intensity recreational activities, the following management strategies are relevant:

(i) where practical, avoid road construction within the immediate vicinity of monadnocks to discourage vehicle use and to minimize problems of erosion and disease;

(ii) facilitate access by foot by providing facilities at the base of hills; and

(iii) provide written guides to flora, fauna and landscape characteristics.

In the abovementioned Recreation Plan, it is proposed that a long term development plan be written for the Saddleback Block. This plan can form the basis for developing recreation guidelines for rehabilitation prescriptions.

3.2 Rehabilitation Objectives

The broad objective is to regenerate a stable forest ecosystem planned to maintain recreation, conservation and other nominated forest values.

Specific goals are:

- Recreation - where practicable, to provide or maintain recreational values in accordance with approved CALM plans.

- Conservation - to regenerate, in the long term, floral and faunal characteristics compatible with the eastern jarrah forest.

- Landscape - to create a rehabilitated landscape compatible with the general landform and physiography.

- Hydrology - to restore the hydrological balance through the establishment of deep-rooted vegetation in rehabilitated areas.

- Protection - to minimise impacts on non-mined areas, to conserve the residual soils, to minimize dieback spread, and ensure that unacceptable fire hazards do not accumulate.

In seeking to meet these goals, the desired end result is a multiple-use forest in which rehabilitated and undisturbed stands are integrated to the maximum practical extent.

4. STRATEGIES AND PLANNING

4.1 Rehabilitation strategies

The following measures will be adopted to achieve the objectives:

- the development of prescriptions for rehabilitation procedures for each mined area, in accordance with the designated land use priority and land use management plans;
- the conduct of trial and monitoring programmes into means of improving rehabilitation procedures;
- the monitoring of regenerated areas for their capacity to sustain long-term production of the forest values listed in the objectives; and
- the development of remedial treatments should monitoring reveal that rehabilitation objectives are not being fulfilled.

4.2 Rehabilitation Planning

Rehabilitation planning occurs at two levels: The first is broad-scale regional minesite planning on a 10-year time scale. The second is the detailed operational annual planning on a pit-by-pit basis.

For broad-scale regional planning, Worsley Alumina consults with CALM to produce an annually-updated 10-year Mining Plan for submission to the State. In the preparation of these plans, the following aspects of rehabilitation are considered:

- the sequence of mining and rehabilitation;
- access for mining and future management;
- location of mine facilities;
- dieback hygiene;
- water management systems and water-course protection;
- land use priorities; and
- buffer zones for fire protection.

On a broad scale, CALM will advise on perceived recreational values, so that Worsley Alumina Pty Ltd may take these values into account in developing rehabilitation proposals.

In terms of recreation, the draft proposal will address:

- impacts on natural and cultural (i.e. man-made) landscape attractions and recreational features - 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.

- types of vegetation to be cleared for mining: this information will also be used in selecting species mixes for re-seeding following mining, in selecting treatments to provide faunal habitats, and in determining stocking rates and selecting vegetation structures and types for particular areas of rehabilitation.

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

- proposed action to re-establish or enhance recreation potential.

- post-mining access requirements for recreational use of the area, for incorporation into planning the decommissioning of the mine road network.

- the scheduling of mining and rehabilitation in areas of high visibility, so that visual impacts are minimised to the extent that is practicable.

4.3 Prescription Development

Detailed operational planning will consist of two steps.

Firstly, after completion of each year's rehabilitation plantings, an updated generalized prescription for the next year's rehabilitation works will be jointly prepared. This will specify rehabilitation works common to all pits and identify where options to vary particular rehabilitation treatments exist. It will address:

- preparation of pits for planting, including landscaping, topsoil/overburden management, treatment of "islands" of unmined ore and ripping.

- water management options.

- planting - species selection and layout, fertilizer application rates and success evaluation.

Secondly, Worsley Alumina will prepare a detailed rehabilitation proposal for each pit based on the generalized prescription. This will include:-

- pit identity and location.
- detailed drawings.
- particular options for rehabilitation chosen to suit particular locations.
- any proposed deviations from the general prescription.

Each proposal will be jointly assessed prior to submission seeking formal affirmation from the Executive Director. Departures from the agreed plan may sometimes be necessary, but will only take place after consultation and endorsement by both organizations.

4.4 Documentation

Worsley Alumina will assume responsibility for the progressive graphic and descriptive documentation of rehabilitation efforts. The Department of CALM will advise of its particular requirements for its internal recording; where practical, these requirements will be incorporated into the documentation programme.

5. REVIEW MECHANISMS

The annual reviews of rehabilitation, foreshadowed in Section 4.3, together with regular liaison between Worsley Alumina and CALM, will demonstrate the results of continuing trials and monitoring. Findings for inclusion in operational practice will then be incorporated into planning and into the agreed prescription of operations. Priorities for experimentation will also be evaluated, and work programmes developed as appropriate.

6. PRESCRIPTIONS

6.1 General Prescription - Saddleback State Forest

This prescription is considered to be a dynamic document which will evolve as more information from research into the biological and hydrological nature of the area becomes available, as future recreational planning progresses, and when the results of on-going trial rehabilitation treatments identify change requirements. The development of new or improved rehabilitation implements may also effect the methods employed to achieve the rehabilitation objective.

The following general prescription will be supplemented annually with specific and detailed pit-by-pit plans which will take into account the unique nature of each site to be rehabilitated.

6.1.1 Preparation Of Areas For Planting

As part of the mining operation, and after ore removal, rehabilitation earthworks will be carried out in the following sequence:

- The pit floor will normally be deep ripped on contour to a depth of 1.5m at 1m intervals, but areas programmed for heath development might not be ripped.

- Pit sides will be battered down and the entire area landscaped to enhance aesthetic and recreational land use values. Where bauxite mineralization necessitates the clearing of narrow forest strips, which in turn may result in apparent long straight batter runs following mining of deep ore horizons, the slopes of the landscaped batters will be varied along strike to soften the visual impact of the final rehabilitated surface. Large boulders derived from deep ripping, or residual from the mining operation, will be buried.

- Pit drainage and water management structures will be designed to promote retention and infiltration, and to prevent prolonged surface or sub-surface ponding. 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 mid-slope contour banks and a pit bottom sump, or by a system of grade discharge banks directing flows to predetermined sump areas within the pit. Criteria for designing these drainage structures include:

  - Each sump will have the capacity to cope with the runoff from a 10-day 15-year storm event (170mm, derived by Worsley Alumina from Marradong rainfall data, Station No.009575, 1907-1980) as calculated from meteorological records and mine-pit characteristics.

- Contour interceptor banks, where constructed, will be established at vertical intervals of up to 10m. Such banks will not exceed 1m in height or have steep sides which present an obstacle to future access.

- Where used, contour interception banks will be provided with suitably constructed overflows and non-erodable spillways. Construction of these devices will be completed before the first autumn rains.

- Grade discharge banks, where used, will comprise stabilised waterways which direct water to detention sumps within the pit. Sump and drain locations will be indicated on the rehabilitation plans.

- If the design of banks conflicts with landscape considerations, alternative systems of drainage may be examined.

° Overburden will be replaced.

° Topsoil, including forest litter and trash remaining after clearing, will be re-spread and the entire area lightly scarified on contour.

° Where pits exceed 5 hectares, temporary internal access tracks will be provided for the revegetation programme, on-going biological monitoring and general forest management operations.

6.1.2 Revegetation

TREE SEEDLING ESTABLISHMENT

(i) Planting Layout and Design

- Generally, tree species are to be established as mixtures, but pure stands may be planted in localised portions of the landscape.

- Plant spacing will be varied according to the annual detailed site rehabilitation objectives. In certain situations, areas such as prominent view points and along selected roads, some areas may be left unplanted. In other instances, trees may be planted in small groups or clumps to minimise the rigid plantation effect created by row planting on a regular spacing.

- Initial stocking of about 500 planted trees/hectare.

- Planting will commence when the soil is wet to a depth exceeding 1m, generally after about mid-June. Planting will be completed by 1st August.

(ii) Species Selection

- In every mixture, species indigenous to the Saddleback area will be included. Species mixes will be determined in advance and confirmed in the agreed Annual Rehabilitation Plan with the Department of Conservation and Land Management.

- Seedling specifications: plants in jiffy pots or paper pots, approximately 12cm in height with a minimum of 2 pairs of leaves; pots and soil mix sterile.

- In addition to seedlings planted, all rehabilitated pits will be sown with *E. calophylla, E. marginata* and *E. wandoo* seed, at the rate of 1000 viable seeds per hectare.

(iii) Fertilizer Application

- Each tree seedling will receive one (1) 200g Di-ammonium Phosphate fertilizer tablet at planting. The tablets will be speared in below the soil surface up-slope and between 200mm and 300mm from each seedling.

(iv) Success Criteria

- 80% survival of planted species, at 9 months after planting, as determined by a 10% systematic sample.

UNDERSTOREY ESTABLISHMENT

(i) Species Selection and Establishment

- Species for understorey and groundcover seeding will be selected from those known to be "indicator" or "associated" species of the vegetation communities representative of the type of community being re-established (Worsley Alumina Pty Ltd, 1985), from experience gained on the Trial Rehabilitation Exercise One (TRE-1) site, and to facilitate erosion control and soil nutrition-building. Detailed provenance data will be recorded for all seed/seedlings used in rehabilitation.

- The base species for the seeding mix will include the major Saddleback State Forest legume species, together with species identified as having high "relative importance values" in the majority of plant community types represented within the area (Worsley Alumina Pty Ltd 1985). The base mix will comprise about 75% of the total understorey seed mix and will generally include the following species:

Acacia alata

A. celastrifolia

A. drummondii

A. pulchella

Boronia fastigiata

Bossiaea ornata

Daviesia decurrens

D. rhombifolia

Dryandra nivea

Hakea lissocarpha

Kennedia coccinea

K. prostrata

Macrozamia riedlei

Xanthorrhoea preissii

- In order to promote species diversity, a large number of minor Saddleback State Forest species will generally make up the balance of seed in the base mix, including other nitrogen fixing species (e.g., *Allocasuarina* spp.). Importantly, plants which are "indicator" or "associated" species for particular sites e.g. heathland etc, may be selected in advance and confirmed in the agreed annual rehabilitation plan with CALM.

- Mixed seed will be sown at the rate of 1.0kg/hectare.

(ii) Fertilizer Application

- All areas will be broadcast with Superphosphate No. 1 at a rate of 450 kg/hectare.

(iii) Success Criteria

- One plant established per square metre, 9 months after sowing, as determined by a sample quadrat survey of each pit.

SADDLEBACK STATE FOREST

BAUXITE PIT REHABILITATION - 1987 APPENDED PRESCRIPTION

1. INTRODUCTION

A total of 42.6 hectares of mined land in Saddleback State Forest are scheduled for rehabilitation by Worsley Alumina in 1987. The locations of the areas involved in the programme are illustrated at 1:10,000 scale on the attached General Location Plan (Drawing No. 206-7-7) and described as follows:

- North Pit areas - 30.1 hectares, comprising Worsley Alumina's Clearing Notice areas WOR/1/84, WOR/5/85, WOR/9/85, WOR/10/85 and portions of WOR/5/81, WOR/1/83, WOR/4/85 and WOR/7/85, with planned final pit-floor contours and drainage works as detailed at 1:1000 scale on Drawing Nos 206-7-9 and 206-7-10;

- South Pit area - 9.9 hectares, comprising Clearing Notice areas WOR/2/85, WOR/5/86 and portion of WOR/7/81, with planned earthworks as detailed at 1:1000 scale on Drawing No. 206-7-8; and

- West Pit area - 2.6 hectares, comprising a portion of WOR/6/85, with planned earthworks as detailed at 1:1000 scale on Drawing No. 206-7-11.

2. PREPARATION OF AREAS FOR PLANTING

Rehabilitation earthworks, including provisions for pit drainage and water management, will be as detailed in the above-mentioned plans and as described in the *"General Prescription - Saddleback State Forest"*, contained in the document "Bauxite Pit Rehabilitation, Agreed Arrangements Between Worsley Alumina Pty Ltd and the Department of Conservation and Land Management".

3. REVEGETATION TREATMENTS

3.1 Site Descriptions Prior to Clearing

NORTH PIT AREAS

The major continguous portion of this mid-slope site supported an open forest of *Eucalyptus marginata - E. calophylla* with dominant admixtures of *Allocasuarina fraseriana* (Worsley vegetation code 19JLc - the dominant mid-slope Jarrah Community Type in Saddleback State Forest, and an eastern variant of Site-vegetation Type P defined by Havel [1975]). Gravel depths varied from 0.2 to 4.9 metres over the area and ore depths ranged from 2 to 10.1 metres.

The discrete southern portion of WOR/7/85 supported similar vegetation on the western half of the site; the eastern half was originally covered by a woodland of *E. marginata*, with a few *E. calophylla* and *Banksia grandis* (Worsley code 19JPs, similar to Havel's Site-vegetation Type H). Gravel depths ranged from 0.2 to 2.8 metres, with ore depths from 4.7 to 9.3 metres.

SOUTH PIT AREA

The northern portion of this mid-slope saddle site supported the vegetation described above as Type 19JLc, together with some small patches of predominantly heathland understorey plant species (Type 23HDc, which has close affinities with Havel's Site-vegation Type G). The vegetation on the southern half of the area was typical of the 19JPs Type. Gravel was from 0.3 to 0.7 metres deep, with ore depths ranging from 5.7 to 10.3 metres. A dolerite intrusion has been identified close to the excavated surface in one section of the site.

WEST PIT AREA

This steep mid-slope site supported the 19JLc vegetation Community Type; some heathland patches (23HDc) are located in the fringing vegetation to the south of the site. Gravel depths varied from 0.2 to 0.6 metres, with ore depths ranging from 3.7 to 12.8 metres.

3.2 Revegetation

Plant species selection criteria, tree spacings, sowing rates, fertilizer treatments and establishment success assessment will be based on the afore-mentioned *"General Prescription - Saddleback State Forest"*.

As the three areas involved in the 1987 programme supported similar Jarrah vegetation community types prior to mining, all areas will receive the same general revegetation treatment; where site conditions, original vegetation anomalies and existing fringing vegetation communities warrant modifications to this treatment, these have been outlined below.

Tree seedlings and planting ratios for the general revegetation treatment will be as follows:

Species	Planting Ratio
Eucalyptus accedens	1
E. drummondii	0.5
E. laeliae	1
E. marginata	4
E. melliodora	1
E. patens	1
E. sideroxylon	1
E. wandoo	3

E. drummondii will be planted over and around the dolerite intrusion and on a number of other locations where heath patches will be over-sown within the South Pit. The species may also be planted on other rocky sites, where its shallow-rooted habit will be most suitable, and on the southern batters of the West Pit area adjacent to the fringing heath vegetation.

The remaining Eucalypt species will be planted as mixtures, with *E. marginata* and *E. accedens* generally located up-slope and away from the water-gaining sites (shown as infiltration areas on the attached drawings); *E. patens* and *E. wandoo* will be concentrated on these sites.

Additionally, Eucalypt seed will be spread over the rehabilitated areas at the rate of 1000 seeds of each of *E. calophylla*, *E. marginata* and *E. wandoo* per hectare.

The base understorey species seed mix listed in the General Prescription will be augmented with a large number of minor Saddleback State Forest Jarrah community species to promote understorey species diversity. Seed from a range of heathland species will also be over-sown on patches of the South Pit area, where *E. drummondii* is planted, and on the southern batters of the West Pit area adjacent to the fringing heath vegetation. Actual species used and sowing rates will be documented when seed collection programmes in the Saddleback area have been completed, but it is expected that in excess of fifty species will be included in the understorey seeding programme for 1987.

4. REFERENCES

Havel, J.J. (1975). Site-vegetation mapping in the Northern Jarrah Forest (Darling Range). I. Definition of site-vegetation types. *Bull. For. Dept. West. Aust.* 86.

Worsley Alumina Pty Ltd (1985). "Worsley Alumina Project. Flora and Fauna Studies, Phase Two", pp. 348. Worsley Alumina Pty Ltd, Perth.

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