A REVIEW OF THE 2000 CHRISTMAS ISLAND MINESITE REHABILITATION PLANS

Prepared for

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CENTRE FOR MINED LAND REHABILITATION

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EXECUTIVE SUMMARY

This report represents the outcomes from discussions and site inspections with staff from Parks Australia North (PAN) and Christmas Island Phosphates (CIP) during a visit to Christmas Island in April 2006. The visit itself was in response to a request to re-visit and review the rehabilitation plans that the Centre for Mined Land Rehabilitation (CMLR) at the University of Queensland (UQ) developed for the Christmas Island Rainforest Rehabilitation Program (CIRRP) in 2000. The original intention of this review was to examine the implementation outcomes of the Plans and to assess what modifications have been made and may be still necessary.

Unfortunately, once on Island it became clear that the Plans were only implemented for one year (2000/2001), after which time the Government suspended the program until DOTARS re-instated the funding as the CIMFR in 2004. With the time lag required for the raising of nursery stock, it was not until 2005 that the next out-planting of seedlings was undertaken. As a result of these actions, the available data to review was minimal and lacked a temporal sequence against which to measure progression towards the end point. However, valuable discussion and site visits proved to be very informing, and the following report provides some insights into the ways in which PAN and CIP have been approaching the issues over recent years. The difficulties and/or dilemmas that remain to be tackled are raised, and some draft recommendations and actions required are presented.

In summary, the recommendations are:

1. Re-assess the government decision that prevents PAN rehabilitating land still on mining lease;
2. Increase the effort, through additional resources, to identify the volume of soil available for rehabilitation currently held in stockpiles;
3. Assess the ecological values of vegetation communities currently growing on the oldest stockpiles;
4. Undertake research to understand the nitrogen dynamics of the rehabilitated landscape with a view to also contributing to weed management;
5. Modify and update the CI GIS with any changes necessary to the endpoints nominated in the original Plans due to variation in land use at North-west point and South Point;
6. Review the monitoring program after the 2006 data collection phase;
7. Link the spatial and visual information with the databases;
8. Rationalise the differences in rehabilitation approaches between PAN and CIP and explore opportunities for a joint approach and division of tasks; and
9. Obtain additional funding from government (supplementary to the Conservation Levy) to properly address the legacy of past mining and to maximise the potential for all rehabilitation priority areas to progress towards the desired end use.

BACKGROUND

In 2000, the Centre for Mined Land Rehabilitation (CMLR) at The University of Queensland (UQ) undertook a project on behalf of the Christmas Island Rainforest Rehabilitation Program (CIRRP) to develop a set of rehabilitation plans for those areas of the Island that had been historically disturbed by phosphate mining. The report that was produced from that project provided:

- A generic plan applicable to all areas on the Island disturbed by mining activities and requiring rehabilitation.
- A matrix combining a range of starting points and earthworks options required to achieve a range of rehabilitation outcomes.
- Specific plans for each minefield or sub-division of fields readily accessible through the existing spatial data within the CIGIS.
- Opportunities to readily update the plans and record the status of progressive earthworks and rehabilitation.
- Operational plans and specific details of on-ground earthworks, pre-planting requirements, nursery management and planting techniques.
- Detailed information on the species required and the planting densities necessary to achieve the targeted end-points.
- A recommended monitoring program for the short term to identify areas requiring maintenance, and for the long term, to measure the performance of the rehabilitation against a set of success criteria.

As an operational extension of these plans and also an earlier report by CSIRO in 1996 entitled *"Technical Assessment of the Christmas Island Rainforest Rehabilitation Program and Review of Strategic and Economic Factors Affecting the Management of the Christmas Island Rainforest Rehabilitation Program for Parks Australia North"*, a task register was produced by the Environment Branch of the WA Department of Mineral and Petroleum Resources for the Territories Branch of the Commonwealth Department of Transport and Regional Services (DOTARS). This preliminary Task Register (Version 22 – November 2002) represented an initial expansion of the methodologies and approaches described and/or recommended in the Christmas Island Minesite Rehabilitation Plans (CIMRP) produced by the CMLR in 2000. A number of modifications to these plans were made by Parks Australia North as outcomes from more recent rehabilitation trials and undertakings became known, and there were also adjustments to some of the methodologies and procedures that were driven by practicality and logistical constraints. Parks Australia North (PAN) has stated that of the approximately 3,000ha of previously disturbed mined land, most of which was originally primary rainforest, about 220ha has been rehabilitated by PAN under the CIRRP, and a further 150ha was taken over by PAN following various former rehabilitation exercises not designed to replace rainforest. Of this 370ha total, 210ha is targeted for progression to rainforest, 140ha need further inputs, and 20ha have failed. Current projections based on rough estimates of potential stockpiles of 'soil' and a two-metre requirement as the depth of the root zone for the target rainforest ecosystem, are that only about 400ha of the remaining 2,780ha will be able to be rehabilitated back to rainforest. The remainder (2,380ha) of the disturbed land will have an end land-use other than that of primary rainforest.

OBJECTIVES

At a rehabilitation workshop in Perth on 18th January 2006 chaired by DOTARS, the various government and company representatives and associates met to discuss the 2002 Task Register. Other issues relating to improving the efficiency and effectiveness of the rehabilitation process and outcomes were also discussed. As a part of the process to update the Task Register, one of the actions to come out of the meeting was an agreement to review the plans upon which the register was largely based, the CIMRP, now that an implementation phase by PAN had been underway for 4-5 years.

The primary objective of this project was to review the Christmas Island Minesite Rehabilitation Plans produced in 2000 by the CMLR with the view to:

1. Assessing if any changes are needed following some five years of implementation; and
2. Assessing whether the end land-use objectives nominated in the plans are still appropriate for the various areas of disturbance and if not, what end land-use objectives are appropriate.

A secondary objective of the site visit was to visually review Christmas Island Phosphates' rehabilitation sites.

The CMLR visited the Island from 7-13 April 2006, the timing of which was designed originally to also encompass a further on-site meeting of the group that met in Perth in January. Unfortunately, other unforseen commitments by many of the group meant that this meeting did not proceed. However, Tony Webster and Danielle Risbey from the Western Australia Department of Environment were on the Island at the same time and many of the site visits were in common as were a number of the valuable discussions with PAN and CIP.

RECENT HISTORY AND ACTIVITIES TO DATE

As stated above, the primary purpose of the visit was to review the outcomes of five years of implementation of the CIMRP. However, upon arrival, it was made known that there was not five years of implementation. The program was adopted in 2000 (with a summer planting in early 2001), and then due to a ministerial decision to cease the funding to CIRRP, the full program was not re-implemented until 2004 (in preparation for planting in early 2005).

Against this context, Table 1 summarises the major activities relating to the 2000 Plans that have occurred over the period 2000-2006. Table 2 illustrates the sequence of rehabilitation priority areas that Parks Australia established several years ago and their status as of April 2006.

Table 1. A summary of the program activities since 2000.

Year	Activities
2000	• New equipment and supplies purchased as per CMLR plans • Rehabilitation earthworks carried out per new CMLR plans • Nursery and field staff retrained in new CMLR methodology • Nursery stock propagated as per new CMLR plans
2001	• Planting completed using a mixture of species from old and new CMLR rehabilitation plans • New plant stock raised according to CMLR plans • Monitoring native tree species survival and growth in new planting started • Fertiliser application rate trial in new planting started • Federal government shuts off funding to CIRRP • All non-essential CIRRP activities cease • Maintenance of new plantings starts
2002	• Restorative clearing and planting occurs on some old rehabilitation sites to place remaining nursery stock • Native tree species survival and growth monitoring and fertiliser application rate trial continued • Maintenance of new plantings (only) continue • Half of CIRRP staff leave with redundancies • Brief Abbott's Booby helicopter survey
2003	• Restorative clearing and planting continues on old rehabilitation sites to use up remainder of nursery stock • Small new trial planting at LB4 to use up remainder of nursery stock • Maintenance of new plantings (only) continue • DOTARS indicate that they would like DNP to start a new rehabilitation program and negotiations begin
2004	• Three year MOU between DNP and DOTARS signed on new rehabilitation program, the CIMFR. Different funding arrangements and only National Parks land to be rehabilitated. CMLR rehabilitation plans adopted • CIMFR operations commence • Species survival and growth monitoring completed • New staff employed and trained • New plant stock raised • Earthworks planned and completed • Continuation of maintenance of new plantings only
2005	• Plantings completed • New plant stock raised • Earthworks planned and completed • Continuation of maintenance of new plantings only • Monitoring completed
2006 (April)	• Plantings underway • New plant stock raised • Earthworks in planning stage • Continuation of maintenance of new plantings only

Table 2. 'Current' Parks Australia rehabilitation priorities

Priority and location	ML	Comments	Status in April 06
1. Field 20 West	110	Selected as the highest conservation priority because of the high density of Abbott's Booby nest trees in the forest to the N and W of ML 110.	Rehabilitation in both National Park and Mine Lease areas completed in 2001.
2. Field 20 East	109	Rated as a high conservation priority for the same reasons as Field 20 West.	Rehabilitation (in NP section only) completed in 2005.
3. Field 18D	108	This SW section of Field 18 is rated number three in the conservation priority list because of its location at the leading edge of where the minefield clearings overlap with Abbott's Booby habitat.	Not addressed to date as mainly on Mine Lease area.
4. Field 27	138	The southern end of this area was previously listed as a high priority to protect the adjoining primary forest remnants and associated Abbott's Booby habitat. The construction of the Immigration Reception and Processing Centre (IPRC) reduced the area available for rehabilitation.	Not addressed to date under the current program as mining is still active in the area and the IPRC has taken most of the site.
5. 500 Foot Quarry	136	This mine lease includes a tongue of land (2.7 ha) protruding into the NE section of the National Park. This land has a high conservation priority as it is adjacent to Christmas Island Frigatebird habitat.	Deleted from the priority list due to access difficulties and an absence of nesting occurring.
6. Field 23	116 117	This field has an area of 56.5 ha with the south-western section being the most significant portion in relation to the Abbott's Booby habitat.	Rehabilitation (in NP section only) almost completed in 2006.
7. Field 23A		Adjacent to Abbott's Booby sites (as above).	Scheduled for the 2006/2007 program
8. Field 21	111 112 113	The majority of this field has been the focus of rehabilitation work since 1992.The area has high water catchment conservation value and is adjacent to significant Abbott's Booby habitat.	Completion of this field is scheduled in the 06/07, 07/08 and 08/09 rehabilitation.
9. Field 18 North	105	This area was included in the priority list to maintain the integrity of the forest in the adjacent National Park.	Mainly on mining lease and hence cannot be currently addressed.
10. Field 18 South	106	This section of ML 106 separates two areas of Abbott's booby nesting habitat and is also located at the leading edge of the bird's population range. If it were to be rehabilitated, this area would become a corridor linking the SE section of the Park with the larger western portion. It would also assist to buffer the forest on the leeward side of Wharton Hill from the SE wind	This area is mainly on mining lease and hence cannot be currently addressed.

In addition to the above, with time and resources permitting, by 2008/09 the program will revisit LB4, additional parts of Field 23, and re-work several older failed rehabilitation areas. Beyond those sites listed in Table 2, the current priority list includes a further 8 fields and locations across some or all of MLs 139, 107, 101, 132, 140, 128, 130, 121 and 124. However, under the current resourcing arrangements, many of these areas will not be completed in the lifetime of the next 3-year agreement with DOTARS. Furthermore, unless there is a policy change, a number of important areas on the priority list will not be rehabilitated as they occur on current mining leases. The original intent of the 2000 Plans was not to make the distinction.

As has historically been Parks Australia's position, the primary driver for the priorities is the protection of Abbott's Booby habitat (ie its nesting sites), the most recent survey of which was undertaken in 2002. The priorities then further take into account areas of significance to other significant bird species (including the Christmas Island Frigatebird), the need for contiguous forested areas for general wildlife habitat and refuge areas, and those areas of water catchment conservation value.

FIELD OBSERVATIONS

PAN sites rehabilitated under the plans since 2000

FIELD 20 WEST

As per the priority listing, and as flagged in the 2000 Plans, Field 20 West was the first site rehabilitated under the new plans. The earthworks were undertaken during late 2000 and the area (22ha) planted early the following year (2001). The site was thus about 5 years old as of April 2006. Due to the timing of the development and acceptance of the new plans in 2000, the tubestock species used at this site were those that already existed in the nursery and hence the rehabilitation does not fully reflect the species list in the plans. As suggested in the 2000 Plans, simultaneous planting of primary, secondary and tertiary species was carried out, a practice that was subsequently changed to a split planting (see Field 20 East description). The fertiliser application at this site was also viewed as sub-optimal (the plans suggested an initial application of 500kg/ha at planting, though 'current' practice has moved to 3 applications per year at a rate of 200kg/ha per application). PAN staff suggest that this transition site (ie the initial 'testing' ground for the new plans and hence the anomalies with species and fertiliser practices) is probably 12-18 months behind what a 5-year-old site using 2006 practices would be. Monitoring at this site has occurred at 0, 1 and 3 years (May 2001, February 2002 and April 2004).

Fig.1. Examples of the 5-year-old rehabilitation in Field 20 West.

FIELD 20 EAST

Field 20 East was prepared in the dry season of 2004 and 28,000 seedlings planted in February 2005. The areas (21-22ha) were thus 14 months old at the time of the visit. Only the primary and harder secondary species were planted initially, with the 'softer' secondary and tertiary species to be planted two years later, ie February 2007. A denser planting of primary (and harder secondary) species was used (2m x 2.5m spacing) to assist with earlier canopy closure and hence weed control. The fertiliser regime of 3 times per year at 200kg/ha per pass was introduced, and this area was last fertilised in December 2005. The areas were monitored in June 2005 (Year 0).

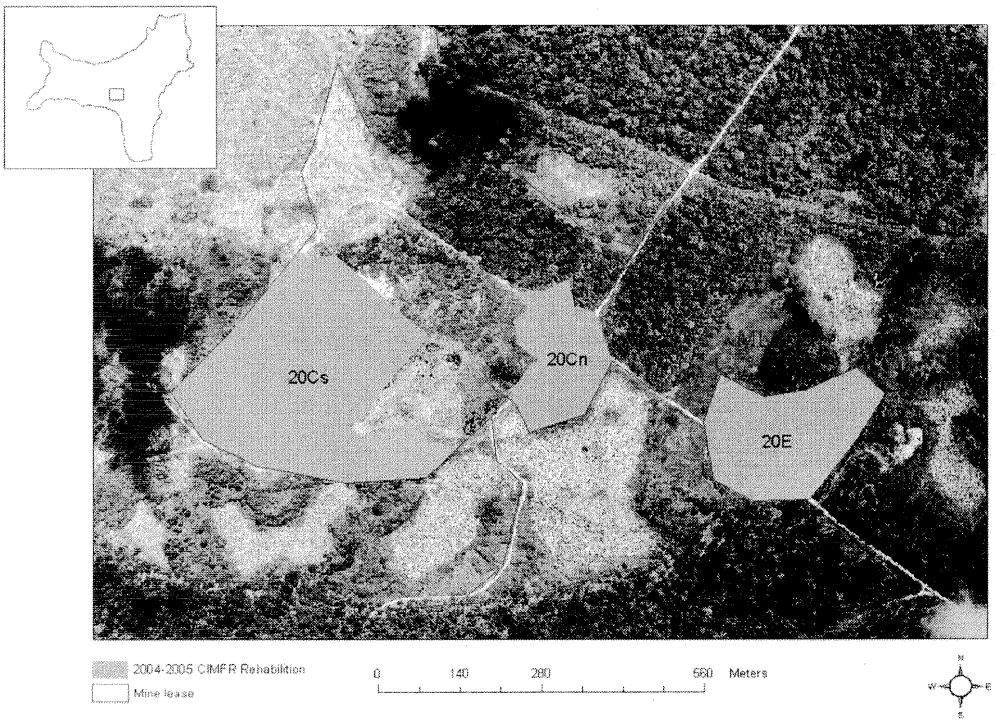

Fig. 2. Areas in Field 20 East that were targeted for rehabilitation by the CIMFR program in 2004-2005. (Source: Jeff Clausen, PAN – Annual Report on the CIMFR Rehabilitation 2005).

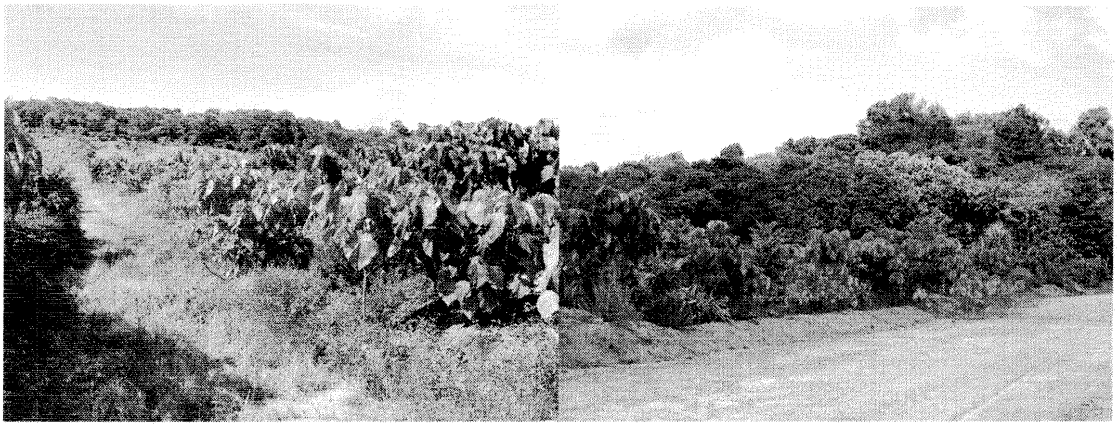

Fig. 3. Examples of 14-month-old rehabilitation in Field 20 East (foreground).

FIELD 23 (7 separate sites)

Earthworks were completed at the end of 2005, and planting took place in February and March 2006. Only 13-14ha was planted (22-23,000 plants) out of a total preparation area of 25ha due to a lack of rain. As for Field 20 East, only the primary species and hardier secondary species have been planted to date, with the softer secondary and tertiary species to be planted in early 2008. At the April inspection the seedlings were 'young' for the time of year due to the poor wet season and the fact that the seedlings were transplanted as larger plants (due to fertilising in the nursery prior to planting and then delayed transplanting while waiting for rain). Several species were removed from the list this year due to scaling and the resultant presence of the crazy ant. The preparatory earthworks for the 7 sites in the sections of Field 23 that were rehabilitated took 4-5 months (August-December 2005) and cost $370,000.

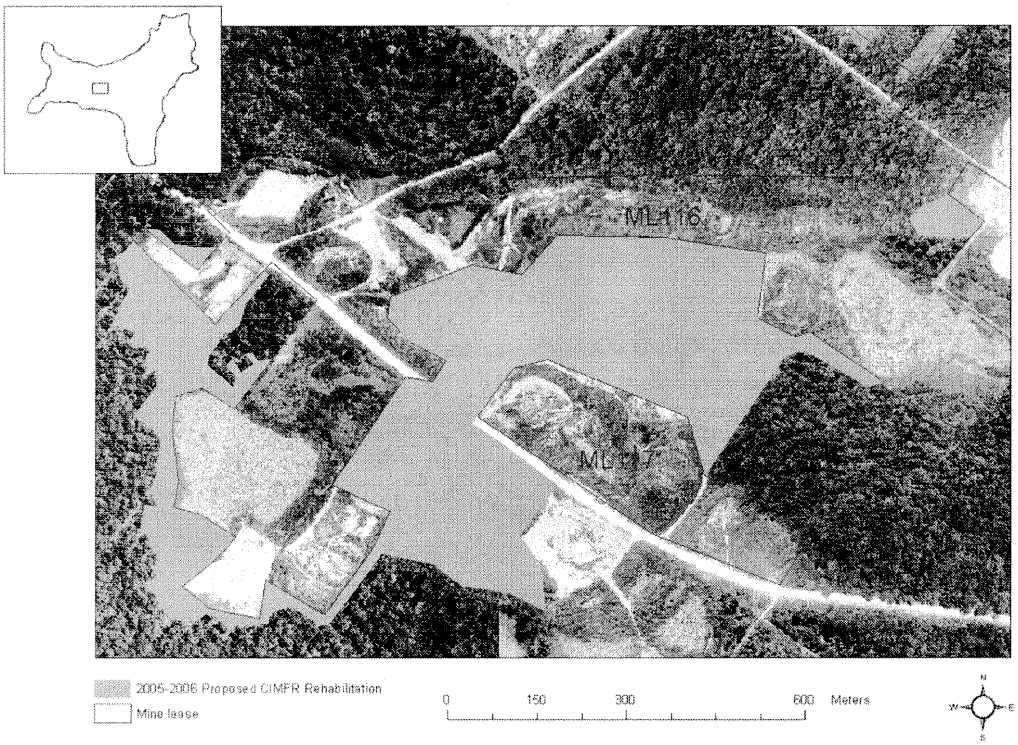

Fig. 4. Areas in Field 23 that were targeted for rehabilitation by the CIMFR program in 2005-2006. (Source: Jeff Clausen, PAN – Annual Report on the CIMFR Rehabilitation 2005).

Fig. 5. Examples of the recently planted (2 months old) rehabilitation sites in Field 23.

LB4

In 2003, at a time when funding for the program had ceased, an area at LB4 was planted out with any tubestock remaining in the nursery. No soil was brought in to this site and earthworks consisted of ripping only. No ongoing maintenance has occurred and as a result, this area, which is now 3 years old, has trees with growth rates less than those which would be expected for a well-prepared site.

Fig. 6. A section of theLB4 area rehabilitation that was used for outplanting nursery stock in 2003.

CIP sites rehabilitated since 2000

ML 111

This area visited was a stockpile base that had been ripped and planted in January 2006 (ie 3 month old). Slow release 'microcote' was applied to the 350-400 plants transplanted into this site.

Fig. 7. Young rehabilitation (3-months-old) on a stockpile base at ML 111.

FIELD 18

This section of the stockpile base was planted 4 years previously. Fertilisation was planned to continue on a 6-monthly basis, and weed control (including leucaena, gotcha grass, and various creepers) was on a schedule of 3 times per year. Both Glyphosate and Access have been applied as a foliar spray and/or via basal cut.

Fig. 8. Four-year-old rehabilitation on a stockpile base at Field 18.

SOUTH POINT WEST

The first area of former deep pinnacles (with no soil brought into the area) was rehabilitated in 2000/2001 (5 years old), and a more recent area was planted in 2005 (15 months old as of April 2006). The latter area included fertiliser trials comprising 3 treatments (NPK Blue, Dynamic Lifter, and Blood and Bone plus trace elements).

Fig. 9. Five-year-old rehabilitation on pinnacle/boulder fields at South Point West.

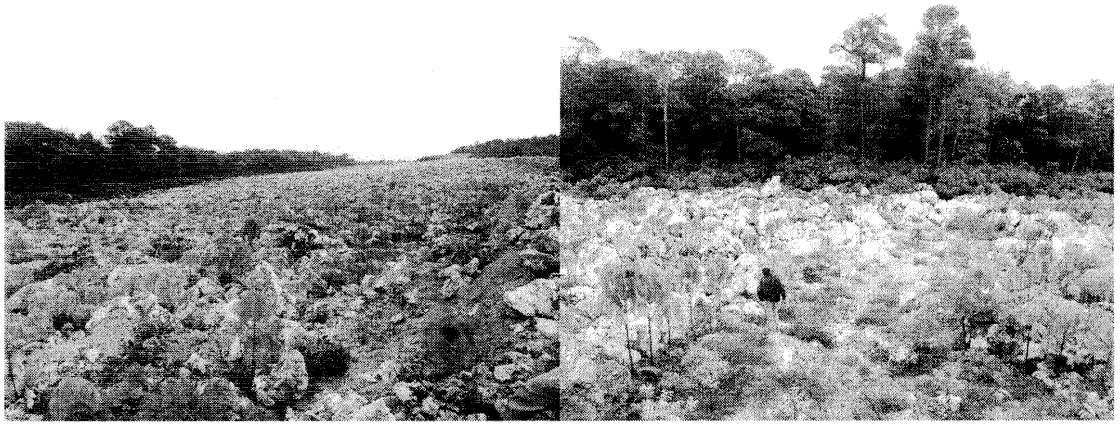

Fig. 9. Fifteen-month-old rehabilitation on boulder fields at South Point West.

ML 101 / FIELD 17

This area, originally a part of the proposed Spaceport land, was rehabilitated in 2000/2001. After 2 years, many of the trees, apart from the hibiscus, started to decline and it is suspected to be due to highly alkaline substrate, reportedly pH 9-10.

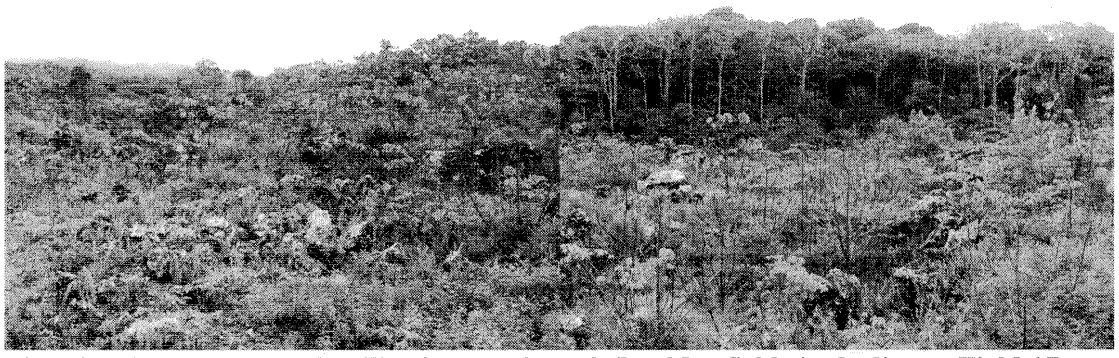

Fig. 10. Five-year-old rehabilitation on pinnacle/boulder fields in decline at Field 17.

FIELD 24P

This area, the base of a former stockpile, was dozer-ripped and planted in 2000/2001. More recently (early 2006), extensive manual clearing of *Leucaena* from within the site has been undertaken.

Fig. 10. Five-year-old rehabilitation on a stockpile base at Field 24P.

8D

This area, also a former stockpile base, was first planted 4 years previously. However, the site became infested with dense swards of *Cordia* and the original plantings were suppressed. The site was re-worked with a bobcat and in-planting was undertaken in early 2006.

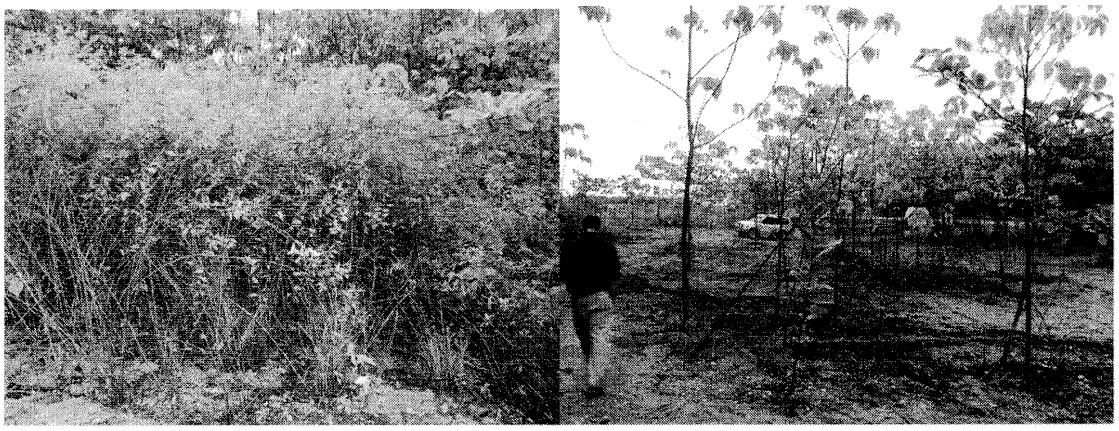

Fig. 11. *Cordia* investation at 8D (left) and after removal in preparation for in-planting.

VARIATIONS TO END USES

Various other older sites were visited during the time on the island, partly to assess whether the original 2000 Plans were still relevant and appropriate in terms of earthworks category and end uses nominated. According to discussions with PAN staff, the 2000 Plans and nominated targets are still relevant, apart from a few significant exceptions, largely due to unforseen changes in island infrastructure.

1. The Government's removal of the requirement to rehabilitate the South Point area due to the impending construction of the Spaceport Facility at the time, and the subsequent decision not to proceed with the Spaceport, has effectively changed the status of that large area that now requires a re-assessment as to its future end-use (Fig. 12).
2. The construction of the IPRC at NW Point has removed rehabilitation target areas from the list (Fig. 13).
3. The planned extension of the airport runway has meant that the end-points in that vicinity may also need to be modified.

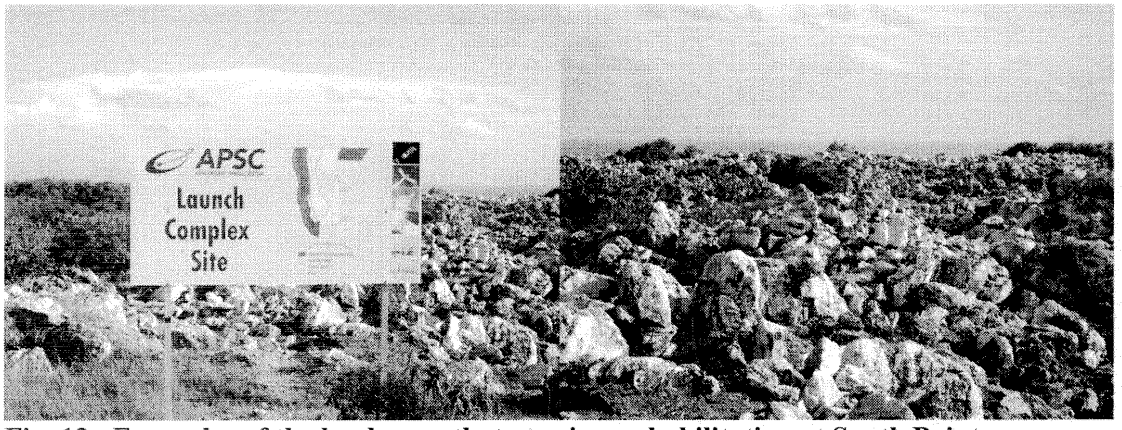

Fig. 12. Examples of the landscape that requires rehabilitation at South Point.

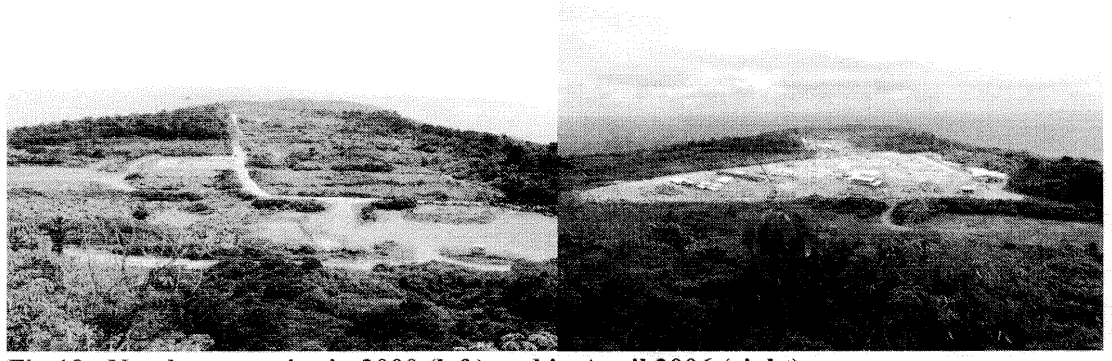

Fig.13. North-west point in 2000 (left) and in April 2006 (right).

VARIATIONS TO METHODOLOGY

Species

Table 3 lists the species recommended in the 2000 Plans and the adjustments and reasons made for changes by PAN since that time. The species mix scheduled for the 2007 planting campaign by PAN appears as Table 4. First-pass planting in Field 23A, 21 and the balance of 23 (17ha in total) will be carried out, as will secondary planting of the less hardy late-successional species for Field 20E and 20W. The species that have been used by CIP in both the pinnacle areas and on stockpile bases over recent years are also listed in the Table. There are some differences in species currently used

by the two organisations, and an impending difference in approach in regards to the two-stage planting to be instigated by PAN. As this is an approach yet to be tested, and as there is no quantitative monitoring information from CIP as to the success of particular species, the success of one approach versus the other is unknown.

Table 3. The species originally proposed in the 2000 Plans and relevant comments.

SPECIES	COMMENTS – reason for removal
Pioneers	
Claoxylon indicum	Failed to effectively establish
Dendrocnide peltata	'Stinging tree' – risk to workers
Dendrocnide sinuata	'Stinging tree' – risk to workers
Grewia glabra	
Hibiscus tiliaceus	
Klienhovia hospita	Scale insects attract crazy ants
Macaranga tanarius	
Melia azederach	An 'exotic' species
Melochia umbellata	
Pipturus argentus	
Faster growing mid-late succession species	
Ficus microcarpa	
Ficus saxophila	
Pittosporum ferrigineum	
Spondias cytherea	Limited distribution on island
Syzygium nervosum	
Late successional species	
Acronychia trifoliolata	
Barringtonia racemosa	
Berrya cordifolia	
Calophyllum inophyllum	
Celtis timorensis	
Cryptocarya nitens	
Dysoxylum gaudichaudianum	
Erythrina variegata	
Guettarda speciosa	
Gyrocarpus americanus	
Hernandia ovigera	
Inocarpus fagifer	Scale insects attract crazy ants
Leea angulata	
Ochrosia ackeringae	
Pandanus christmatensis	
Pandanus elatus	
Pisonia umbellifera	
Planchonella nitida	
Pongamia pinnata	Scale insects attract crazy ants
Terminalia catappa	
Tristiropsis acutangula	

Table 4. PAN species currently on the list to be planted in the 2006/07 campaign and the range of species used by CIP over the past several years.

PAN species – First planting (%)	CIP species
Pioneer	
Macaranga tanarius (40)	✓
Melochia umbellate (10)	✓
Pipturus argentus (10)	✓
Mid-successional and hardy late successional	
Dysoxylum gaudichaudianum (5)	✓
Ficus macrocarpa (5)	
Guettarda speciosa (5)	✓
Ochrosia ackeringae (5)	
Pandanus elatus (5)	✓
Tristiropsis acutangula (5)	✓
Barringtonia racemosa (2.5)	✓
Berrya cordifolia (2.5)	
Calophyllum inophyllum (2.5)	✓
Gyrocarpus americanus (2.5)	✓
PAN species – Second planting (%)	
Less hardy late-successional	
Planchonella nitida (20)	✓ (S only)
Syzygium nervosum (20)	✓ (S only)
Terminalia catappa (20)	✓
Celtis timorensis (10)	✓ (P only)
Cryptocarya nitens (10)	
Hernandia ovigera (10)	
Leea angulata (5)	
Pisonia umbellifera (5)	
	S = stockpile base; P = pinnacle field

There are 7 species in the PAN list (*Ficus macrocarpa, Ochrosia ackeringae, Berrya cordifolia, Cryptocarya nitens, Hernandia ovigera, Leea angulata* and *Pisonia umbellifera*) that are not typically used by CIP and there are 8 other species used by CIP in recent years on stockpile bases or pinnacle areas or both that are not a part of the current PAN schedule. The CIP additional species are *Erythrina variegate, Grewia glabra, Hibiscus tiliaceus, Inocarpus fagifer* (pinnacle fields only), *Melia azederach, Scaevola taccada, Schefflera elliptica* and *Spondias cytherea* (pinnacle fields only).

Fertiliser

As recommended in the 2000 Plans, the use of fertiliser Tree Tablets and water absorbent crystals have been discontinued by PAN. Following the results from fertiliser rate trials conducted in 2001-02, the strategy for the application rate of fertiliser has also been modified from that prescribed in the original Plans. The graphs in Figure 14 illustrate the average percentage increases in tree height and basal

diameter between January 2001 and January 2002, justifying the shift from a once-off application of 500kg/ha at the outset to 600kg/ha applied as 200kg/ha once every 3-4 months.

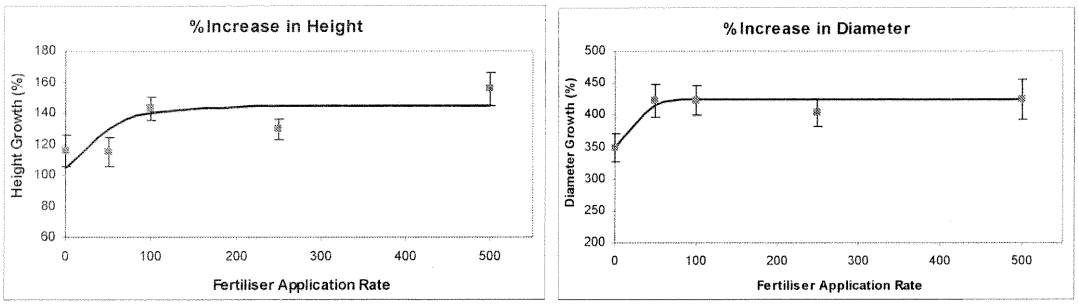

Fig. 14. Examples of the data captured from fertiliser rate trials commenced in 2001.

While PAN uses *Horticulture Special* fertiliser, CIP uses slow release *Microcote* at an application frequency of every 3-6 months.

Monitoring

The monitoring currently adopted by PAN generally reflects that which was suggested in the original 2000 Plans. Transects have been altered in dimensions to fit within the typical site geometries, and thus 10 transects of 50m x 4m (as opposed to 100m x 2m) have been implemented. The vegetation parameters collected (and indices calculated) is quite extensive and upon further collection and analysis of data, a re-assessment of the range of parameters used should be conducted. Similarly, the soil parameters measured need to be re-examined in light of the practicalities, the robustness of the methodologies employed and the informing power and relevance of the results.

Insufficient data has been collected thus far, due to the 3-year suspension of the program, to determine whether changes to the monitoring should be implemented. Clearly, as the number of rehabilitation sites increase, so will the requirement for resources to keep the monitoring up to date.

OTHER PAN RESPONSES TO THE PLANS

In addition to the initial recommendation for fertiliser rate trials to clarify this aspect of the inputs, the 2000 Plans also suggested that there could be merit in testing direct seeding options, particularly for those smaller areas where access is difficult. As was the case with the fertiliser experiments, this suggestion was also readily embraced by the PAN staff in the first year of implementation, 2001. Trials using three densities of the pioneer species were established in both an old pinnacle site as well as an area where there had been recent preparatory earthworks. While the season was a good one, and seedlings emerged, survival rates were very low, and further exploration of this option has not been pursued as the risks of failure are considered too high.

Other aspects like number of seedlings planted per day have also been adjusted from the figures forecast in the original Plans to match the realities and operational practicalities that have been gained by the experience of PAN staff and the field teams. Cost estimates have also been able to have the reality check imposed given the implementation of the Plans, as modified, over the past two years in particular.

THE OUTSTANDING DILEMMAS

Despite the inability to fully gain an understanding of how the Plans have delivered due to the program suspension and consequent short time period over which the 'optimal' strategy has been 'in-ground', a number of issues, many of which have been known for many years, remain as 'dilemmas'.

Inefficiencies due to policy?

The undisputable reality, and a given, is that there is not enough soil on the Island to attempt to rehabilitate all past mining areas to primary rainforest. That being the case, the approach of prioritising areas is the next best option and the Plans were developed to support this. What is very obvious from the aerial imagery, at least, is the patchwork mosaic that exists across the Island, and the correction of the loss of contiguous rainforest should, and was planned, to be addressed. However, this intention has stalled by a government decision not to allow PAN to rehabilitate land over which a mining lease is still active. This appears to be the case even where the company had determined the stockpiles on those areas were no longer required or of value to the company from a commercial point of view and were therefore available to Parks to use as backfill as a part of its program. The resultant patchwork is not entirely due to this decision as there remain stockpiles that CIP still wish to keep as potential product (especially as the blended product is now a major component of the marketable commodity). However, as shown in Figures x and y, there are clearly economic and certainly ecological inefficiencies that are introduced as a result of this decision. It is taken to the extreme when a stockpile has only been able to be half removed (and hence half the potential material is not made available) because the lease boundary line (on the map) runs through the middle of it.

Fig. 15. A section of Field 23 South showing the ML boundary and the half stockpile unable to be used

Soil or product?

Beyond the overall deficiency of soil for the desired level and extent of the rainforest rehabilitation program, it still not clearly known how much soil is potentially available for the CIMRP, and as a part of that, its location and therefore the economics of mobilisation. CIP has been, and still is, conducting a resource assessment of the stockpiles. Without full knowledge of the original legal agreements re cut-off grade as to the distinction between product and soil, it is clear however that with the new markets for a blended product, and if, for reasons at a level beyond this review that new leases for CIP are not granted, it is reasonable to assume that pressure on existing stockpiles and mining leases could be even greater.

Utilising old stable stockpiles?

There exists across the Island numerous old deep stockpiles that support considerable species richness and productivity and many have progressed to what appears to be quite sustainable ecosystems. These ecosystems naturally developed without intervention because the number of introduced weeds on the Island at the time was minimal. Such a strategy today would, without management inputs to control the weeds, be unlikely to allow the same progression. The question thus arises as to the decision-making process about these systems that sacrifices such regeneration for the redistribution of the soil resource over a much larger area, the rehabilitation of which

(including the stockpile footprint) will undoubtedly require much more input for an extended period of time.

Fig. 16. A developing ecosystem on an old stockpile

The fertiliser – weed conundrum

The dilemma remains that fertiliser is required to ensure the early pioneer species (eg *Macaranga* in particular), get a good start while at the same time the ongoing fertilising equally encourages weed growth. The current strategy is one of fertilising and controlling weeds in parallel until such time as canopy closure can hopefully reduce the level of competition from the weed species. This is a labour intensive (3-4 times a year for each activity) which will become progressively more onerous as the number and area of rehabilitated sites increases with time. It is not yet clear, given the limited longevity of sites established under the modified Plans, at what age the system will cease to be dependent on such inputs. Unfortunately, the legumes that were originally in the species list have had to be removed as they develop scale that attracts the crazy ants.

Managing the pinnacle fields

In those areas where a decision has been made not to attempt rainforest restoration by not replacing soil to a sufficient depth on the mined landscape, the pinnacle lands present a special challenge. As soon as there is any soil left, weed management will be required and hence access will be needed. Where CIP has adopted a strategy of planting directly into these pinnacle fields, there is a recognised problem that restricts

safe access necessary for the ongoing maintenance of these sites, and in particular weed control and fertiliser management. Future (necessary) monitoring and enrichment planting of these sites will also present high risks of injury to field operatives. In older fields, the provision of tracks across the landscapes should be a minimum requirement, and for areas that are being mined in the future, consideration could be given to only mining to the tops of the pinnacles, thus leaving a relatively even landscape surface upon which revegetation and management practices can be developed and practiced into the future. From the company's perspective, such an approach potentially sterilises considerable resource at depth, the cost of which however may be offset by the reduced costs of future rehabilitation to ensure compliance with regulatory expectations at the time of mine closure.

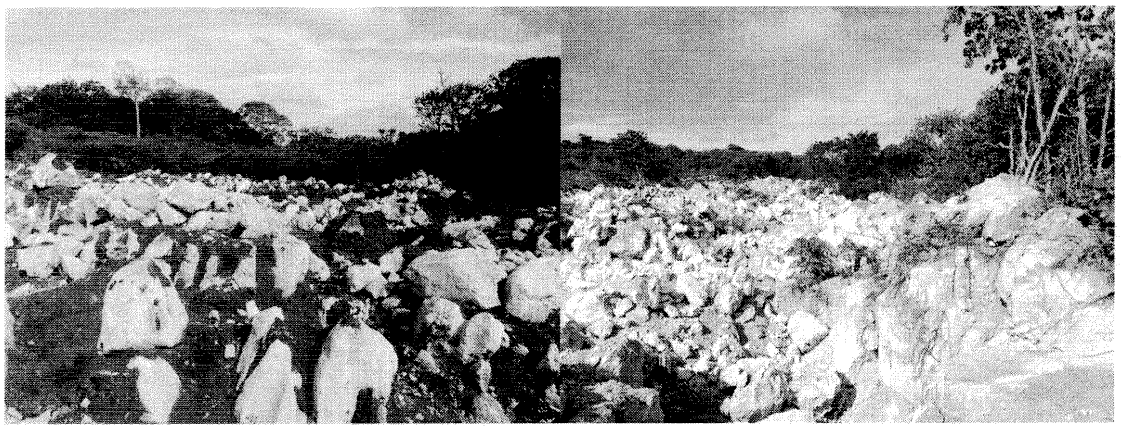

Fig. 17. Pinnacle fields remaining following mining activity that makes access, and hence subsequent site management, very difficult.

The addition of the large areas of boulder fields following extensive mining at South Point (on what was to be the Spaceport area) to an end-use category where 'do nothing' is likely no longer appropriate needs to be considered as a change to the Plans. Given the circumstances, it is now likely to be the responsibility of the Government to rehabilitate this area.

Development of success criteria

A draft set of success (or end-point or completion) criteria were presented in the 2000 Plans but the rehabilitation is too young to challenge those generic parameters as to their appropriateness. Once sufficient monitoring data has accumulated over a number of years, a closer scrutiny will enable realistic targets to be set in regards to what might be expected to be achieved by the rehabilitation strategy at a particular age. Key indicators such as:

- floristic structure;
- time to canopy closure (and hence weed suppression);
- transition from pioneer dominance to subsequent successional species (and their emergence through the pioneer canopy);
- quantification of nutrient cycling processes becoming effective and reducing/eliminating the requirement for maintenance fertilisers; and
- evidence of recolonisation by faunal assemblages characteristic of the target forest

are all aspects that can be incorporated into criteria at various temporal stages that will provide the basis for decisions about how successful rehabilitated parcels of land are tracking towards the designated end point.

Towards (and the need for) a common approach

The 2000 Plans were originally provided as a whole-of-Island approach for the areas where both PAN and CIP had responsibility, but issues over soil availability, the level of ground preparation required and the differing views on whether rainforest 'restoration' was a practical goal at all, appears to have resulted in a divergence of approaches. However, there is no doubt that a consistent and holistic approach is the best outcome for the Island and all its stakeholders. Given the limited soil resource, there needs to be mutual agreement about priorities and a common approach to the basic practices of vegetation establishment and maintenance, fertiliser and weed management, monitoring and target setting, and data and information management.

PAN has a very active embracement of GIS systems as a means of documenting the vast amount of spatial information relating to all aspects of the rehabilitation program. CIP likewise uses this platform effectively. However, there are some inconsistencies and a rationalisation and management of a central GIS system would seem a more effective way to proceed. The linking of the databases with the visualisation format should also be undertaken to increase the efficiency of data and information retrieval, and to ensure that knowledge is not lost as a result of staff turnover.

Apart from the obvious divergent paths that have been taken place in recent years, especially in relation to rehabilitating the pinnacle and boulder fields (stockpile bases are far less problematic and should be able to readily addressed with a common approach), there is much merit in considering the option that for its current active areas, the mining company conclude its role with the rehabilitation at the point of leaving a stable, safe and accessible landform, the specific criteria for which constitutes this to be mutually agreed. Thereafter, it may be appropriate for PAN to assume responsibility for the rehabilitation and revegetation strategy, its implementation and continuance, to whatever end use is designated. How such an arrangement would be funded will need to be addressed, but in principle, the approach is probably sound and will greatly contribute to consistency.

RECOMMENDATIONS

As an outcome from the visit and against the background of some of the above dilemmas, the following draft recommendations are put forward for consideration, comment and/or action:

1. The ecological and economic inefficiencies created by the decision not to allow PAN to rehabilitate priority lands that, while still on existing MLs, CIP has sanctioned for 'handover' needs to be re-assessed. Mechanisms through the WA legislative system exist to be able to protect such areas once rehabilitated.

2. Expedite the analysis of stockpiles across the Island to enable an informed decision about exactly what and how much is where and whether it is product or soil. The timely completion of this task is critical to both parties and the outcomes are of benefit to all. As such, and to enable this task to be completed in a timely and transparent manner, consideration should be given to this being a joint initiative with funding support from the Commonwealth.
3. Related to the above activity, an informed assessment of the 'value' of the ecosystems that have developed on the oldest stockpiles and whether their re-mobilisation to meet the priority needs elsewhere is always the best course of action.
4. Further explore, either through internal resources, or through commissioned research, the nutrient (in particular nitrogen) dynamics of the soil-plant systems of the rehabilitated landscapes in order to more effectively address the cross-purpose management regimes that on the one hand encourages weed growth while on the other seeks to eliminate weeds.
5. While PAN staff view the 2000 Plans in terms of the designated end uses across the Island still generally applicable, there are areas (particularly in the north-west and south) where there have been significant changes in recent years. Such modifications and/or updates to the CI GIS need to be incorporated as does an accurate inventory of stockpiles and their category.
6. In the short-term, review the monitoring program and its outcomes following the 2006 campaign to examine early trends and in light of those findings consider appropriate modifications if required.
7. Link the spatial and visual information with the databases to more effectively store, manage and retrieve information.
8. Give consideration to commencing dialogue relating to the possibility of new areas of disturbance (or re-disturbance) by the mining company being completed up to an agreed point in terms of landform and thereafter the government (PAN) becoming responsible for the decision relating to end use and the implementation of the relevant revegetation course of action.
9. Given the backlog of rehabilitation to be completed, the resource (both physical and human) limitations to the rate at which rehabilitation can be undertaken, and the absolute necessity to undertake the works in order to minimise risks to the highly valued natural asset of the rainforest ecosystems on the Island, the sole reliance on the finite conservation levy being paid by the mining company to the government is inappropriate. The Commonwealth Government needs to accept responsibility for the damage caused by historic mining activities conducted by the Commonwealth and provide funding to support the rehabilitation program accordingly.

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