FLORA SURVEY

for

ENVIRONMENTAL IMPACT STATEMENT

BATCHELOR MAGNESESIUM PROJECT
MLN1984, BATCHELOR, NT

Prepared for

Mt Grace Resources N L

and

URS AUSTRALIA PTY LTD

by

KRISTIN METCALFE ॐ CONSULTANT ENVIRONMENTAL SCIENTIST

September 2001

Executive Summary – Flora

- The vegetation of the proposed 357 ha Batchelor Magnesium Project mining lease area, located approximately 4 km east of Batchelor, comprises mainly *Eucalyptus*-dominated woodland and open woodland communities. This vegetation formation, also known as savanna, is common, widespread and characteristic of the region generally

- The existing vegetation indicates significant levels of disturbance from previous landuse both within and adjacent to the project area including mining, agriculture, extensive clearing for pastoralism and frequent burning

- The flora survey, undertaken during May to September 2001, recorded a total of 173 plant species from 55 families and 136 genera, including 16 introduced species

- Sixteen introduced species were recorded during field surveys and weeds were found within all major habitats, mainly in disturbed sites. Dense infestations of Gamba Grass (*Andropogon gayanus*) are characteristic of the project area. Although not a declared species, Gamba Grass is recognised as a serious environmental weed and fire management hazard

- Field surveys and aerial photograph interpretation distinguished six main vegetation types within the project area including extensive Mixed Eucalypt woodland in upland terrain and *Lophostemon* open woodland associated with drainage areas

- A narrow band of riparian (or riverbank) vegetation fringes Coomalie Creek, a semi-permanent watercourse which flows through the northern section of the project area. The creek and small waterholes with permanent water provide habitat for a relatively diverse aquatic plant community

- Isolated pockets of dry monsoon vine-forest vegetation occur on dolomite outcrops within the project area, particularly in the vicinity of Janier Rocks. Immediately upstream of the project area, a small area of evergreen monsoon vine-forest vegetation occurs, associated with permanent water of Coomalie Creek

- No rare or endangered plant species of conservation significance occur within the project area. Indeed, rarity is unlikely as none of the plant communities recorded have special conservation status at the local, regional or national scale

- The vegetation of the project area suggests frequent, possibly annual burning. The presence and continued spread of introduced tall grasses including *Pennisetum polystachion* and *Andropogon gayanus* will perpetuate late season, high intensity fires. Implementation of a Fire Management Property Plan will be necessary to meet protection and control objectives within the lease and in relation to the local area

- The major impacts of the proposed development on flora focus in the creek diversion area. Impacts include loss of riverine habitat behind the diversion bund and creation of a seasonal drainage way along the new channel alignment. Substantial clearing of native vegetaion will occur in upland areas

- During the construction and operational phases of the project, downstream sedimentation must be prevented and high water quality standards maintained within Coomalie Creek in order to conserve existing diverse and healthy aquatic ecosystems

FLORA SURVEY

for
ENVIRONMENTAL IMPACT STATEMENT

BATCHELOR MAGNESIUM PROJECT
MLN1984, BATCHELOR, NT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

FLORA SURVEY

for
ENVIRONMENTAL IMPACT STATEMENT

BATCHELOR MAGNESIUM PROJECT
MLN1984, BATCHELOR,NT

FLORA

1.0 Introduction

This report presents the results of an examination of the terrestrial flora occurring within the 367 ha site of the proposed Batchelor Magnesium Project, located 4 kilometers east of Batchelor, Northern Territory (Figure 1). Mt Grace Resources NL plans to mine and process extensive deposits (16.6 million tonnes) of high-grade magnesite within the Winchester Magnesite Deposit within mining lease MLN1984 (Figure 2) commencing in 2003. This report describes the flora, maps the vegetation communities occurring within the project area and provides detailed information on the vegetation of specific areas that may be affected by the proposal. The terrestrial vertebrate fauna of the project area is described in Section 3.4.2 of the EIS document. The flora survey aims to meet a number of principal objectives:

- to examine and describe the existing vegetation within the 367 ha mining lease with particular focus on those habitats that will be most affected by the proposed development eg. Coomalie Creek corridor and *Eucalyptus*-dominated woodland
- to determine the distribution of the major vegetation communities present within the survey area (vegetation mapping)
- to undertake detailed examination of the flora at key locations (by line transects, species inventories etc)
- to assess the site for the presence of flora of special conservation significance including rare or endangered species and vegetation communities of restricted distribution
- to assess the botanical and ecological significance of existing vegetation in the local and regional contexts
- to make an initial weed assessment and discuss proliferation and control issues
- discuss the potential impacts of the development on flora and
- recommend mitigation measures and safeguards to minimise negative impacts

This report is a compilation of the results of research and baseline field surveys, as outlined below, to facilitate the overall environmental assessment of the project.

2.0 Methodology

The vegetation of the proposed development site was examined during four site visits between 25 April and 15 September 2001. Prior to field reconnaissance, preliminary mapping of the area from aerial photographs distinguished several distinct vegetation communities within three broad habitat types: upland woodland, drainage areas and monsoon vine-forest.

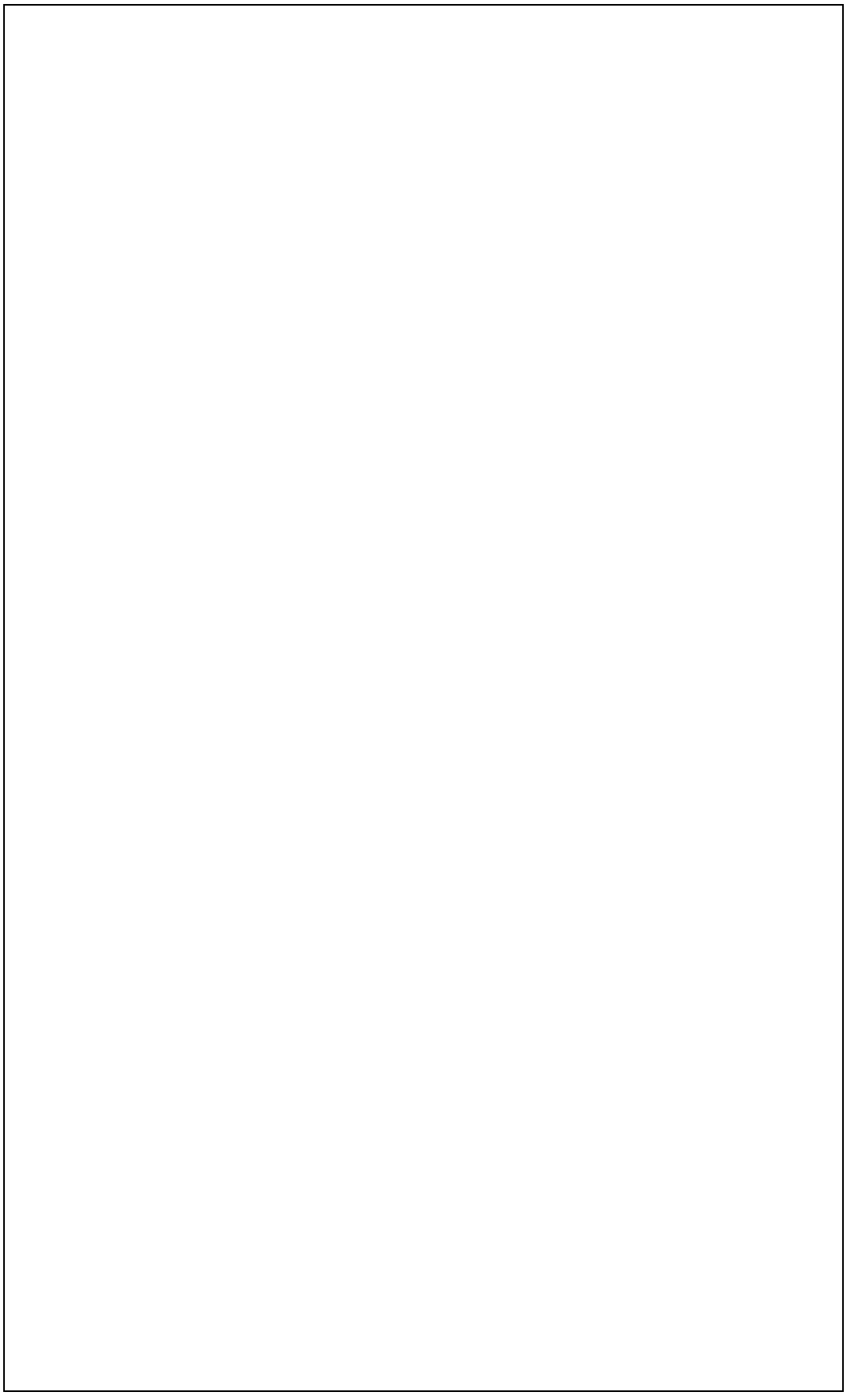

Figure 1. : Location map of the Top End of the Northern Territory, showing Batchelor and the proposed Batchelor Magnesium Project area.

Figure 2: Map of the Batchelor region, indicating the location of the Winchester Magnesite Deposit within Mining Lease 1984

To characterise terrestrial flora, the following information was recorded at selected sites within the major vegetation communities:

- species composition and dominance
- vegetation structure (heights of upper, mid & ground stratum species)
- ground cover (%)
- % canopy cover (calculated from crown separation ratio)
- presence and abundance of introduced species (weeds)
- disturbance (including fire, feral animals and anthropogenic impacts)
- environmental features including slope, landform, soils and drainage
- GPS location

Plant species lists were compiled of the plant species in the upper, mid and ground strata for the main vegetation types (Appendix 1). However, species lists are intended as checklists rather than complete botanical inventories, which is beyond the scope of the current project. Flora surveys were commenced in May (late Wet season) in order to sample deciduous species, ferns and other ephemeral wet season species absent during the Dry season. The major vegetation communities were photographed during field surveys (Appendix 2)

Quantitative assessment of the existing vegetation was made at selected locations within each of the major vegetation communities (Table1). The height and location of all plant species intercepted by a straight line (using a 50m surveyors tape and compass) was recorded and crown separation ratio calculated along each transect. Data from vegetation transects was used for compilation of vegetation profile diagrams (Figures 4 to 12). The vegetation profiles present baseline information on species composition, community structure and species richness, while providing a rapid visual and botanical characterisation of the vegetation at each site.

The study area was examined for the presence of rare plant species and ecological communities of conservation significance. However, the majority of fieldwork was undertaken during the late wet season and the early dry, when some of the early to mid Wet season flora may have been absent (annual species) or unidentifiable (as a consequence of grazing, fire or dessication). Unknown plants were collected and pressed for later identification by Chris Mangion, Ian Cowie and Bob Harwood of the Northern Territory Herbarium. Where appropriate, collected plant samples were lodged with the Herbarium as voucher specimens.

3.0 Vegetation

3.1 Flora

Appendix 1 contains a species list compiled for the project area based on four field visits. A total of 172 plant species from 55 families and 136 genera were recorded. Plant families represented by the most species were: Myrtaceae (22 species); Poaceae (25 species); Fabaceae (15 species) and Euphorbiaceae (8 species). Genera represented by the most species were *Eucalyptus* (9); *Melaleuca* (5) and *Ficus* (5). A total of 16 introduced species were recorded which is an indication of relatively high levels of disturbance.

The flora of the project area is poorly known with only a few common species (including *Eucalyptus* and *Cycas*) recorded on the NT Parks and Wildlife Commission database for the area surrounding the proposed mine site. In contrast, a 5 kilometer boundary around the mining lease area produced approximately 165 records (Appendix 4). However, the PWCNT records includes habitats such as

Table 1: Summary Table of Major Vegetation Communities within the Batchelor Magnesium Project mining lease area

MAP UNIT	TRANSECT No & PROFILE DIAGRAM No	VEGETATION COMMUNITY AND DESCRIPTION (mean % canopy cover)	SPECIES RICHNESS (per 50m transect)	GPS LOCATION
UPLAND COMMUNITIES				
1	Transect # 7 **Figure 3**	***Eucalyptus tetrodonta/ E. miniata* Open Woodland** Open woodland to open forest on gentle sidelopes and hills Typically upslope of Map unit 2, quite extensive in survey area (21 %)	24	0724784 E 8556003 N
2	Transect # 1 **Figure 4**	**Mixed Eucalypt Woodland** Variable dominant species forming woodland to open woodland on lower slopes and floodplain of Coomalie creek. Extensive within survey area (36 %)	29	0722600 E 8556528N
	Transect #2 **Figure 5**		23	0723340 E 8556513N
DRAINAGE AREAS				
3	Transect # 5 (at creek) **Figure 6**	**Riparian corridor** Narrow linear band of riverbank species whose roots often define the creek channel. Fringed by levees and surrounding alluvial flats with sparse trees amongst dense grassland. (24 %)	12	0723522 E 8557036 N
	Transect #6 (at billabong) **Figure 7**		19	0723809 E 8557050 N
4	Transect # 4 **Figure 8**	***Lophostemon* open woodland** Open woodlands on broad drainage way surrounding Coomalie Creek. Often forming monospecific stands or in association with *Melaleuca* (Paperbark) and scattered *Eucalyptus* spp. (15 %)	19	0723654 E 8557010 N
	Transect #9 **Figure 9**		19	0722347 E 8556345 N
MONSOON FOREST COMMUNITIES				
6	Transect #3 **Figure 10**	**Monsoon vine-forest** Floristically distinct and diverse community on rock outcrop comprising evergreen and semi-deciduous species. Contains high numbers of vine species and often dense weeds on margins (66 %)	28	0724784 E 8556003 N
	Transect #8 **Figure 11**		21	0724136 E 8556866 N

evergreen monsoon vine-forest habitats, grasslands etc that are not found within the survey area and are therefore not expected to occur within the project area.

3.2 Vegetation Communities

Previous vegetation surveys

Previous mapping of the study area at 1:1,000,000 scale and description of the vegetation at a gross level was undertaken by Wilson *et. al* (1990) as part of vegetation mapping of the Northern Territory. This stratification distinguished only one vegetation type within the proposed lease area - *Eucalyptus tetrodonta* (Stringybark), *E. miniata* (Woolly Butt), *E. bleeseri* (Smooth-stemmed Bloodwood) woodland with *Sorghum* grassland understorey (Map Unit 9). Forming a broad swathe, this community extends south from Darwin almost to Adelaide River with large expanses also occurring further to the south and west.

The vegetation of the area has been mapped at a scale of 1:500,000 by Christian and Stewart (1953) as part of early Land Systems mapping for the Darwin-Katherine region. These maps classify the landscape in terms of recurring patterns of landform, soils and vegetation. However, no recent, more detailed mapping of the region including the study area has been undertaken as part of Land Resource surveys.

Previous mapping indicates that the *Eucalyptus*- dominated savanna formation is widespread and well represented in the region generally. However, to satisfy EIS requirements, a more detailed stratification and description of the project area was necessary in this instance.

Terrestrial Vegetation Communities

The vegetation in the lease area closely reflects the interplay of topography, soils and the influence of seasonal fluctuations in fresh water supply and drainage. Consequently the pattern of vegetation broadly corresponds with major topographic contours. Overall, the main factor determining the distribution of vegetation within the site is the pattern of drainage areas associated with Coomalie Creek (Right Branch). The riparian corridor, it's surrounding alluvial flats and minor tributary creeks dominate the lowland section of the project area. Upland vegetation occurs on the surrounding gentle lower slopes - which rise more sharply to low hills at the base of a major east -to-west ridge - beyond the boundary of the BMP lease area.

Disturbance to the area has been significant in shaping the nature of the existing vegetation. During the early 1900's the area was aquired for use as an experimental farm. Most of the project area was cleared, fenced and cultivated and in 1912 the Batchelor Demonstration farm commenced operation (Appendix 3). The farm was not successful and the site was used as a Government depot, for farming and for defence purposes during World War II. During the 1970's the lowland area near Janier Rocks was cleared again and sown to improved pasture for cattle and horses. The area currently supports dense infestations of exotic grasses (Section 5) which exacerbate the effect of frequent, widespread fires which play a major role in determining overall vegetation types in the local area.

During the current survey, aerial photograph interpretation, field work and ground truthing distinguished 6 main vegetation types in terrestrial areas (Table 1). Preliminary mapping was ground truthed and a draft vegetation map of the lease area

was compiled. The final vegetation map of the project area (Figure 4) was prepared at approximately 1:9,000 at A3.

3.2.1 Upland communities

The majority of the Batchelor Magnesium project area (76%) comprises upland vegetation on gentle lower slopes and foothills which support *Eucalyptus* dominated communities. These communities comprise various formations ranging from open woodland (with sparse trees with well separated canopies – 0.3 to 20% canopy cover) to woodland (where upper stratum trees have clearly separated canopies – 20 to 52% canopy cover). Three main upland communities were distinguished and are described as follows:

***Eucalyptus tetrodonta/ E. miniata* open woodland (Map Unit 1)**

The *Eucalyptus tetrodonta/ Eucalyptus miniata* open woodland community (Community 1) covers approximatey 64 ha (18%) of the 357 ha survey area and comprises Eucalypt-dominated open woodlands with minor areas of more dense woodland habitat (Figure 3). The dominant species is characteristically *E. tetrodonta (*Darwin Stringybark) with *Eucalyptus miniata* (Darwin Woollybutt), either singly or in co-dominant stands. *E. confertiflora* may be locally abundant and *Erythrophleum chlorostachys* (Ironwood), *E. tectifica* and *E. foelscheana* are common canopy-forming species throughout the open woodland habitat. This formation typically occurs on the well-drained lower slopes and foothills, upslope of Community 2.

This community is characterised by a relatively sparse upper stratum of *Eucalyptus miniata* and *E. tetrodonta*, 8 to 13 m high, over a sparse to mid-dense understorey (Figure 4). Common secondary tree species include *Planchonia careya, Ficus opposita, Terminalia ferdinandiana* and *Buchanania obovata.*

The mid-stratum layer typically comprises mixed species approximately 2 to 6 m high including many widespread and characteristic woodland shrubs and low trees. Common mid-stratum species include *Cycas armstrongii*, *Brachychiton megaphyllus* and *Livistona humilis.* Abundant coppicing from lignotubers, especially by *Eucalyptus* spp.and *Erythrophleum*, is indicative of a high frequency of fire.

The relatively open tree canopy promotes a dense layer of grass species and subshrubs. Species composition in the ground layer might include *Flemingia lineata* and *Fleuggia virosa,* low herbs such as *Buchnera* sp. and *Uraria lagopodiodes* and vines including *Ampelocissus* spp. may be locally abundant. Grasses include annual sorghum (*Sorghum* spp.) and *Heteropogon contortus*, and are widespread and common throughout Community 1, with the introduced grasses *Pennisetum polystachion* and *P. pedicellatum* (Mission Grass) common along roadsides and disturbed areas. Gamba Grass is also abundant in disturbed areas, but unlike most other weeds, this species may also extend throughout intact woodland habitat.

Part of the infrastucture for the magnesite plant and crusher will be located within this vegetation community and consequently some clearing will be necessary within Community 1. Figure 5 is a vegetation profile through this open woodland habitat at site 7 and is characteristic of the vegetation structure and species composition within this vegetation type.

Figure 3 : Vegetation map of Mining Lease 1984, proposed location of the Batchelor Magnesium Project, showing flora study site locations

Mixed Eucalypt Woodland (Map Unit 2)

The extensive undulating lowlands and lower sideslopes of the main east-west range bordering the project area support a variable vegetation formation of *Eucalyptus* dominated woodlands. This community covers approximately 58% (or 207 ha) of the project area (Figure 3). Community 2 is characterised by variable dominance of upper stratum species, reflecting local variations in topography, soils and drainage. This community is reasonably well drained but soils become heavier and less well drained toward the valley floor. The upper stratum species commonly include *Eucalyptus miniata*, *Eucalyptus foelscheana*, *Eucalyputus polycarpa* and *Eucalyptus tectifica* with canopy trees to 10 or 15m high.

The dominant *Eucalyptus* species varies locally with changing topographic conditions and associated variations in drainage and soil type. *Eucalyptus miniata* (Darwin Woollybutt) is the most widespread dominant tree on the shallower, yellowish soils of the upper slopes. In these areas, thin *Eucalyptus tetrodonta* may also be present, with occasional *E. tectifica* especially in rockier areas and on low crests. On the lower slopes, and particularly where this community intergrades with alluvial flats and low-lying areas *E. confertiflora, E. polycarpa* and *E. papuana* may assume dominance. Other species including *E. bigalerita* and *Erythrophleum chlorostachys* become locally common towards drainage areas. Ironwood (*Erythrophleum chlorostachys)* is a ubiquitous canopy-forming tree throughout this community, becoming locally abundant to co-dominant under suitable conditions.

A varied, typically mid-dense understorey layer of low trees and shrubs approximately 4 to 6 m high is characteristic of this community. Figures 5 and 6 show cross-sections through this vegetation type, indicating typical structure and species composition of Community 2 in the northern section of the project area. Common mid-stratum species include *Petalostigma pubescens*, *Cycas armstrongii, Pandanus spiralis, Livistona humilus, Planchonia careya, Terminalia ferdinandiana, Brachychiton megaphyllus* and *Pandanus spiralis.*

The ground stratum may include a variety of herbs and subshrubs such as *Hibbertia* spp., *Flemingia lineata* and *Pachynema complanatum.* A diverse range of grasses were recorded within the ground stratum, particularly in lowland areas, with *Eriachne stipacea, E. triseta, Bothriochloa bladhii, Pseudopogonantherum contortum* and *P. irritans* common species throughout Community 2.

A full listing of plant species recorded from upland areas is contained in Appendix 1.

3.1.2 Drainage Areas

Drainage areas within the survey area include several distinct habitats associated with Coomalie Creek (Right Branch) that retain or carry water during the wet season. The main drainage line is characteristically a well defined, incised channel 1 to 2 m deep that lies within a relatively narrow riparian corridor (Community 3). This linear band is situated within a broad drainage way comprising alluvial flats with heavy soils supporting *Lophostemon* open woodlands (Community 4). These flats surrounding the creek represent wet season floodplain areas and transitional habitats between upland woodlands and the lowland drainage lines. They are characterised by seasonal inundation or waterlogging for up to several months of the year and include several swampy areas and/or areas of perched water table supporting Paperbark forests (Community 5). In general, site drainage is typically slow and substrates in drainage

Figure 4: Profile diagram of vegetation transect (Site 7) in *Eucalyptus tetrodonta/ E.miniata* open woodland – near site of proposed plant and crusher

Figure 5: Profile diagram of vegetation transect through mixed species Eucalyptus woodland (Site 1), characteristic of much of the project area

Figure 6: Profile diagram of vegetation transect through mixed species Eucalyptus woodland (Site 2) near proposed Stage 1 pit

Figure 6 : Profile diagram of vegetation transect through mixed species Eucalyptus woodland (Site 2) near proposed Stage 1 pit

Figure 7: Profile diagram of vegetation transect through riparian corridor lining the banks of Coomalie Creek (Site 5) – within proposed creek diversion area

Figure 8: Profile diagram of vegetation transect through riparian corridor habitat, Coomalie Creek, at permanent waterhole (Site 6). Located downstream of pit and creek diversion bund

Figure 9 : Profile diagram of vegetation transect through *Lophostemon* woodland habitat (Site 4)- within Stage 1 pit area

Figure 10: Profile diagram of vegetation transect through *Lophostemon* woodland habitat (Site 8) – within proposed Stage 2 pit and inside creek diversion bund

Figure 11: Profile diagram of vegetation transect through minor rocky outcrop (Site 3) – near proposed Stage 1 slag dump

Figure 12: Profile diagram of vegetation transect through Monsoon vine forest on dolomite outcrop (Site 8) near Janie Rocks

areas tend to have clay soils at depth. Three main vegetation communities have been distinguished and mapped within drainage areas in the project area (Figure 3) and are described as follows

Riparian Corridor (Map Unit 3)

Coomalie Creek, where it flows through the project area, is a semi-permanent stream within a distinct, incised channel. The bed is typically narrow with steep earthy banks that shelve more gradually near occasional deeper, permanent waterholes (Appendix 2, Drainage Areas). The root systems of the riverbank species frequently define the creek channel and the creek itself is clear and swift-flowing well into the dry season. *Pandanus spiralis, Nauclea orientalis, Acacia auriculiformis, Lophostemon grandiflorus, Timonius timon* and *Ficus racemosa* are the tree species characteristic of this narrow riparian zone (Figure 7).

This community is relatively restricted in the survey area occupying approximately 4% (or 14ha) of the total lease area. Roughly 1.2 km of the existing channel will be truncated by the proposed stream diversion bund surrounding the main magnesite pit.

Creekbank vegetation may be only several trees in width, but is characteristically flanked by a corridor of grassland in which *Ischaemum* spp. and *Imperata cylindrica* (Bladey Grass) forms dense monospecific stands. Scattered trees amongst the grassland include *Eucalyptus papuana, E. polycarpa, Lophostemon grandifloru, Melaleuca dealbata* and *Acacia auriculiformis* (Darwin Black Wattle).

Seven weed species were recorded from this habitat and may form dense infestations on river levees and where the native vegetation has been disturbed either by seasonal flooding and feral animals. Intensive previous landuse has encouraged the proliferation of weeds in this community. *Stachytarpheta spp., Hyptis suaveolens, Andropogon gayanus* and *Sida acuta* were particularly abundant in the riparian corridor (see Section 5).

The creek widens and forms several small waterholes within the survey area, described as refuge pools in the Aquatic Ecology Section of this EIS (Section 3.4.3). These water holes provide habitat for a diverse range of aquatic and semi-aquatic plant species (Figure 8) described below.

Aquatic flora

The typically narrow steep-sided creek channel provides habitat for the fern *Ceratopteris thalictroides* and herbs including *Blyxa* sp.and *Najas* sp. These submerged species are abundant both in the deeper pools and on banks within fast-flowing sections of the creek. The upper creekbanks support the delicate herb *Canscora diffusa* and dense Bladey Grass (*Imperata cylindrica.* Occasional clumps of tall grass *Phragmites vallatoria* and erect herbs to 1m occur in shallow water.

Common semi-aquatic and emergent species recorded in the main channel also include *Cyperus aquatilis, Staurogyne leptocaulis* and the abundant purple-flowering *Pogostemon stellatus.* As the water level gradually falls and the larger pools recede during the dry season, several species grow in the drying streambed including *Eleocharis geniculata, Nelsonia campestris* and the fine grass *Pseudoraphis spinescens*.

Deeper pools have a diverse aquatic flora with thick beds of submerged species on the muddy sand margins (*Hydrilla verticillata, Najas* sp., *Blyxa* sp.and

Figure 13: Schematic cross-sections through aquatic habitats on Coomalie Creek (right branch) within the project area

Ceratopteris thalictroides). The fertile, dry season forms of robust, emergent aquatic herbs including *Hygrophila angustifolia, Persicaria attenuata* and *Persicaria barbata,* are characteristic of these pools and deeper sections of the drying stream bed later in the year. Water lillies (*Nymphaeae violacea)* were recorded only in the deepest pools such as near Janie Rocks and two minor water holes within the project area.

Thus, the aquatic vegetation within Coomalie Creek, typically shows zonation, largely reflecting changes in water depth. However, species composition was also observed to change with the seasonal cycle. Figure 13 shows schematic cross sections through the two main aquatic habitats (creek channel and small waterhole) as observed within the project area.

Lophostemon Open Woodland (Map Unit 4)

The broad drainage way flanking Coomalie Creek typically supports an open woodland formation characterised by *Lophostemon grandiflorus* (Community 4). This community covers approximately 50 ha within the project area (14%), occupying much of the Coomalie Creek floodplain and associated lowland areas.

Lophostemon grandiflorus is a ubiquitous species, well adapted to seasonal inundation and waterlogged soils. Within the project area *Lophostemon* forms monospecific stands in areas with prolonged seasonal inundation and it also occurs as a common riparian species lining the main creek channel. It typically grows in association with Paperbarks (*Melaleuca dealbata, M.cajuputji, M. nervosa, M leucadendra)* and *Pandanus spiralis. Eucalyptus* species (particularly *E.papuana* and *E. polycarpa*) occur in slightly higher sites with better drainage and may become common to co-dominant in transitional areas.

The mid-stratum is sparse and characterised by *Pandanus spiralis, Melaleuca viridiflora* and *Planchonia careya.* Grasses are dense and diverse in this habitat, the most common species including *Eriachne burkittii, Paspalum scrobiculatum, Themeda triandra, Bothriochloa* sp., *Ischaemum* sp., *Imperata cylindrica, Pseudopogonantherum contortum* and *Sorghum stipodeum.*

Other species tolerant of seasonal waterlogging, including sedges (*Fuirena ciliaris, Fimbristylis pacucifora)* and floodplain herbs (*Ludwigia perrenis, L. octovalvis, Nelsonia campestris* and *Limnophila fragrans)* were also recorded in this community. Figures 9 and 10 indicate the typical structure and composition of Community 4.

Melaleuca Woodland (Map Unit 5)

Woodland formations in which *Melaleuca* spp. is dominant occasionally occur along the main drainage way within the survey area and as isolated pockets in lowland terrain, covering approximately 14ha (less than 4%) of the project area. Paperbarks are characteristic of areas with high soil moisture conditions, waterlogging and/or seasonal inundation. These areas may support tall open forest (52 to 81% canopy cover) to low woodland formations (3-6m high), characterised by almost monospecific stands of *Melaleuca* spp. (Paperbark). Community 5 is of relatively restricted distribution in the project area and typically intergrades with the riparian corridor and *Lophostemon* open woodland.

This community is relatively simple floristically, with the upper stratum mainly comprising *Melaleuca* species, particularly *Melaleuca viridiflora, M. nervosa,*

M. dealbata or *M. leucadendra (*mostly 2 to 8 m high*).* Occasional *Lophostemon grandiflorus, Pandanus spiralis* and *Acacia* spp. may occur in this habitat. Dense grasses including *Themeda triandra, Ischaemum australe* and *Eriachne burkittii* typically comprise the ground layer. Sedges (*Fimbristylis* sp., *Fuirena ciliata, Rhyncospora* sp.) and wetland herbs (*Limnophila fragrans, Drosera indica)* are common ground layer species.

3.2.3 Rainforest communities

Dry vine-forest on dolomite outrops (Map Unit 6)

Outcrops of dolomite are not uncommon within the project area and these areas typically support a dry vine-forest community (Community 6). These areas occupy approximately 13 ha and represent only a minor proportion of the project area (3.7%). However, floristically they are rich and support a suite of species not normally associated with other more widespread Eucalypt woodland habitats (Appendix 1). Vine-forest species are frequently fire-sensitive and may be largely restricted to habitats associated with permanent water or to fire-protected rocky outcrops.

Within the project area, the larger outcrop near Janie Rocks comprises dry vine forest in an open forest formation containing occasional palms and abundant vines. However, Site 3 (Figure 11) sited on a narrow, rocky ridge, is significantly smaller, has a more open canopy and is floristically more similar to surrounding Eucalypt forests than to evergreen vine-forest communities.

Common upper stratum species in Community 6 include the rainforest coloniser species *Acacia auriculiformis,* tall *Erythrophleum chlorostachys* and *Ficus* spp. Common canopy species include *Terminalia microcarpa, Timonius timon* and *Nauclea orientalis.* In areas where the canopy is closed, a mid-stratum layer may be relatively sparse and the ground layer characterised by vines and seedlings and saplings of upper stratum species. Common vines include *Tinospora smilacina, Parsonsia velutina, Smilax australis* and *Abrus precatorius*. Patches of *Hypoestes floribunda* and ferns including *Cheilanthes contigua* and *Cheilanthes nitida* are particularly common ground level species.

Dense weed infestations are characteristic of the fringes of these areas with class B noxious weeds *Hyptis suaveolens, Cassia obtusifolia* and *Pennisetum polystachion* recorded at Site 8. The smothering vines *Passiflora foetida* and *Calopogonium mucunoides* were also extremely thick at this location. Figures 11 and 12 show typical cross-sections through this community as it occurs within the survey area.

Evergreen Monsoon Vine-forest (Map Unit 7)

Immediately upstream of the project area, Coomalie Creek is bordered by a zone of evergreen monsoon vine-forest, probably associated with springs or permanent water at depth (Figure 3). This community is more extensive than vine-forest patches within the project area, although during the brief dry season field survey, was not found to be more diverse florisitically (Appendix 1). Weed species were less common and where present were in low numbers and restricted to the fringes.

The dominant upper stratum species, *Syzygium nervosum,* occurs in association with *Terminalia microcarpa* and *Acacia auriculiformis* forming a closed-canopy vine-forest formation. Other canopy species include *Carallia brachiata, Erythrophleum chlorostachys, Lophostemon grandiflorus* and *Sesbania formosa.*

The orchid, *Dendrobium affine* was common on the upper limbs of riparian trees. Ground orchids are also expected to occur in this habitat during the wet season.

The dense shade provided by the canopy in the vicinity of the creek resulted in a rather open mid and ground stratum and the habitat provided a cool haven for butterflies and birds.

4. 0 Conservation Significance - Flora

Although the majority of habitats within the project area are in a relatively natural condition, the site has a long history of disturbance. Anthropogenic impacts include clearing, grazing, mining, the introduction of exotic plant species and impacts from domestic and feral animals. Nevertheless, the regeneration of native vegetation over many decades has resulted in a landscape that overall, does not appear to be significantly degraded. In particular, Coomalie Creek remains a clear flowing stream with no aquatic weeds, low turbidity and high water quality, which supports a healthy riparian ecosystem.

The conservation significance of vegetation in natural habitats can be considered on a number of different levels (ie at the level of the individual species, or the plant community) and at several different spatial scales (eg local, regional or national) as follows;

4.1 Plant species of conservation significance

Overall, the plant species recorded during field surveys are common and widespread in the region generally. These findings however, are based on the results of relatively limited field surveys commenced in the late wet season. A more comprehensive botanical survey during the early to mid-wet season may reveal different results. Nevertheless, the current survey indicates that it is unlikely that any plant species of botanical significance are present on the site. There are, however, a number of specific conservation issues regarding flora which are considered separately below:

Rare species

None of the 172 plant species recorded during this survey and listed in Appendix 1 are classified as rare, endangered or vulnerable. The species present were checked against local (Northern Territory Herbarium database), regional (Connors, Oliver and Woirnarski, 1996) and national (Briggs and Leigh 1988; Leach *et al.*1992;) lists of plants of conservation significance.

Indeed, rarity is unlikely, given the extensive clearing involved with previous land uses and the current frequency of fire. Further, the absence of plant communities of restricted distribution or vegetation types known to contain a high proportion of rare species (sandstone escarpment habitats or spring-fed rainforest for example) significantly reduces the likelihood that rare and endangered flora would occur there.

A number of species endemic to the Northern Territory were recorded from the project area including *Flemingia trifoliastrum, Livistona humilus, Briedelia tomentosa*, and *Lophostemon lactifluus.* However, 11% of the flora is endemic to the NT these species are locally common and do not have declared rare status (Leach *et al.*1992).

Protected species

A high proportion of Northern Territory plant species from the Orchidaceae and Cycadaceae families have rare status and these groups are generally conferred some intrinsic ecological value due to their relatively restricted distribution (Ian Cowie pers. comm). Thus the presence of cycads and orchids in the project area is of some botanical importance as follows:

Cycads

Within the survey area *Cycas armstrongii* is a common understorey species particularly within *Eucalyptus* dominated woodlands (Map Units 1 and 2). This species is common, having a wide distribution within the region and elsewhere across the Top End. However, to ensure the conservation and sound environmental management (including harvesting) of this species, it is classified by Northern Territory Environmental Legislation as a protected species (Schedule 8, Regulation 15 of the Territory Parks and Wildlife Conservation Act 1994).

The implications of this legislation are that *Cycas armstrongii* may not be collected or removed from bushland unless it is part of the lawful use of the land. Thus although cycads are protected species, with some intrinsic ecological value, their presence does not preclude development in areas with appropriate zoning or development approval.

Orchids

The same legislation that classes all members of the Cycadaceae family as protected species, states that all members of the Orchidaceae family have the same conservation status. Two epiphytic orchid species (*Dendrobium affine* and *Cymbidium canaliculatum)* were recorded from within the project area during field surveys. However, these species are widely distributed and do not have declared rare status.

Summary

No rare or endangered plant species, nor any plant species of special conservation significance were observed during field surveys within the proposed project area.

4.2 Plant communities of conservation significance

Approximately 76% of the project area comprises *Eucalyptus* dominated vegetation communities, either as woodland or open woodland formations. Overall, this vegetation type, where trees co-occur with a more or less continuous grass cover, is commonly known as savanna and occurs across vast areas of northern Australia. Savanna is characteristic of the monsoonal tropics where there is a distinct dry season and where fire is a major factor determining vegetation structure.

Minor areas of riparian, *Lophostemon* and Paperbark communities also occur within the site, but these communities are common and widespread in the region generally. The small areas of vine-forest vegetation associated with rock outcrop that are located within the project area do not have botanical significance and their small extent leaves them prone to degradation, particularly from fire and weed invasion.

Thus, no plant communities of special conservation significance occur within the project area. However, the development of the proposed mine may impinge upon adjacent plant communites of some conservation significance. In particular, the evergreen monsoon vine-forest located immediately upstream of the project area.

This rainforest community is more extensive than vine-forest patches within the project area, is relatively intact with weed species restricted to the fringes. The channel of Coomalie Creek runs through the forest and overall, although not particularly diverse floristically, this small rainforest patch represents a good example of closed-canopy vine-forest habitat. This area has some aesthetic and ecological value and is consequently of some local significance as a habitat to fauna and in terms of maintaining habitat heterogeneity and water quality. Thus future development in the vicinity of the forest – particularly in relation to the rediversion of Coomalie Creek - should be undertaken with the conservation of this area in mind.

4.3 Ecological and Conservation Values - Flora

Local Significance

Despite its proximity to Darwin and to Batchelor, the current levels of weed infestation and the previous history of landuse, the vegetation of the study area comprises a range of habitats that remain in relatively natural condition. Consequently the area contains a variety of ecosystems with habitats of importance to a variety of fauna (Section 3.4.2 of EIS).

Historical photographs of the area indicate that revegetation of the lowland areas previously cleared for farming has been significant (Appendix 3). Clearly, riparian habitat near Janie Rocks has long been appreciated and its value as a habitat has probably improved during the course of the last 90 years. The local significance of this section of the Creek is further recognised by Aboriginals, acknowledged by its declaration as a sacred site. Downstream of the project area the creek is currently utilised in an *ad hoc* fashion for swimming and recreation. The proximity of the swimming hole to Batchelor increases the local recreational significance of the site.

Healthy natural habitats have an intrinsic conservation significance that is difficult to quantify and not often recognised, but which contributes to important values such as clean air and water, biological diversity and environmental stability. Thus although the flora does not have local conservation significance, its value as a habitat, (especially Coomalie Creek's high quality aquatic environment), confers some local significance in terms of its intrinsic ecological value and its limited recreational values.

Regional Significance

The terrestrial vegetation communities within the area proposed for development are typical of *Eucalypt* forest and woodland of the Top End and comprise part of an extensive bioregion (the Pine Creek bioregion covering 30,404 km^2. Thus in the regional context, the conservation value of terrestrial flora found on the site is not significant. Further, 42.7% of the bioregion is currently reserved, predominantly for conservation purposes (Woinarski, Connors and Oliver 1996) so these woodland habitats are well represented in reserves elsewhere in the region.

Summary

The project area contains common and widespread vegetation types of low conservation value in the local and regional context. The proposed development will not directly affect any significant areas of monsoon vine-forest (rainforest) and will avoid areas of quality riparian habitat. Thus it is anticipated that the proposed development will have a negligible impact on the conservation values of vegetation in the area

5.0 Weeds

The project area currently contains dense weed infestations distributed patchily within all the major habitats in the project area. Of particular significance, is the distribution and abundance of the tall, introduced grasses *Andropogon gayanus* (Gamba Grass) and *Pennisetum polystachion* (Mission Grass). The prolific seasonal growth of Gamba Grass produces dense, robust stands, 3 to 4m high that, in contrast to native species, remain green until late into the dry season.

Weed infestations are typically concentrated in disturbed areas, such as roadsides, along tracks and seismic lines and around mines and associated areas cleared of vegetation. Riparian habitats and the fringes of monsoon vine-forest are also key habitats, where a wide variety of weed species were recorded. Further, riverine habitats are often subject to intermittent natural disturbance from flooding and are prone to impacts from feral animals, particularly rooting by feral pigs and pugging by buffalo and cattle.

A total of 16 weed species were recorded from the project area (Table 2), seven of which are declared noxious weeds Class B (NT Weeds Management Act 2001). Under NT legislation, the growth and spread of plants classified as Class B weeds has to be controlled. However, many of these species are widespread and so attempted eradication is impractical, but the prevention of their further spread is possible and a requirement of Northern Territory legislation. Indeed, under the Weeds Management Act passed in July 2001, the landholder must take all reasonable measures to prevent the land being infested with declared weeds and is responsible for preventing their spread to other land. Consequently all landholders are encouraged to develop and comply with a weed management plan for their property. The most common noxious weeds observed were *Pennisetum polystachion (*Mission Grass), *Hyptis suaveolens* (Horehound) and *Sida cordifolia (*Flannel Weed).

Table 2 : Weed species recorded within the proposed Batchelor Magnesium Project Area

Weed species	Common Name	Classification
Ageratum conyzoides		—
Andropogon gayanus	Gamba Grass	—
Calopogonium mucunoides	Calopo	—
Capsicum annuum	Bird's Eye Chilli	—
Cassia fistula	Golden Shower Tree	—
Hibiscus sabdariffa	Rosella	—
Hyptis suaveolens	Horehound	Noxious, Class B
Lantana camara	Lantana	Noxious, Class B
Melia azedarach	Neem Tree	Native, introduced to area
Passiflora foetida	Wild Passionfruit	—
Pennisetum pedicellatum	Mission Grass	—
Pennisetum polystachion	Mission Grass	Noxious, Class B
Senna obtusiflolia	Sicklepod	Noxious, Class B
Sida acuta	Spinyhead Sida	Noxious, Class B
Sida cordifolia	Flannel Weed	Noxious, Class B
Stachytarpheta spp.	Snake Weed	Noxious, Class B

However, the delineation and classification of other exotic species such as Gamba Grass (*Andropogon gayanus)* is quite problematical. Although this species is recognised by the Department of Primary Industries and Fisheries as a serious environmental weed that invades native habitat, displaces native species and dramatically increases fuel loads (threatening not only native vegetation but infrastructure), this species is still actively utilised by pastoralists (L Hills, DPIF, pers. comm.). Consequently, although Gamba Grass poses a serious environmental threat to the region and is considered a major environmental weed elsewhere in the world, it is currently not a declared species under current legislation (Smith 1995).

Nevertheless, the presence and potential spread of Gamba Grass and Mission Grass is considered the most serious weed management issue for the proposed mine site and potentially represents a major environmental and fire hazard for surrounding land (B Williams, NT Bushfires Council). The Department of Primary Industries strongly recommends that a Weed Management Plan be implemented to prevent this, to ensure that Class B weeds are dealt with and that weeds do not become a major financial or management problem.

Of the 16 weed species observed (Table 2) several species were recorded in very low densities eg. Lantana (*Lantana camara*), *Melia azedarach, Hibiscus sabdariffa, Capsicum annuum, Ageratum conyzoides* and *Cassia fistula.* No aquatic weeds were observed within the survey area and wetland habitats overall were in relatively intact condition. However, widespread clearing of native vegetation and the large scale terrain disturbance involved in the development of the mine will create conditions favourable for the proliferation of weed species, particularly in locations where adjacent areas already support populations of exotic species (eg near the abandoned Sundance gold mine).

New weed species may spread into the project area by human activity, windborne seed or by machinery that has previously been operating in weed infested areas. It follows that mine machinery and vehicles that have worked on the magnesite mine site may continue to spread Class B weeds once they leave the site. Consequently, the installation of washdown facilities for mine equipment may be necessary to satisfy weed control and management regulations.

The declared noxious weed Mission Grass, (*Pennisetum polystachion)* was common but not particularly abundant within the project area and where present, was largely restricted to roadsides and disturbed areas. Unlike Gamba Grass, this species does not readily invade Eucalypt dominated savanna.

The riverine and monsoon vine-forest habitats were found to have the highest numbers and densities of exotic species. High seasonal soil moisture levels within the drainage way and disturbance by flood events, dirt tracks and feral animals appears to encourage the growth of weed species particularly *Hyptis suavelolens, Stachytarpheta* spp. and the smothering vines *Calopogonium mucunoides* and *Passiflora foetida.*

At the time of this survey, no Class A weeds (to be eradicated) were present and the declared Class B noxious weeds Prickly Mimosa (*Mimosa pigra*), Salvinia (*Salvinia molesta)* and Candlebush (*Senna alata)* were not observed within the project area. Infestations of these species are common in the Darwin region. No Coffee Bush (*Leucaena leucocephala*), Para Grass (*Brachiaria mutica),* Aleman Grass (*Echinochloa polystachya)* nor Olive Hymenachne (*Hymenachne amplexicaulis)* were observed during field surveys. Introduction of these recognised environmental weeds could lead to environmental decline and loss of biodiversity through the exclusion of native plant species and may create management problems within the mining lease.

Given the current high, but localised levels of weed infestation, the priority for weed management in the project area is to assist in the control of existing weeds and to prevent introductions of class B weeds into natural and disturbed habitats. The development of a weed management plan would detail appropriate control measures which might include slashing, select chemical control and washdown facilities. Given that the site is bordered to the east and west by abandoned mines that are major sources of windborne seed, the management plan may include long-term rehabilitation goals for these areas.

Listed in decreasing order of importance, the following weed species were considered by officers of the Department of Primary Industry and Fisheries as 'priority' weeds in the Batchelor area: *Hyptis suaveolens, Mimosa pigra, Sida acuta, Senna obtusifolia, Senna occidentalis, Senna alata, Stachytarpheta spp., Salvinia molesta* and *Jatropha gossypifolia.* Four of these species already occur within the project area. During and after mine construction, regular monitoring for introductions of those species not already present on site should be undertaken. New outbreaks and spread of those species already present should also be a priority for control.

Of some concern is *Mimosa pigra,* which could colonise the alluvial flats fringing Coomalie Creek. The proliferation of Gamba Grass (*Andropogon gayanus*) is likely to result from clearing and associated disturbance, and this may lead to degradation of surrounding monsoon vine-forests due to it fostering more frequent, high-intensity fires.

A second priority for weed control is to minimise environmental changes that will encourage the spread and proliferation of weeds (Section 7). Terrain disturbance and enrichment of normally nutrient poor substrates could facilitate the proliferation of exotic or native increaser species. The complete dominance of certain invasive weed species has a serious effect on biodiversty and destabilises previously diverse ecosystems.

The project area is surrounded to the west by intact evergreen monsoon vine-forest on the headwaters of Coomalie Creek and to the south by low hills supporting Eucalypt savanna and dry vine-thicket on rock outcrops. These vegetation formations are currently in a healthy condition and are relatively free of exotic species. A weed management program should acknowledge this and provide for the protection of these habitats.

Summary

The vegetation of the proposed project area is overall in reasonable natural condition especially given the previous landuse history. However, of a total of 16 weed species recorded from the survey area, 7 species are declared Class B weeds. Consequently weed management of the site will, by law, focus on control of these species and the prevention of their spread - particularly into areas disturbed by construction and operational activities.

It will also be necessary to prevent the escape of declared weeds or invasive species into surrounding natural habitats and important to prevent the introduction of new declared weeds to the mine from other areas. The development of a weed management plan and the installation of washdown facilities for mine equipment is recommended to satisfy weed control and management regulations.

6.0 Fire

Similar to tropical savannas throughout the world, fire is an annual event in the landscape of Northern Australia, with up to 50% of the region burnt each year (Williams 1995). Consistent with this trend, field surveys of the proposed lease area indicate a pattern of frequent, extensive burning with roughly 80% of the site burnt during the 2001 dry season. Coppicing from lignotubers, the sparse mid-stratum layer, the species present and abundant grasses all suggest frequent, probably annual burning within the project area.

Future fire management on the site will have a number of key objectives including reduction of the flammable fuel loads around the area for fire protection and to prevent extensive, destructive wildfires. Landholders are legally responsible for containing fire on their property and may be held liable if fire escapes and damages the property of others (the adjoining tree farm for example). Consequently, clearing of vegetation along fire breaks and trails are basic requirements for fire prevention and control. It is a legal requirement that a 4m fire break be maintained around the entire boundary.

The NT Bushfires Council recommends that contact with the Batchelor Regional Fire Control Officer be established and coordination sought in the preparation of a fire management property plan for the project area. The plan may involve strategic fuel reduction, controlled burns, clearance around assets, provision of appropriate fire control equipment and the clearing and maintenance of fire breaks. Given the serious fire hazard posed by Gamba Grass on the site, fire management should include its control or removal from certain areas due to its high fuel loading. The grading of extensive linear corridors for fire breaks and trails will encourage the spread of weeds into areas where they were previously absent. Consequently fire and weed management will need to be coordinated within the project area.

7.0 Potential environmental impacts -flora

The major potential impacts of the proposed mine on flora will be the clearing of roughly 30% (112 ha) of the exisiting vegetation for the construction of the pit, waste dumps and processing plant and storage facilities. Major imacts on flora will also include the short and long term effects of the construction of the creek diversion bund around the pit. Figure 14 shows the proposed site layout for Stages 1 to 3 of the magnesite mine.

Construction phase

The majority of clearing for the Stage 1 construction phase will be within the lowland drainage area where the main pit is located. Roughly 1% of the project area (3 ha) will be cleared for the creek diversion bund. *Lophostemon* woodland will mainly be affected by construction in the vicinity of the pit, with minor clearing of mixed Eucalpyt woodland and loss of approximately 800m of the riparian corridor. A further 400m of riparian vegetation will be affected by the truncation of the exisiting creek from the main seasonal flow, both upstream and downstream of the bund (Figure 14). Gradual dieback of hydrophilic creek bank species is expected in this area due to the changed hydrologic regime. Species such as *Nauclea orientalis* and aquatic and semi-aquatic species requiring perennially wet conditions will not survive the new drainage regime. However, the hardier tree species such as *Acacia auriculiformis* and *Lophostemon grandiflorus* may persist along the old creek alignment and alluvial flats.

Figure 14: Proposed site layout - Batchelor Magnesium Project

The construction of the creek diversion bund will redirect the flow of the creek further to the south, where it will traverse mainly *Lophostemon* woodland habitat, rejoining the creek just upstream of the first main waterhole (see Appendix 2-Photographs). The new flood channel will direct flows away from the mine and through minor areas of existing Paperbark forest, mixed Eucalypt woodland and *Lophostemon* woodland. Species not adapted to seasonal waterlogging from temporary flooding may diminish in these areas depending on the nature and duration of wet season flows. However, riparian species may colonise the new creek alignment, particularly if directed through an incised channel, and consequent shifts in species composition will occur along the new flood channel. Species such as *Pandanus spiralis*, *Melaleuca* spp. and *Lophostemon* may proliferate along the new creek alignment. Floodplain grasses area also expected to expand into this area with a decrease in upland woodland grass species.

The proposed plant and crusher will be located on higher ground comprising mainly *Eucalyptus* woodlands. Roughly 26% of the project area, or 92 ha of upland communities will be cleared for mine infrastructure (to stage 3). Secondary impacts on downslope habitats will include increased sedimentation and changes to the natural pattern of drainage resulting from major earthworks.

Overall, the aquatic and riparian flora are probably the most vulnerable plant communities to negative impacts arising from the proposed mine, particularly given that the location of the main ore body is directly below the current creek channel. Increased turbidity in runoff (resulting in downstream sedimentation) from vegetation clearing and earthworks may change the exisiting pattern of zonation of aquatic species which is largely determined by water depth (Figure 14). Heavy sediment loads will decrease photosynthesis by aquatic plants and may smother sensitive species. Changes in the plant community and dieback of aquatic species will impact on the riparian habitat as a whole, reducing environmental quality and opportunities for fauna. As well as sedimentation, the physico-chemical properties of discharge water will need to be closely monitored to maintain high water quality standards.

Operational phase

The operational phase will introduce substantial waste dump (including slag, fines and sludge piles) and ore storage areas, to be located in upland woodland areas. Drainage from these areas will need to be carefully designed, maintained and monitored to prevent the contamination of surrounding areas of natural vegetation or transport of soluble wastes into drainage lines.

The spread of weeds into adjacent habitats from disturbed areas is likely if a weed management plan is not implemented in order to prevent this. If weeds such as the robust, tall grasses *Pennisetum polystachion* and *Andropogon gayanus* proliferate over the site, consequent high intensity fires from increased fuel loadings may seriously damage native vegetation and create a serious fire hazard for remnant native vegetation, mine infrastructure and neighbouring properties.

.

However, the design and implementation of a comprehensive fire management property plan will have a positive impact on the vegetation of the project area. If the distribution and abundance of Gamba Grass and Mission Grass is controlled and the intensity and frequency of fire reduced, remnant vegetation, particuarly woodland, riparian and monsoon vine forest communities will benefit. This will also assist in the protection of fire sensitive vine-forest communities both within and adjacent to the project area.

The predicted positive and negative impacts of the development on flora are summarised in Table 3.

Table 3: Summary table of impacts and safeguards for flora

Table 3 (page 2.)

8.0 Mitigation measures - flora

Construction phase

Clearing and loss of habitat represents the major impact in upland woodland areas in the construction phase. In order to minimise these impacts, clearing of native vegetation should be kept to the minimum necessary for construction and operation of the proposed mine and associated infrastructure.

Plant communities in drainage areas, especially aquatic vegetation, will be more susceptible to negative impacts during both the construction and operational phases of the project. Particularly given the extremely high seasonal rainfall, the flood risk in lowland habitats and the location of the main pit in the valley floor. Consequently, vegetation clearing and earthworks should avoid wherever possible natural drainage lines, particularly the main creek channel, in order to maintain water quality standards. Silt traps, bunds, settling ponds and comprehensive water monitoring and treatment facilities will be necessary to prevent sedimentation and pollution within drainage lines.

The construction of the new creek alignment within the proposed flood channel could be undertaken in a way that encourages the rapid establishment of a diverse and varied aquatic ecosystem. An incised channel could be dug/graded through the existing woodland, at the lowest point in the local terrain. Selection of a suitable alignment may encourage the formation a permanent creek bed incorporating sloping banks and occasional deeper pools. This better approximates the existing situation and may be preferable to haphazard seasonal sheet flow though the area because it would maintain continued flows to permanent downstream refuge pools. Variations in the depth and bank form of the new, graded channel might further encourage habitat diversity and the colonisation of fauna. Diversity of aquatic fauna was found to be lower in steep sided pools and within existing creek diversions on the site during fauna studies for this EIS.

Construction activity during Stages 1 to 3 should avoid any direct or indirect negative impacts on upstream monsoon vine-forest areas associated with Coomalie Creek. Similarly, areas of riparian and vine-forest vegetation within the project area, but located outside those areas essential for mine development should be protected during mine construction. Isolated areas of vine-forest are important to fauna which depend on a disjunct network of rainforest patches. Conservation of vine-forest and riverine areas is also important in terms of maintaining habitat heterogeneity at the landscape scale.

Operational phase

Environmental monitoring, including aquatic plant species diversity and abundance at permanent sampling locations, should be undertaken at each of the three stages of development to ensure that major negative environmental impacts do not result as a consequence of the mine. Woodland vegetation in the vicinity of waste dumps, the main pit and plant, could also be monitored in this manner.

Adequate weed control will be necessary to minimise adverse impacts on flora during the operational phase of the mine. Weed control measures may be extended to significant source areas within abandoned mines on adjacent properties. Such a gesture would be very positive in the community context and would directly benefit the mine in terms of its long-term goals for weed management. It follows that adequate strategies should be in place for rehabilitation of the project area on the closure of the mine.

Maintenance of large waste rock and slag dumps (Figure 14) and monitoring of the wet season drainage from these areas will be necessary to prevent mining wastes entering the creek system and affecting the growth and survival of aquatic plants. Similarly, drainage from the crusher, plant and fines storage areas will need to be retained, filtered/settled and monitored before release into natural environments. Mitigation measures relevant to construction and operational phases of the Batchelor Magnesium Project are summarised in Table 3.

Acknowledgements
The author gratefully acknowledges the assistance of the following people and organisations in the compilation of this report:

Susie Williams – URS
Greg Smith – Mt Graces Resources
Brent Williams – NT Bushfires Council
Leslee Hills – NT DPIF, Weeds Division
Lee Miller - NT DPIF, Weeds Division
Paul Lloyd – Environment Australia
Chris Mangion, Bob Harwood, Ian Cowie - NT Herbarium

References

Briggs, JD and Leigh, JH (1988) Rare or Threatened Australian Plants. Australian National Parks and Wildlife Service, Special Publication No 14. Canberra, ACT

Brock, J (1997) Native Plants of Northern Australia. Reed Books, Australia.

Christian, G S and G A Stewart (1953) General report on survey of the Katherine-Darwin Region, 1946. *Land Research Series, No.1,* CSIRO, Melbourne.

Connors, G , Oliver B and Woinarski, J (1996) *Bioregions in the Northern Territory: Conservation Valuse, Reservation Status &Information Gaps.*www.nt.gov.au

Cowie, I D, Short, P S and Osterkamp Madsen, M (2000). Floodplain Flora. Flora of Australia Supplementary Series Number 10. Australian Biological Resources Study. Canberra, ACT

Dunlop, C (ed) (1990) Checklist of Vascular Plants of the Northern Territory, Australia. Conservation Commission of the Northern Territory.

Dunlop, C R, G J Leach and I Cowie (1995) Flora of the Darwin Region, Volume 2. Northern Territory Botanical Bulletin No. 20. Conservation Commission of the Northern Territory.

Environment Australia 2001. Threatenedspecies.www.biodiversity.environment.gov.au

Leach, G J, C R Dunlop, M J Barritt, P K Latz, N Sammy (1992) Northern Territory Plant Species of Conservation Significance. Northern Territory Botanical Bulletin No 13. Conservation Commission of the Northern Territory

McDonald, R C, Isbell, R F, Speight, JG, Walker, J and Hopkins, M S (1990) Australian Soil and Land Survey. Field handbook. Inkata Press.

Northern Territory Weeds Management Strategy. NT Government publication, 1996.

Smith, N M (1995) Weeds of Natural Ecosystems. A field guide to environmental weeds of the Northern Territory Australia. NT Environment Centre

Weeds Management Act (2001). Department of Primary Industry and Fisheries. Reprint Number : REPW017

Wilson, B A, Brocklehurst, P S, Clark, M J, and Dickinson, K J M (1990). Vegetation Survey of the Northern Territory, Australia, *Technical Report* No 49, Conservation Commission of the Northern Territory.

Williams R J (1995) Tree Mortality in relation to fire intensity in a tropical savanna of the Kakadu region, Northern Territory, Australia. CALM Science Supplement 4: 77-82

Table 3 : Potential Environmental Impacts and Management Register

Environmental Factor	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
BIOLOGICAL				
Vegetation clearing *Refer Section 7 and 8*	Extensive Eucalypt woodlands dominate the upland vegetation with open woodlands fringing a narrow riparian corridor along Coomalie Creek Small patches of floristically distinctive vine-forest occur on dolomite outcrops Evergreen monsoon vine-forest occurs upstream of the project area No endangered plant species or special vegetation communities have been recorded in the lease area.	Loss of vegetation during construction will result in clearing of ~ 106 ha of the 357 ha project area during Stages 1-3 The main pit will be constructed in lowland areas requiring the diversion of Coomalie Creek through alluvial flats further to the south Waste areas will largely be located within mixed Eucalypt woodland with the crusher, plant and storage located further upslope in *E. tet/E.min* open woodland. Clearing will encourage the spread and proliferation of weeds Increases in the distribution of Gamba Grass and Mission Grass will dramatically increase the fire hazard	Mine layout should be designed to minimise loss of vegetation and conserve areas of restricted distribution and of importance to fauna. As far as possible vegetation should be retained ➢ to reduce erosion and sedimentation ➢ to maintain a visual buffer from the Batchelor road ➢ to reduce sediment loads in runoff ➢ to minimise the spread of weeds Construction adjacent to riparian areas should be minimised where possible to protect riverine areas from negative impacts including increased siltation & changes in drainage. Construction activities should be restricted to specified areas. Movement of construction vehicles should be managed to ensure that tree loss is minimized. On decommissioning of the mine, appropriate vegetation will be reestablished according to a comprehensive rehabilitation plan	Total loss due to clearing through to Stage 3 development: ~92 ha of eucalypt woodland; ~14 ha of drainage line communities; The communities to be cleared are well represented elsewhere within the surrounding region. Permanent refuge pools on Coomalie Creek will be avoided as will vine-forest on rocky outcrops. No significant adverse ecological impacts are anticipated as long as environmental management guidelines area adhered to eg ;monitoring and control of weeds, sediment loads and pollution. The implementation of weed and fire management plans designed for the project area will have a positive impact on weed distribution and abundance and will result in protection of native vegetation respectively
Diversion of Coomalie Creek *Refer Section 7 and 8*	Coomalie Creek is a narrow, semi-permanent stream within a distinct incised channel 1-2m deep wthin the project area The proposed pit will be located within the current drainage way and alluvial flats associated with Coomalie Creek. The creek will be diverted by a bund into a flood channel to the south of the current alignmnent Tracts of similar riparian habitat occur outside the boundary of the lease area and are represented in reserves elsewhere in the bioregion	Approximately 1.2 km of riparian vegetation will be affected by the creek diversion. Some areas of riparian vegetation not cleared prior to mine construction may survive if water table levels remain sufficiently high. The new creek alignment and flood may provide habitat suitable for colonisation by native aquatic plant species and wetland communities	Clearing will be kept to the minimum necessary for construction of the diversion bund Clearing within drainage lines will be selective and minimised to prevent erosion and habitat loss. Regular surveys of lowland areas and the creek channel should be undertaken to control the introduction and spread of aquatic and floodplain weeds (eg *Mimosa pigra*) A staged approach to the development will ensure that unless Stage 1 of the development is successful, further development will not proceed. Feedback from environmental monitoring during the initial stages may be incorporated into later stages of the mine to minimise impacts on native flora	Loss of riparian and lowland habitat will occur and unless water quality is maintained, aquatic ecosystems will be adversely affected. New habitats will be created in which colonisation of riparian vegetation will occur. If the new flood channel is well designed, the loss of habitat should be balanced in the long term by expansion of new riparian areas

Environmental Factor	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Indirect vegetation changes *Refer Section 5,7 and 8*	Currently the native vegetation is in reasonably intact condition. Disturbance from grazing and agriculture has resulted in high numbers of weeds and exploration for mining and extensive terrain disturbance around adjacent mines has led to major sources of weeds both within and around the project area Part of the existing creek is a rediversion and diversity of fauna and flora was found to be is lower in these modified habitats No existing major sources of heavy metals, suspended solids, petro-chemical or organic pollution occur within the project area Upland vegetation is well drained and although drainage in lowland areas may be slow, with extensive waterlogging in the wet season, natural patterns of drainage exist in the project area and the creek is clear and fast-flowing for much of the year	Changes to the pattern of drainage, seepage and sedimentation are expected to lead to the loss of riparian vegetation immediately downstream of the diversion bund. Upstream monsoon vine forest vegetation may be affected if major changes in water retention or dispersal occur. Gradual shifts in species composition will occur within the new flood channel and creek alignment with upland species diminishing and species requiring high soil moisture (Paperbark and *Lophostemon* communities for example) increasing in these areas. Proliferation of weeds from increased disturbance may alter fire regimes – dramatic increases in fuel loads result from Gamba Grass infestations	Development of the mine will be undertaken according to sound principles of environmental management. Ongoing monitoring at each stage of the development would detect and prevent major indirect changes to flora within the project and in upstream and downstream locations	Riparian vegetation and species characteristic of drainage ways are expected to colonise the new flood channel. Colonisation will be minor and regionally insignificant No major indirect changes to vegetation are anticipated if environmental guidelines are followed and site monitoring is undertaken.(particularly of weeds and water quality)
Weeds *Refer Section 5,6,7,8*	In the project area weed infestations are common in the major habitats but are particularly dense in disturbed areas. 16 introduced species were recorded, 7 of which are declared noxious weeds (Class B) the most important noxious weeds to control in the vicinity of the mine are *Hyptis suaveolens, Sida acuta, Stachytarpheta* spp. and Senna obtusifolia. Although not a declared weed, Gamba Grass (*Andropogon gayanus*) represents the most serious environmental weed and fire hazard on the site	Extensive clearing of native vegetation and terrain disturbance will create conditions favourable for the proliferation of weed species The new floodplain channel may provide conditions suitable weed species including *Mimosa pigra*	Weed management and prevention measures will include compilation of a Weed Management Plan for the project area. Strategies might include: ➢ earthmoving equipment washed-down prior to entering the lease area to prevent spread ➢ weed removal from selected areas ➢ control of class B weeds including select chemical control ➢ slashing of fire breaks ➢ annual weed surveys	Management of weed issues will result in low risk of introductions and ideally, a reduction in the extent of infestations and the further spread of weed will be controlled.
Fire regime *Refer Section 6 and 7*	Frequent, extensive burning of project area and surrounds The presence of Gamba Grass decreases the effectiveness of early season, cool burns Fuel loadings are significantly higher where these grasses occur – damaging native flora	Reduction in frequency, timing and spread of fires if strict fire management plan is implemented Frequent, high intensity fires if the spread of Gamba Grass around the mine site is unchecked	Development of a comprehensive Fire Management Property Plan in coordination with Regional Fire Council. The plan will include: ➢ fire break construction; ➢ reduction of flammable fuel loads by slashing/chemical control of tall grasses ➢ protection of fire-sensitive flora ➢ promotion of habitat heterogeneity	A reduction in the frequency and intensity of fires will result in a shift in vegetation species composition towards a more dense mid-stratum layer, including fire-sensitive monsoon forest species Frequency, timing and spread of fires should be reduced due to site access restrictions, construction of fire breaks and safety regulations. This will have a positive impact on the protection of fire-sensitive vine-forest and riparian vegetation.

APPENDIX 1

PLANT SPECIES LIST

Plant species recorded during field surveys of the 357 ha mining lease (MLN 1984), for the proposed Batchelor Magnesium Project, recorded during the late wet season (May) and dry season (September) 2001, listed according to Dunlop *et al.* (1995).

* denotes an introduced species
S indicates plant species collected for botanical identification by the NT Herbarium
e denotes a species endemic to Northern Territory (Leach *et.al.*, 1992)
B denotes a Noxious Weed Class B (Smith 1995)

Map Unit	Species	Family	Conservation status
1	***Eucalyptus tetrodonata/E.miniata* Woodland to Open Forest** (30 species)		
	Upper stratum		
	Corymbia disjunta	Myrtaceae	S
	Erythrophleum chlorostachys	Caesalpiniaceae	
	Eucalyptus bigalerita	Myrtaceae	
	Eucalyptus bleeseri	Myrtaceae	
	Eucalyptus confertiflora	Myrtaceae	
	Eucalyptus foelscheana	Myrtaceae	
	Eucalyptus miniata	Myrtaceae	
	Eucalyptus tectifica	Myrtaceae	
	Eucalyptus tetrodonta	Myrtaceae	
	Mid stratum		
	Acacia sp.	Mimosaceae	S
	Brachychiton megaphyllus	Sterculiaceae	
	Buchanania obovata	Anacardiaceae	
	Cycas armstrongii	Cycadaceae	
	Cymbidium canaliculatum	Orchidaceae	
	Eucalyptus sp.	Myrtaceae	
	Ficus opposita	Moraceae	
	Flueggia virosa	Euphorbiaceae	
	Livistona humilis	Arecaceae	e
	Planchonia careya	Lecythidaceae	
	Terminalia ferdinandiana	Combretaceae	
	Lower stratum		
	Ampelocissus acetosa	Vitaceae	
	* *Andropogon gayanus*	Poaceae	
	Buchnera sp.	Scrophulariaceae	
	Flemingia trifoliastrum	Euphorbiaceae	e
	Heteropogon contortus	Poaceae	
	Jasminum aemulum	Oleaceae	
	Sorghum sp.	Poaceae	

Sorghum stipodeum	Poaceae	
Rynchospora sp.	Rubiaceae	
Themeda triandra	Poaceae	
Wedelia urticifolia	Asteraceae	S

Map Unit 2: Mixed Eucalypt Woodland (69 species)

Upper stratum

Alstonia actinophylla	Apocynaceae	
Bryachychiton diversifolius	Sterculiaceae	
Erythrophleum chlorostachys	Caesalpiniaceae	
Eucalyptus confertiflora	Myrtaceae	
Eucalyptus miniata	Myrtaceae	
Eucalyptus tectifica	Myrtaceae	
Eucalyptus tetrodonta	Myrtaceae	
Syzygium suborbiculare	Myrtaceae	
Syzygium eucalyptoides ssp. *blesseri*	Myrtaceae	
Terminalia grandiflora	Combretaceae	

Mid stratum

Acacia lamprocarpa	Mimosaceae	S
Erythrophleum chlorostachys	Caesalpiniaceae	
Eucalyptus confertiflora	Myrtaceae	
Brachychiton megaphyllus	Sterculiaceae	
Brachychiton diversifolius	Sterculiaceae	
Bridelia tomentosa	Euphorbiaceae	
Buchanania obovata	Myrtaceae	
Carpentaria acuminata	Arecaceae	
Canarium australianum	Burseraceae	
Clerodendrum floribundum	Verbenaceae	
Cochlospermum fraseri	Bixaceae	
Cycas armstrongii	Cycadaceae	
Denhamia obscura	Celastraceae	
Erythrophleum chlorostachys	Caesalpiniaceae	
Ficus opposita	Moraceae	
Fleuggia virosa	Euphorbiaceae	
Gardenia megasperma	Rubiaceae	
Hakea arborescens	Proteaceae	
Litsea glutinosa	Lauraceae	
Livistona humilis	Arecaceae	e
Melaleuca viridiflora	Myrtaceae	
Pandanus spiralis	Pandanaceae	
Persoonia falcata	Proteaceae	
Petalostigma pubescens	Euphorbiaceae	
Planchonia careya	Lecythidaceae	
Pouteria arnhemica	Sapotaceae	
Terminalia ferdinandiana	Combretaceae	
Terminalia grandiflora	Combretaceae	
Timonius timon	Rubiaceae	
Wrightia saligna	Apocynaceae	

Lower stratum

Alloteriopsis semialata	Poaceae	S
Ampelocissus acetosa	Vitaceae	
* *Andropogon gayanus*	Poaceae	
Bothriochloa bladhii	Poaceae	S
Crotalaria medicaginea	Fabaceae	
Eriachne stipacea	Poaceae	S
Eriachne triseta	Poaceae	S
Flemingia trifoliastrum	Fabaceae	e
Fuirena ciliata	Cyperaceae	
Gymnanthera oblonga	Asclepidaceae	
Heteropogon contortus	Poaceae	S
Hibbertia oblongata	Dilleniaceae	
Hibbertia sp.	Dilleniaceae	
* *Hyptis suaveolens*	Lamiaceae	B
Jasminum aemulum	Oleaceae	
Limnophilla fragrans	Scrophulariaceae	
Mitrasacme aggregata	Loganiaceae	
Pachynema complanatum	Dilleniaceae	
Panicum mindanense	Poaceae	Se
**Passiflora foetida*	Passifloraceae	
**Pennisetum pedicellatum*	Poaceae	B
Polygala sp.	Polygalaceae	S
Pseudopogonantherum contortum	Poaceae	
Pseudopogonantherum irritans	Poaceae	S
Pycnospora lutescens	Fabaceae	S
**Sida acuta*	Malvaceae	B
**Sida cordifolia*	Malvaceae	B
Smilax australis	Smilacaceae	
Sorghum sp.	Poaceae	
Sorghum stipodeum	Poaceae	
Themeda triandra	Poaceae	

Map Unit 3: Riparian corridor (56 species)

Upper and Mid Strata

Acacia auriculiformis	Mimosaceae	
Breynia cernua	Euphorbiaceae	e
Carallia brachiata	Rhizophoraceae	
* *Cassia fistula*	Caesalpiniaceae	
Dendrobium affine	Orchidaceae	
Eucalyptus papuana	Myrtaceae	
Eucalyptus polycarpa	Myrtaceae	
Ficus racemosa	Moraceae	
Litsea glutinosa	Lauraceae	
Lophostemon lactifluus	Myrtaceae	
Lophostemon grandiflorus	Myrtaceae	
Melaleuca cajuputji	Myrtaceae	
Melaleuca dealbata	Myrtaceae	
Melaleuca leucadendra	Myrtaceae	
Nauclea orientalis	Rubiaceae	

Pandanus aquaticus	Pandanaceae	
Pandanus spiralis	Pandanaceae	
Planchonia careya	Lecythidaceae	
Sesbania formosa	Fabaceae	
Stachytarpheta sp.	Verbenaceae	
Terminalia microcarpa	Combretaceae	
Timonius timon	Rubiaceae	

Lower Stratum

**Ageratum conyzoides*	Asteraceae	S
**Androphogon gayanus*	Poaceae	
Bridelia tomentosa	Euphorbiaceae	e
**Calopogonium mucunoides*	Fabaceae	
Canscora diffusa	Gentianaceae	S
Cayratia trifoliata	Vitaceae	
Eleocharis geniculata	Cyperaceae	S
Nelsonia campestris	Acanthaceae	S
Eleutheranthera ruderalis	Compositae	S
Ficus racemosa	Moraceae	
Grewia retusifolia	Tiliaceae	
Heteropogon contortus	Poaceae	S
**Hyptis suaveolens*	Lamiaceae	
Imperata cylindrica	Poaceae	S
Ixora timorensis	Rubiaceae	
Ischaemum sp.	Poaceae	
Ludwigia octovalvis	Onagraceae	S
Nelsonia campestris	Acanthaceae	S
Pandanus spiralis	Pandanaceae	
**Passiflora foetida*	Passifloraceae	
Phyllanthus reticulatus	Euphorbiaceae	S
Pseudoraphis spinescens	Poaceae	
**Stachytarpheta* sp.	Verbenaceae	
Urena lobata	Malvaceae	
Whiteochloa sp.	Poaceae	

Aquatic Species

Blyxa sp.	Hydrocharitaceae	S
Ceratopteris thalictroides	Parkeriaceae	S
Cyperus aquatilis	Cyperaceae	S
Eleocharis geniculata	Cyperaceae	S
Hydrilla verticillata	Hydrocharitaceae	S
Hygrophila angustifolia	Acanthaceae	S
Ludwigia octovalvis	Onagraceae	S
Lymnophila fragrans	Scrophulariaceae	
Najas sp.	Najadaceae	S
Nymphaea violaceae	Nymphaeaceae	S
Persicaria attenuata	Polygonaceae	S
Persicaria barbata	Polygonaceae	S
Phragmites vallatoria	Poaceae	
Pogostemon stellatus	Lamiaceae	S
Staurogyne leptocaulis	Acanthaceae	S

Map Unit 4: *Lophostemon* Woodland (37 Species)

Upper stratum

Buchanania obovata	Anacardiaceae	
Corymbia disjuncta	Myrtaceae	
Eucalyptus papuana	Myrtaceae	
Eucalyptus foelscheana	Myrtaceae	
Lophostemon grandiflorus	Myrtaceae	
Lophostemon lactifluus	Myrtaceae	
Melaleuca dealbata	Myrtaceae	
Melaleuca nervosa	Myrtaceae	
Melaleuca leucadendra	Myrtaceae	
Melaleuca viridiflora	Myrtaceae	
Pandanus spiralis	Pandanaceae	

Mid stratum

Acacia sp.	Mimosaceae	
Brachychiton megaphyllus	Sterculiaceae	
Breynia cernua	Euphorbiaceae	e
Buchanania obovata	Anacardiaceae	
Eucalyptus sp.	Myrtaceae	
Erythrophleum chlorostachys	Caesalpiniaceae	
Ficus opposita	Moraceae	
Livistona humilis	Arecaceae	e
Lophostemon grandiflorus	Myrtaceae	
Melaleuca viridiflora	Myrtaceae	
Pandanus spiralis	Pandanaceae	
Planchonia careya	Lecythidaceae	
Timonius timon	Rubiaceae	

Lower stratum

Aeschynomene sp.	Fabaceae	
**Andropogon gayanus*	Poaceae	
Buchnera sp.	Scrophulariaceae	S
**Calopogonium mucunoides*	Fabaceae	
Crotalaria medicaginea	Fabaceae	S
Cymbopogon sp.	Poaceae	S
Eriachne burkittii	Poaceae	
Flemingia lineata	Fabaceae	
Fuirena ciliaris	Cyperaceae	
Heteropogon contortus	Poaceae	S
Ipomoea sp.	Convolulaceae	
Paspalum scrobiculatum	Poaceae	S
Poaceae sp. A	Poaceae	
Pseudopogonantherum contortum	Poaceae	
Rynchopora exserta	Rubiaceae	S
Themeda triandra	Poaceae	
Uraria lagopodoides	Fabaceae	S
Sorghum sp.	Poaceae	

Map Unit 5: *Melaleuca* Open Woodland (26 species)

Upper stratum

Lophostemon grandiflorus	Myrtaceae	
Melaleuca cajuputji	Myrtaceae	
Melaleuca leucadendra	Myrtaceae	
Melaleuca viridiflora	Myrtaceae	
Planchonia careya	Lecythidaceae	
Pandanus spiralis	Pandanaceae	

Mid stratum

Lophostemon grandiflorus	Myrtaceae	
Melaleuca leucadendra	Myrtaceae	
Pandanus spiralis	Pandanaceae	
Planchonia careya	Lecythidaceae	

Lower stratum

Aeschynomene indica	Fabaceae	S
**Andropogon gayanus*	Poaceae	
Bacopa floribunda	Scrophulariacae	
Bothriochloa sp.	Poaceae	S
Eriachne burkittii	Poaceae	S
Eriachne sp.	Poaceae	S
Fimbristylis pauciflora	Cyperaceae	S
Fimbristylis sp.	Cyperaceae	
Fuirena ciliaris	Cyperaceae	
Imperata cylindrica	Poaceae	
Ischaemum sp.	Poaceae	
Limnophila fragrans	Scrophulariaceae	
Ludwigia octovalis	Onagraceae	S
Ludwigia perrenis	Onagraceae	S
Mucuna gigantea	Fabaceae	S
Nelsonia campestris	Acanthaceae	S
Pandanus spiralis	Pandanaceae	
**Passiflora foetida*	Passiforaceae	
Sorghum sp.	Poaceae	
Themeda triandra	Poaceae	
Whiteochloa sp.	Poaceae	

Map Unit 6: Dry Vine-forest on rock outcrops (60 species**)**

Upper stratum

Acacia auriculiformis	Mimosaceae	
Brachychiton diversifolius	Sterculiaceae	
Canarium australianum	Burseraceae	
** Cassia fistula*	Caesalpiniaceae	
Corymbia disjuncta	Myrtaceae	
Erythrophleum chlorostachys	Caesalpiniaceae	
Eucalyptus bigalerita	Myrtaceae	S

Eucalyptus tectifica	Myrtaceae	
Eucalyptus tetrodonta	Myrtaceae	
Ficus platypoda	Moraceae	
Ficus racemosa	Moraceae	
Ficus virens	Moraceae	
Nauclea orientalis	Rubiaceae	
Terminalia ferdinandiana	Combretaceae	
Timonius timon	Rubiaceae	

Mid stratum

Acacia auriculiformis	Mimosaceae	
Antidesma ghaesembilla	Euphorbiaceae	
Breynia cernua	Euphorbiaceae	e
Bridelia tomentosa	Euphorbiaceae	e
Buchanania obovata	Anacardiaceae	
Canarium australianum	Burseraceae	
Carpentaria acuminata	Arecaceae	
Cycas armstrongii	Cycadaceae	
Denhamia obscura	Celastraceae	
Drypetes lasiogyna	Euphorbiaceae	
Embelia curvinervia	Myrsinaceae	S
Erythrina variegata	Fabaceae	
Ficus platypoda	Moraceae	
Ficus virens	Moraceae	
Flueggia virosa	Euphorbiaceae	
Litsea glutinosa	Lauraceae	
Livistona humilis	Arecaceae	e
Micromelum minutum	Rutaceae	
Planchonia careya	Lecythidaceae	
Syzygium nervosum	Myrtaceae	
Terminalia microcarpa	Combretaceae	
Wrightia pubescens	Apocynaceae	

Lower stratum

Abrus precatorius	Fabaceae	
Ampelocissus acetosa	Vitaceae	
** Andropogon gayanus*	Poaceae	
Callicarpa candicans	Verbenaceae	S
**Calopogonium mucunoides*	Fabaceae	
**Capsicum annuum*	Solanaceae	
**Cassia obtusifolia*	Caesalpiniaceae	
Cheilanthers contigua	Sinopteridaceae	
Cheilanthes nitida	Sinopteridaceae	
Chrysopogon latifolius	Poaceae	S
Flemingia lineata	Fabaceae	S
Flemingia sp.	Fabaceae	S
Hypoestes floribunda	Acanthaceae	
**Hyptis suaveloens*	Lamiaceae	B
**Lantana camara*	Verbenaceae	
Livistona humilis	Arecaceae	
Parsonsia velutina	Apocynaceae	S
** Passiflora foetida*	Passiforacea	

Poaceae sp A	Poaceae	
Protoasparagus racemosa	Liliaceae	
**Senna obtusifolius*	Caesalpiniaceae	
**Sida acuta*	Malvaceae	
**Sida cordifolia*	Malvaceae	
Smilax australis	Smilacaceae	
Sorghum sp.	Poaceae	
Sterculia quadrifida	Sterculiaceae	
Tinospora smilacina	Menispermaceae	S
Urena lobata	Malvaceae	
Vigna lanceolata	Fabaceae	S

Map Unit 7 : Evergreen Monsoon Vine-forest associated with permanent water (39 species**)**

Upper stratum

Acacia auriculiformis	Mimosaceae	
Canarium australianum	Burseraceae	
Carallia brachiata	Rhizophoraceae	
Carpentaria acuminata	Arecaceae	e
* *Cassia fistula*	Caesalpiniaceae	
Dendrobium affine	Orchidaceae	
Erythrophleum chlorostachys	Caesalpiniaceae	
Ficus racemosa	Moraceae	
Ficus virens	Moraceae	
Lophostemon grandiflorus	Myrtaceae	
Melaleuca cajuputji	Myrtaceae	
Mellicope elleryana	Rutaceae	
Pandanus aquaticus	Pandanaceae	
Nauclea orientalis	Rubiaceae	
Sesbania formosa	Fabaceae	
Sterculia quadrifida	Sterculiaceae	
Syzygium nervosum	Myrtaceae	
Terminalia microcarpa	Combretaceae	
Timonius timon	Rubiaceae	

Mid stratum

Acacia auriculiformis	Mimosaceae	
Antidesma ghaesembilla	Euphorbiaceae	
Bambusa arnhemica	Poaceae	
Breynia cernua	Euphorbiaceae	e
Carpentaria acuminata	Arecaceae	
Embelia curvinervia	Myrsinaceae	S
Ficus hispida	Moraceae	
Flagellaria indica	Flagellariaceae	
Gmelina schlechteri	Verbenaceae	
Ixora timorensis	Rubiaceae	
Litsea glutinosa	Lauraceae	
Melia azedarach	Meliaceae	
Micromelum minutum	Rutaceae	
Syzygium nervosum	Myrtaceae	

Terminalia microcarpa	Combretaceae	
Lower stratum		
**Hyptis suaveolens*	Lamiaceae	
Lantana camara	Verbenaceae	
Lomandra sp.	Xanthorrhoeaceae	
Opilia amentaceae	Opiliaceae	
Parsonsia velutina	Apocynaceae	S
Poaceae sp.	Poaceae	
Stephania japonica	Menispermaceae	
Tinospora smilacina	Menispermaceae	S
Urena lobata	Malvaceae	