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KEMERTON SILICA SANDS

REVIEW OF FLORA, VEGETATION AND

CONSERVATION VALUES

ON

KEMERTON PROJECT AREA

Prepared for:
Kemerton Silica Sands

Prepared by:
Mattiske Consulting Pty Ltd

May 2003



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1. SUMMARY

This report provides an updated summary of previous botanical studies within the Kemerton project area, previously collated for Gwalia Consolidated Ltd by Mattiske Consulting Pty Ltd's (1999). The minesite is located at Kemerton, approximately 3km north of the Kemerton Industrial Park, 27km northeast of Bunbury and west of Benger Swamp.

The initial operation was assessed and approved by the Environmental Protection Authority in July 1994, subject to conditions stated in the *Kemerton Silica Sand Mining Proposal Gwalia Consolidated Ltd. Report and Recommendations, Bulletin 471* (Environmental Protection Authority 1994).

The project area occurs within the Drummond Sub-District of the Darling Botanical District (Diels 1906; Gardner 1942) in the South-western Botanical Province, as defined by Beard (1980). Previous authors have stressed the significance of landforms, soils and climate in determining the distribution of plant communities in this area (Diels 1906; Havel 1968; Smith 1974; Heddle *et al.* 1980).

Eight botanical studies were undertaken in the project area between 1993 and the 1999 by Mattiske & Associates (1993 a,b,c,d), Ecos Consulting Pty Ltd (1998), Arbortech Pty Ltd (1997) and Muir Environmental (1999). A total of 65 families, 174 genera, and 365 plant taxon (including varieties and subspecies) were recorded. Species representation was greatest in the Papilionaceae (34 taxon), Myrtaceae (39 taxon), Proteaceae (18 taxon) and Cyperaceae (21 taxon) families. This flora composition is typical of the Bassendean (Central and South) Complex, as described by Heddle *et al.*, 1980. 58 introduced taxon were recorded, occurring predominantly in the Asteraceae (11 taxon), Poaceae (10 taxon) and Papilionaceae (7 taxon) families. Weed encroachment was low, with the exception of pasture and cleared areas within the project area.

As a result of the merging of the findings on the flora and also subsequent taxonomic changes, there is a need to update the information on the flora through some targeted survey work to search for a few species and subspecies (namely – *Adenanthos cygnorum* subsp. *chamaephyton* (P3), *Eucalyptus rudis* subsp. *cratyantha* (P4) and *Pimelea ciliata* subsp. *longituba* (P3); which have been recorded previously at the species level but not the subspecies level). All of the latter subspecies have been recorded previously in the general area and therefore need to be re-checked. In addition, *Stylidium scandens*, has been recorded previously but not allocated to a particular assessments. This needs clarification in any future reporting.

Following a search of the databases managed by the Department of Conservation and Land Management (2003), a total of four Declared Rare, no Priority 1, three Priority 2, ten Priority 3 and five Priority 4 species are potentially found on the Swan Coastal Plain near the Kemerton project area.

In the specific project area, one Declared Rare Flora species, *Conostylis micrantha* (R), pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950), was located by Ecos Consulting Pty Ltd (1998) and Arbortech Pty Ltd (1997). The collection needs verification as it has not been recorded on other surveys in the area. The latter species is listed as Endangered under the Environmental Protection and Biodiversity Conservation Act (1999).

Six Priority flora species were located within the project area over an extended period. These included *Boronia juncea* subsp. *juncea* (P1), *Boronia gracilis* subsp. *gracilis* (P2), *Acacia semitrullata* (P3), *Goodenia filiformis* (P3), *Caladenia speciosa* (P4) and *Acacia flagelliformis* (P4).

Further investigations are required to address the distribution of the rare and priority species on the project area, as defined above (E.M. Mattiske and Associates 1993a, 1993b, 1993c, 1993d; Ecos Consulting Pty Ltd 1998 and Arbortech Pty Ltd 1997). In addition surveys are required to search for the species as defined above, which may occur in the area (as defined by Keighery 1998 and Muir Environmental 1999).

A total of 24 vegetation communities and 27 vegetation mapping units were defined and mapped for the Kemerton Sands project area, with three of the mapping units comprising disturbed stages of vegetation communities in the area. The representation of the different vascular plant species in the respective vegetation communities at the proposed Kemerton Silica Sands survey area and transport corridor are summarized in Appendix B.

In summary the key issues related to the flora and vegetation values on the Kemerton area:

- . The area is recognized as supporting regionally significant vegetation as large sections of the Swan Coastal Plain have been cleared and modified for agricultural and urbanization activities.
- . The southern section of the Kemerton survey area has been part of a previous negotiation to protect some of the values in a conservation area (see conservation zones in Bunbury regional planning reports).
- . There are a series of EPP wetlands within the Kemerton survey area.
- . There are a significant number of conservation category wetlands (including sumplands and damplands) in the Kemerton survey area.
- . There are a range of rare and priority species that have been either recorded in the Kemerton survey area or in adjacent areas (and consequently may potentially occur within the specific project area).
- . The vegetation communities provide an east-west corridor in an area where few corridors of native vegetation remain. The latter is significant for native fauna movement through the area.
- . The vegetation communities, as a result of their very structure and composition provide habitats for vertebrate fauna.
- . The structure of the vegetation in some areas has been modified by historical logging as sections of the area were logged in preparation for clearing and pine plantations, which did not eventuate.
- . There are several pockets of *Phytophthora cinnamomi* on the survey area and this has significant implications for operational activities as the area is low lying and seasonally wet.

As a result of the timing of the previous studies there is a need to undertake targeted research on selected rare and priority species, updating the map legends with recent taxonomic changes (e.g. *Agonis linearifolia* to *Taxandria linearifolia*) and review the specific values on the proposed development areas as compared with the wider Kemerton area as compared with regional flora and vegetation values. The latter work cannot be undertaken until more specific project specifications and location details are supplied.

2. INTRODUCTION

Mattiske Consulting Pty Ltd. was commissioned in October 1999 by Sons of Gwalia Ltd to review past botanical studies, and determine vegetation and conservation values and rehabilitation requirements within Gwalia Consolidated Ltd's Kemerton Silica Sand project area. This report has been reviewed and updated for Kemerton Silica Sands in February 2003.

2.1 Location

The project area is located 3km north of the Kemerton Industrial Estate and 27km north-north-east of Bunbury and west of Benger Swamp. A transport route runs south through the project area and through the Kemerton Industrial Estate to Marriott road.

2.2 Project and Operation

The initial operation at Kemerton was assessed and approved by the Environmental Protection Authority in July 1994, subject to conditions stated in the *Kemerton Silica Sand Mining Proposal Gwalia Consolidated Ltd. Report and Recommendations, Bulletin 471* (Gwalia Consolidated Ltd, 1993; Environmental Protection Authority, 1994).

Kemerton Silica Sands proposes to extend operations within the wider Kemerton survey area. This report summarized values on the wider Kemerton area and does not address the specific values affected by any proposed proposal at this juncture as these details were not supplied by the Kemerton Silica Sands.

2.3 Flora and Vegetation

The Project Area is located in the South Western Botanical Province of Western Australia, in the Darling Botanical District (Diels, 1906) and the Swan Coastal Plain (Coastal Belt) Subregion of the Drummond Botanical Subdistrict (Diels, 1906; Beard, 1990). The distinctive biological values of the Darling System were recognised by Diels (1906) and developed by Gardner (1942). Previous authors have stressed the significance of landforms, soils and climate in determining the distribution of vegetation communities in this area (Diels, 1906; Havel, 1968; Smith, 1974; Heddle *et al.*, 1980).

The flora and vegetation of this area has been defined by Beard (1981), Smith (1974) and Heddle *et al.* (1980) at a regional scale utilising the structure and floristics of the native vegetation. Heddle *et al.* (1980) produced a vegetation map at 1:250 000 scale, which defined vegetation complexes in relation to the landform-soil units, determined by Churchward and McArthur (1980). This regional mapping work defines the Study Area as occurring within the Swan Coastal Plain, predominantly in the Bassendean (Central and South) Complex. Vegetation ranges from a woodland of *Eucalyptus marginata* subsp. *marginata* (jarrah) - *Allocasuarina fraseriana* (sheoak) - *Banksia* spp. to low woodlands of *Melaleuca* spp. and sedgelands on the moister sites. *Banksia menziesii* is replaced in dominance on the upper slopes by *Banksia attenuata* and *Banksia grandis* in these southern areas of the complex. The tree species *Banksia ilicifolia*, *Banksia littoralis* and *Melaleuca preissiana* are common on the lower lying moister sites.

The survey area also includes some representation of the Serpentine River and Cannington Complexes to the east, the Karrakatta Complex (Central and South)(Heddle *et al.*, 1980) and Southern River Complex to the west (Mattiske, *pers. comm.*). The Southern River Complex consists of an open woodland of marri-jarrah-*Banksia* on elevated areas and a fringing woodland of *Eucalyptus rudis-Melaleuca raphiophylla* along streams. This community occurs on soils derived from Aeolian Deposits (Heddle *et al.*, 1980).

2.4 Past Flora and Vegetation Studies

Information has been extracted from the eight botanical studies, which have been undertaken in the project area between 1993 and the 1999, specifically:

- “Gwalia Consolidated Limited - Kemerton Sand Project. Flora and Vegetation Studies by E.M. Mattiske & Associates”. February 1993 report details December 1992 reconnaissance botanical studies undertaken throughout entire project area;
- “Gwalia Consolidated Limited - Kemerton Sand Project. Flora and Vegetation by E.M. Mattiske & Associates”. June 1993 report details April 1993 vegetation mapping in project area;
- “Gwalia Consolidated Limited - Kemerton Sand Project. Updated Flora and Vegetation Report by E.M. Mattiske & Associates”. November 1993 report reviews and supplements flora and vegetation within operational areas undertaken in October 1993;
- “Gwalia Consolidated Limited - Kemerton Sand Project. Vegetation Mapping of Proposed Transport Corridor by E.M. Mattiske & Associates”. November 1993 report details vegetation and flora studies and mapping undertaken in a 50m wide strip along the proposed transport route during October 1993;
- “Kemerton Silica Sand Environmental Monitoring Report 1998 by Ecos Consulting Pty Ltd”. Annual report outlining quarterly flora monitoring conducted within the project area during 1998;
- “Kemerton Silica Sand Environmental Monitoring Report 1997 by Arbortech Pty Ltd”. Annual report outlining quarterly flora monitoring conducted within the project area during 1997;
- “Report of Biological Survey - Phase 1: Kemerton Industrial Estate. Report and Appendices by Muir Environmental”. 1999 Report detailing October to November 1998 Biological Surveys of the Kemerton Industrial Estate; and
- “Vegetation and Flora Conservation Values of the Kemerton Silica Sands Project Area by B.Keighery”. 1998 report for the Department of Environmental Protection.

2.5 Rare and Priority Flora

Species of flora and fauna are defined as rare or priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Conservation and Land Management recognises these threats of extinction and consequently applies regulations towards population and species protection.

Rare Flora species are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to “take” or damage rare flora without Ministerial approval. Section 23F of the Wildlife Conservation Act (1950-1980) defines “to take” as “... to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means.

Table 1: Definition of Rare and Priority Flora Species (Department of Conservation and Land Management, 2003)

Note: In other sections of the report these codes are referred to as the SCC -- State Conservation Code

Conservation Code	Category
R	Declared Rare Flora – Extant Taxa “Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.”
P1	Priority One – Poorly Known Taxa “Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.”
P2	Priority Two – Poorly Known Taxa “Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as ‘rare flora’, but urgently need further survey.”
P3	Priority Three – Poorly Known Taxa “Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as ‘rare flora’ but need further survey.”
P4	Priority Four – Rare Taxa “Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.”

Priority Flora are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the Wildlife Conservation Act (1950) as extracted from Department of Conservation and Land Management (2003). Table 2 presents the definitions of the categories of threatened species under the Environmental Protection and Biodiversity Conservation Act, 1999.

Table 2: Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act, 1999)

Note: In other sections of the report these codes are referred to as the FCC – Federal Conservation Code

Category Code	Category
Ex	<p>Extinct</p> <p>Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.</p>
ExW	<p>Extinct in the Wild</p> <p>Taxa which is known only to survive in cultivation, in captivity or as a naturalized population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.</p>
CE	<p>Critically Endangered</p> <p>Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.</p>
E	<p>Endangered</p> <p>Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.</p>
V	<p>Vulnerable</p> <p>Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.</p>
CD	<p>Conservation Dependent</p> <p>Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.</p>

2.6 Declared Rare or Priority Species – CALM Database Search

Following a search of the databases managed by the Department of Conservation and Land Management (2002) a total of:

- . four Declared Rare *Flora* (*Caladenia huegelii*, *Diuris purdiei*, *Drakaea elastica*, *Drakaea micrantha*),
- . no Priority 1 species,
- . three Priority 2 species (*Oligochaetochilus* sp. Yalgorup (G.Brockman GBB463) (pn), *Boronia capitata* subsp. *capitata*, *Haloragis aculeolata*),
- . ten Priority 3 species (*Schoenus* sp. Waroona (G.J. Keighery 12235) (pn), *Chamaescilla gibsonii*, *Acacia semitrullata*, *Lasiopetalum membranaceum*, *Hibbertia spicata* subsp. *leptotheca*, *Verticordia attenuata*, *Haloragis tenuifolia*, *Myriophyllum echinatum*, *Hemigenia microphylla*, *Rhodanthe pyrethrum*) and
- . five Priority 4 species (*Conostylis pauciflora* subsp. *pauciflora*, *Caladenia speciosa*, *Jacksonia sparsa*, *Pultenaea skinneri*, *Anthotium junciforme*).

Only those species that occur on the western sand dune systems near Kemerton were extracted. Those rare and priority species located on the eastern part of the Swan Coastal Plain on the fluviatile soils were not included in the potential species for the Kemerton area. Therefore all of the species listed above may potentially occur near the Kemerton area (Figure 8).

Of these species, *Caladenia huegelii*, *Diuris purdiei* and *Drakaea elastica* are listed as Endangered under the EPBC Act (1999) and *Drakaea micrantha* is listed as Vulnerable under the EPBC Act (1999).

Caladenia huegelii (DRF) has been recorded largely within *Banksia*-Jarrah Sheoak woodland and low open forest on sandy soils from Perth to Busselton, with several scattered populations south of the Brockman Highway between Nannup and Augusta and also near Albany. The majority of the populations occur on the sandier soils of the Swan Coastal Plain.

Diuris purdiei (DRF) has been recorded in seasonally moist to wet swamps with sandy soils from Cannington. This species fluctuates in numbers in response to fire. As such it is only known from a restricted number of populations on the Swan Coastal Plain.

Drakaea elastica (DRF) was recorded in *Banksia*-Sheoak woodland with Jarrah and/or Marri on sandy soils from several locations between Gingin and Busselton, and also at Lake Guraga. The flowering period is October to November (CALM, 1998) Populations were located by Muir (1999) on the southeast side of the Kemerton Industrial Estate (Muir study site 348) in deep sandy soils associated with lowland Jarrah-*Banksia* woodland. This species may also occur in the "Lower slope Open Woodland of *Eucalyptus marginata* - *Banksia* spp. and *Kunzea ericifolia* over *Melaleuca thymoides*, *Calytrix fraseri* and mixed shrubs" (A-3) vegetation community in the south of the project area.

Drakaea micrantha (DRF) characteristically occurs in *Banksia*-Jarrah-Sheoak woodlands adjacent to winter wet swamps and on hillsides in white-grey sand along the coastal strip between Perth and Albany. The flowering period is between September to October (CALM, 1998) Muir (1999) recorded populations approximately one kilometre from the project area's south western point in deep sandy soil associated with Jarrah-*Banksia* Woodland (Muir study site 183). While not located by Muir (1999), Mattiske (1997,1993a,b,d) or Keighery (1998), it may also be present in the following communities in the project area:

- A-1. Upper slope Open Woodland dominated by *Eucalyptus marginata* - *Banksia* spp. and *Kunzea ericifolia* over *Stirlingia latifolia* and mixed shrubs over *Dasypogon bromeliifolius*, and
- A-3. Lower slope Open Woodland of *Eucalyptus marginata* - *Banksia* spp. and *Kunzea ericifolia* over *Melaleuca thymoides*, *Calytrix fraseri* and mixed shrubs.

The species that may also potentially occur in the area (based on the regional database search, Figure 8) need to also be investigated further to eliminate the likelihood of their occurrence in any potential disturbance areas.

2.7 Declared Rare or Priority Species – Additional Potential Species

In addition, to the records as defined by the Department of Conservation and Land Management above (Section 2.6), Keighery (1998) stated that *Hydatella dioica* (DRF), *Centrolepis caespitosa* (DRF) and *Schoenus capillifolius* (P2) are likely to be present in the project area. *Hydatella dioica* is an annual herb that occurs in muddy claypans in Midland, Ellenbrook, near Bunbury and near Margaret River. *Centrolepis caespitosa* is a tufted annual that flowers from October to December. It occurs in white sand or clay in salt flats. *Schoenus capillifolius* is a semi-aquatic tufted annual that inhabits winter wet clay pans in habitats including *Melaleuca viminea* shrublands, open herb fields. It has also been previously recorded with *Hydatella dioica* (DRF), *Trithuria* sp. and *Triglochin* sp. surrounded by low sedges, low *Verticordia* sp. heath over *Melaleuca lateritia* heath. These three small annual aquatic species can only be located through detailed survey in late spring (CALM, 1998).

2.8 Other Significant Flora

Keighery (1998) found the following taxa to be uncommon and restricted on the Plain, and these have been extracted and summarized in Figure 2:

- An unusual form of *Melaleuca systema* growing to two metres;
- *Melaleuca* sp. (*brachyphylla*-B.Keighery), an uncommon species on the Plain;
- *Hakea trifurcata* – a small-flowered form previously only known from the Peel-Harvey region, previously located by Mattiske in communities D2 and E2; and
- *Hibbertia perfoliata* – an uncommon poorly-collected species on the Plain (Muir, 1999). Found in communities C3 and D2.

Keighery (1998) noted that *Verticordia nitens* and *Banksia menziesii* are at the southern limits of their range. *Verticordia nitens* is common to the sandplains north of Perth, but is known to occur in only two areas to the south of Perth. It was located by Mattiske in community A3. This is the most southern *Banksia menziesii* recording, with the closest known population being from Peel area. It has previously been recorded by Mattiske in communities A3 and G1.

Evandra pauciflora is noted in Keighery's 1998 study to be a distinctive sedge that inhabits damplands on the Swan Coastal Plain from Forrestdale to the Capel Nature Reserve. This sedge is a distinguishing aspect of wetlands with mixed shrubs.

2.9 Threatened Ecological Communities and Significance of Vegetation

A range of communities has been defined as threatened ecological communities (English and Blyth 1997) for Western Australia. This includes a significant number of communities on the Swan Coastal Plain. Although a range of communities have been recognized by the threatened ecological section of the Department of Conservation and Land Management, these communities currently do not have the same level of legal protection at the State level.

The latter situation will be changed when the Wildlife Conservation Act (1950) is updated to the Biodiversity Act (in preparation).

Selected threatened ecological communities are listed under the Environmental Protection and Biodiversity Conservation Act (EPBC Act, 1999) at the Federal level. Consequently those communities listed under the Federal legislation are a trigger under the EPBC Act (1999).

The significance of vegetation on the Swan Coastal Plain has increased in recent decades primarily as large sections have been cleared for agricultural activities and urbanization. In addition, there has been an increasing awareness of the values of remnant vegetation in terms of protecting biodiversity and the ecological functions of catchments.

3. OBJECTIVES

The specific objectives of this study are:

- to review flora and vegetation data collected for the proposed mine area and transport corridor collect between December 1992 and October 2003;
- to review the conservation status of all flora species, with reference to listings on the Declared Rare and Priority Flora species, as defined by the Department of Conservation and Land Management (2003);
- to review the conservation status of the vegetation in relation to conservation category wetlands and threatened ecological communities (as defined by the Environmental Protection and Biodiversity Conservation Act 1999 and English and Blyth 1997).
- to assess potential dieback locations, issues and management; and
- to prepare a series of maps and a report summarizing information collated to date.

4. METHODS

Detailed recordings of the vascular plant species were recorded during eight field studies by E.M. Mattiske and Associates (1993a,b,c,d), Ecos Consulting Pty Ltd (1998), Arbortech Pty Ltd (1997), Keighery (1998) and Muir Environmental (1999).

The most comprehensive field studies for the Kemerton survey area were undertaken by E.M. Mattiske & Associates between December 1992 and October 1993. The initial study in December 1992 concentrated on the wetlands on the north-eastern section of the proposed mining operations. April 1993 studies encompassed the entire Project Area, which was supplemented by additional opportunistic annual and other species collections in October 1993. In the same period, detailed flora and vegetation studies were undertaken over the 50m wide transport corridor.

4.1 Flora

Methods for work undertaken by E.M. Mattiske and Associates can be found in the respective reports (E.M. Mattiske and Associates 1993a, 1993b, 1993c, 1993d). The methods for the work undertaken by other consultants are summarized in the respective reports by Ecos Consulting Pty Ltd (1998), Arbortech Pty Ltd (1997), Keighery (1998) and Muir Environmental (1999).

E.M. Mattiske and Associates systematically recorded flora at each survey site and collections made where further identification was required. Selective opportunistic collecting was carried out at additional sites in vegetation communities of like structure and floristic composition.

A search of the Department of Conservation and Land Management's Declared Rare and Priority Flora records known to occur in the region was undertaken prior to survey (Department of Conservation and Land Management, 1992). During the survey, particular attention was directed towards searching for endangered flora.

All plant specimens collected during the field survey were handled and identified in accordance with the requirements of the Western Australian Herbarium. When necessary, specimens were compared with pressed specimens housed at the Western Australian Herbarium, and plant taxonomists with specialist skills were consulted. Nomenclature of recorded species follows Western Australian Herbarium protocols (2003).

4.2 Vegetation

The studies by E.M. Mattiske and Associates field included regular recordings and were taken at sites within different vegetation communities to assist in the vegetation mapping and definition of conservation values. The transport corridor was surveyed to 50m by two people walking the route.

The vegetation map of 1:10,000 was prepared using:

- field data collected in December 1992, April 1993 and October 1993;
- foot, road and track traverses and opportunistic field observations; and
- aerial photographs supplied by Gwalia Consolidated Ltd.

4.3 Conservation Significance of Vegetation

The local and regional significance of the vegetation communities recorded were ascertained by:

- presence of EPP wetlands, as per the *Environmental Protection (Coastal Plain Lakes) Policy* (EPP 1992, 1999);
- location of Conservation Wetlands defined by the Water and Rivers Commission
- locally and regionally significant communities highlighted by the mapping work of Heddle *et al.* (1980) and the floristic studies of Gibson *et al.* (1994);
- English and Blyth (1997)'s Threatened Ecological Community study;
- Threatened Ecological Communities as defined and listed under EPBC Act (1999);
- Perth's Bush Forever (Environmental Protection Authority *et al.*, 1998);
- unusual or uncommon vegetation types;
- threatened ecological communities (including similar communities);
- native species diversity per vegetation community;
- weed species diversity per vegetation community;
- species diversity compared with Gibson *et al.* (1994) floristic data.

5. RESULTS

5.1 Flora

A total of 65 families, 174 genera, and 365 plant taxon (including varieties and subspecies) were recorded in the mine area from December 1992 to and October 1998 by field studies, Appendix A. The species by site-vegetation types as defined by E.M. Mattiske and Associates (1993c) are summarized in Appendix B.

Native species representation was greatest in the Cyperaceae, Restionaceae, Proteaceae, Papilionaceae, Epacridaceae and Myrtaceae families, a flora composition typical of the Bassendean (Central and South) botanical complex, as described by Heddle *et al.*, 1980. Wetland systems were dominated by species from the Restionaceae, Cyperaceae and Myrtaceae families. Appendix A lists flora species recorded in the proposed mine area and transport route.

5.2 Introduced Species

58 weed species were recorded in the survey areas, occurring predominantly in the Asteraceae (11 taxon), Poaceae (10 taxon) and Papilionaceae (7 taxon) families. Appendix A lists introduced species (denoted by an asterisk) in the survey areas. Weed encroachment was low, with the exception of pasture and cleared areas.

The most common species are annuals or short lived perennials, dominated by Blowfly grass (*Briza maxima*), Shivery grass (*Briza minor*), Smooth catsear (*Hypochaeris glabra*) and Hair's tail grass (*Lagurus ovatus*). These species inhabit the following communities:

Blowfly grass (*Briza maxima*) – in communities A1, A2, A3, C1, C3, D1, E2, G1, G2, H1.

Shivery grass (*Briza minor*) – in communities A3, B1, C3, E3, G2.

Smooth catsear (*Hypochaeris glabra*) – in communities B1, C3, D2, G2, H1.

Hair's tail grass (*Lagurus ovatus*) – in communities A3, E2, F1, H1.

Three major aggressive species have been recorded in the survey area, namely:

- Bulrush (*Typha occidentalis*). This aggressive coloniser of the Swan Coastal Plain inhabits seasonally inundated *Melaleuca raphiophylla* woodlands (community F2)
- Bulbil *Watsonia* (*Watsonia meriana* var. *bulbillifera*) is a serious invader of clay wetlands on the Swan Coastal Plain and occurs on the lower slope *Eucalyptus marginata*-*Banksia* spp. woodlands (community A-3), and
- Tagasaste (*Chamaecystis palmensis*) prolifically regenerates from seed. This species was found in cleared pasture areas.

5.3 Declared Rare or Priority Flora

In the specific project area, one Declared Rare Flora species, *Conostylis micrantha* (R), pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950), was located by Ecos Consulting Pty Ltd (1998) and Arbortech Pty Ltd (1997). The collection needs verification as it has not been recorded on other surveys in the area. The latter species is listed as Endangered under the Environmental Protection and Biodiversity Conservation Act (1999).

Six Priority flora species were located within the project area over an extended period, although specific locations are not available for all of these species as some records were collected by other consultants and this data was not available at the time of this review of information (Figure 1). The six species included *Boronia juncea* subsp. *juncea* (P1), *Boronia gracilis* subsp. *gracilis* (P2), *Acacia semitrullata* (P3), *Goodenia filiformis* (P3), *Caladenia speciosa* (P4) and *Acacia flagelliformis* (P4).

Boronia juncea subsp. *juncea* (P1) characteristically occurs in low scrub in sand between Bunbury and Mandurah and flowers in April (CALM, 1998). In October 1993, Mattiske (1993c) located 4 populations in excess of 50 plants, and two of less than 3 plants in communities H1, H2, F1 (and abutting F1, F3, H1 and H2). Ecos Consulting Pty Ltd (1998) located another population along a 100m stretch of the cleared margin of the return drain within vegetation community H1 (see map).

Field observations suggested this species is short lived and an early coloniser of disturbed areas. Muir Environmental (1999) located *Boronia* populations in the north-east and south (Muir study site locations 67, 91 and 155) in damplands associated with dense *Pericalymma ellipticum* and/or *Astartea fascicularis*. The Department of Conservation's Wildlife Branch considers that further survey work is necessary to determine whether this species should be recommended for conservation (Keighery, 1998).

A detailed search of wetlands for *Boronia juncea* subsp. *juncea* was undertaken near the project area in October 1993. These wetlands included Benger Swamp and a chain of wetlands up to 50km to the north. Only one population of 50 plants was located, in a heath area approximately south of the Kemerton Sands proposed mining area. Many of the wetlands inspected occurred on private property and were disturbed by grazing and infested with weeds.

Boronia capitata subsp. *gracilis* (P2) inhabits winter-wet swamps and hillsides in white/grey or black sand between Yarloop and Yallingup (CALM, 1998). E.M. Mattiske and Associates recorded this species once in the project area at 13750mN/11550mE in vegetation community A-3 (E.M. Mattiske and Associates 1993a and c).

Acacia semitrullata (P3) has been found in wetland areas and sandplains in white/grey sand, sometimes over laterite clay in Kemerton, Collie, Donnybrook, Harvey, Yallingup and Yarloop. The flowering period is June to August (CALM, 1998). E.M. Matiske and Associates (1993c) found this species throughout the survey area in vegetation communities A1, A3, B1, E1, E2, G1, G2, H1. Muir Environmental (1999) recorded populations in dampland sites 91 and 155, along swamp fringes and in damplands.

Cyathochaeta stipoides (P3) occurs in grey or red-brown sands of seasonally wet flats from Bow Bridge to Scott River Plain, and from the Capel Nature Reserve. The flowering period is between October to December or in January (CALM, 1998). Keighery (1998) located one population in the wetland adjacent to the northern margin of the silica sand dredge pond. This is the only record of this species on the Plain, represents the most northerly population and is one of only four or five *Cyathochaeta* species recorded on the Swan Coastal Plain.

Dillwynia dillwynioides (P3) inhabits in winter wet depressions in sandy soils in the coastal strip between Gingin and Harvey and flowers between August to December (CALM, 1998). Keighery (1998) located this species in the heavy wetland communities towards the eastern side of the Plain and wetlands to the west and expects this species to inhabit vegetation communities H1 and potentially in H2, F1 and F2 (ie. the Western Extension area).

Myriophyllum echinatum (P3) has been recorded in *Melaleuca* scrub in winter wet flats in clay soils in Guildford and near Busselton. This species flowers in November (CALM, 1998). Keighery (1998) located this species in the heavy wetland communities towards the eastern side of the Plain.

Acacia flagelliformis (P4) inhabits sandy soils in winter wet areas in the Harvey, Eaton, Bunbury, Capel, Busselton and Donnybrook areas and flowers between July to September (CALM 1998). Matiske collected this species twice within the project area at 8500mN/11200mE and 9000mN/10500mE in vegetation communities H1 and H2. This species was recorded by Muir Environmental (1999) in the Kemerton Industrial Estate in a post-fire dampland complex of *Melaleuca preissiana*, *Calothamnus lateralis* and *Hakea varia*. Muir considers that other damplands are likely to contain dormant seeds of this species.

Anthotium junciforme (P4) occurs in sandy clay or sand in *Melaleuca* shrublands or heathlands in winter wet depressions in the coastal strip just above Perth to Augusta. The flowering period is January to March or in November or (CALM, 1998). Keighery (1998) located this species in the heavy wetland communities towards the eastern side of the Plain.

Caladenia speciosa ms (P4) inhabits Eucalypt and *Banksia* woodlands in the dunes above paperbark swamps on white grey or black sand, between North Dandalup and Busselton (CALM, 1998). The flowering period is September to October. E.M. Matiske and Associates (1993c) located this species in vegetation community H1.

Immature specimens collected in the project area by Keighery (1998) were thought to be *Schoenus* ?sp. Waroona (G.J.Keighery 12335)(P3) and *Drosera occidentalis* subsp. *occidentalis* (P4). *Schoenus* sp. Waroona is an annual herb that occurs on winter wet flats of *Melaleuca* thickets in clay and sandy clay. *Drosera occidentalis* subsp. *occidentalis* has been recorded in swamps and wet depressions on sandy and clayey soils in Cannington, Wattlegrove and Bullsbrook (CALM, 1998).

As a result of the merging of the findings on the flora and also subsequent taxonomic changes, there is a need to update the information on the flora through some targeted survey work to search for a few species and subspecies (namely – *Adenanthos cygnorum* subsp. *chamaephyton* (P3), *Eucalyptus rudis* subsp. *cratyantha* (P4) and *Pimelea ciliata* subsp. *longituba* (P3) which have been recorded previously at the species level but not the subspecies level). All of the latter subspecies have been recorded previously in the general area and therefore need to be re-checked. In addition, *Stylidium scandens*, has been recorded previously but not allocated to a particular assessments.

Consequently, there is a need to undertake further investigations on targeted species, in order to clarify the possibility of locating these taxa on the project area.

In summary, many of these species have been recorded in the Kemerton survey area and consequently there is a need to undertake specific targeted work to further delineate the populations and update Figures 1 and 8 prior to delineating proposed disturbance areas.

5.4 Vegetation

The vegetation was mapped at a detailed level by E.M.Mattiske and Associates (1993a,b,c, d) which defined a total of 24 vegetation communities and 27 vegetation mapping units for the Kemerton Sands survey area, with three of the mapping units comprising disturbed stages of vegetation communities, Figures 3 and 3a. Appendix B summarizes the vascular plant species recorded in each vegetation community at the proposed Kemerton survey area in the E.M. Mattiske and Associates reports (1993a, 1993b, 1993c and 1993d).

Vegetation communities are listed in the following text and, summarised on enclosed vegetation maps. Keighery (1998) reported that the project area also contains *Eucalyptus decipiens* Closed Tree Mallee populations associated with Muchea Limestone communities within vegetation communities D2, F1 and F3. Appendix B illustrates plant species recorded for each vegetation community at the proposed Kemerton Sands Project Area in the Mattiske 1993a,b,c,d reports. Based on interpretations from geological records limestone was not recorded within these areas at Kemerton and therefore the issue of whether the *Eucalyptus decipiens* reflects a particular community or not is still open to interpretation. After reviewing the distribution of this mallee species on FloraBase it appears that although it is associated with the limestone it is not confined to these Muchea limestone areas.

Table 3 summarizes the vegetation communities in the survey area, compares key species and community structures to vegetation studies by Gibson *et al.* (1994) and community rarity assessments by English and Blyth (1997). There are some similarities between the communities but are not necessarily directly comparable. Several need further clarification in relation to the overlap between community composition and those types as defined by Gibson *et al.* (1994).

5.5 Wetlands

Wetlands and their fringing vegetation support a diverse range of flora. Vegetation communities are closely related to flora species composition, the local water table, climate and soils (Havel 1975, Muir 1983). Even minor differences in ground water levels result in differing vegetation community types and flora species compositions (Muir, 1999). Consequently, a wetland's integrity and health is closely tied to changes in the local water regime, in addition to bushland fragmentation and disturbance.

The survey area contains a total of 12 wetlands (See Map 3). The following vegetation communities could be considered to dominate the sumplands and damplands in the project area.

- C3 Closed Woodland of *Agonis flexuosa* - *Eucalyptus rudis* and *Corymbia calophylla* with occasional *Banksia littoralis*, over *Xanthorrhoea preissii*, *Macrozamia riedlei* and sparse mixed shrubs and sedges.
- D-1 Open Woodland of *Eucalyptus rudis* and *Kunzea ericifolia* over *Hypocalymma angustifolium*, *Xanthorrhoea preissii* and mixed shrubs over mixed grasses and sedges.
- D-2 Woodland of *Eucalyptus rudis* - *Melaleuca preissiana* and occasional *Banksia littoralis* over Myrtaceae spp. over mixed sedges.
- D-3 Woodland of *Eucalyptus rudis* and *Melaleuca raphiophylla* over *Melaleuca teretifolia* and *Astartea fascicularis* over *Lepidosperma longitudinale*.
- E-1 Low Open Woodland of *Melaleuca preissiana* and occasional *Eucalyptus marginata* and *Kunzea ericifolia* over *Hypocalymma angustifolium* and *Calytrix* spp. over *Dasyogon bromeliifolius*.
- E-2 Low Woodland of *Melaleuca preissiana* and occasional *Nuytsia floribunda* over *Hypocalymma angustifolium*, *Pelicalymma ellipticum* and mixed shrubs over mixed sedges.
- E-3 Low Woodland of *Melaleuca preissiana* and *Agonis flexuosa* over *Astartea fascicularis* and mixed shrubs over *Lepidosperma longitudinale*.
- E-4 Closed Low Forest of *Melaleuca preissiana*, with occasional *Corymbia calophylla* over dense *Agonis linearifolia* over *Pteridium esculentum* and dense *Lepidosperma longitudinale*.
- F-1 Seasonally inundated Low Closed Forest of *Melaleuca raphiophylla* over Myrtaceae spp. over mixed sedges
- F-2 Seasonally inundated Low Open Woodland of *Melaleuca raphiophylla* over *Melaleuca viminea* and *Melaleuca cuticularis* over mixed shrubs over mixed sedges
- F-3 Waterlogged, Low Woodland of *Melaleuca raphiophylla* over *Baumea articulata*.

(Note – *Agonis linearifolia* has been changed to *Taxandria linearifolia*, see Appendix A)

The sensitivity of wetlands in Western Australia to development and altered hydrological regimes has been recognized by the Environmental Protection Authority of Western Australia and the Water and Rivers Commission (Guidance Statement (Environmental Protection Authority 2003). The sensitivity and significance of these areas was recognized in the *Environmental Protection (Swan Coastal Lakes) Policy*, 1992 (Lakes EPP). The latter provides statutory protection for Swan Coastal Plain lakes from filling, draining, mining and effluent discharge. Landowners, proponents, the State and local Government Authorities are responsible for ensuring the lakes are not affected by the above activities. The Lakes EPP policy area extends from Moore River to Dunsborough on the Swan Coastal Plain, and encompasses lakes depicted on the Department of Land Administration Miscellaneous Plan No. 1815. Lakes are defined in the Lakes EPP as those wetlands containing a minimum of 1000m² of standing (free) water in the first week of December 1991.

The damplands and sumplands have been recognized as being significant in the area, and although the boundaries were defined largely on the basis of aerial photographic interpretation, the extent of these vegetation communities is apparent from the previous listings and the vegetation map (Figure 3).

The presence of the EPP wetlands on the Kemerton area has been incorporated into site specific planning and the extent of the conservation category wetlands has been documented and mapped in other correspondence associated with the project area. In summary there is no doubt that the area has significant local and regional values associated with the series of damplands, sumplands and EPP wetlands.

5.6 Species Richness

Species richness is defined as a measure of the number of plant species present within a specific area. The species richness results from Gibson *et al.* (1994) for the project area's floristic groupings are compared with species richness data collated as part of the E.M. Matiske and Associates (1993c) studies. High species diversity is defined by Safstrom and Craig (1996) as over 25-30 perennial species per 100 square metres.

Table 4: Species Richness in Vegetation Communities

Plant Community E M.Matiske and Associates (1993c)	Gibson et al. (1994)	
	Floristic type	Mean Species Richness
A1	21a	54.6
A2	21a	54.6
A3	21a	54.6
B1	--	--
C1	21b	61.3
C2	21b	61.3
C3	11	27.2
D1	11	27.2
D2	4	36.9
D3	12	26.4
E1	4	36.9
E2	4	36.9
E3	4	36.9
E4	4	36.9
F1	12	26.4
F2	7	46.4
F3	13	17.4
G1	11	27.2
G2	11	27.2
G3	13	17.4
G4	7	46.4
H1	11	27.2
H2	11	27.2
H3	12	26.4
I1	21b	61.3
I2	21b	61.3
I3	11	27.2

5.7 Dieback

Dieback species (known as *Phytophthora* sp.) occur in the project area. These soil-borne pathogens can dramatically alter native vegetation composition by targeting susceptible flora in certain soils and climatic conditions (Old *et al.*, 1980). Many of the species inhabiting the dune systems, and in particular on the lower moist slopes, are vulnerable to this disease.

Dieback has been located at the project area:

- adjacent to the majority of access roads by Ecos Consulting Pty Ltd (1998). The main access road to the plant site, the road to both the dredge pond and the settling pond, the Western Power easement and the Epic Energy Natural Gas Pipeline easement were all found to be infested or was uninterpretable, with a high probability of being infested.
- around the return pond. Dieback was isolated by Arbortech (1997) from samples of dying or dead *Banksia attenuata* around this area.
- in pockets throughout the project area by general observations during vegetation mapping by Mattiske (1993a,b,c,d).

The potential direct and indirect effects of the dieback disease caused by this fungus is an important concern in the short-term management of the vegetation during operations. Based on the information gathered during the above assessments, a dieback management plan prepared by Ecos Consulting Ltd is now in place in the mining area. The Hygiene Management programme involves:

- ensuring the hygiene of vehicles and equipment entering and leaving the project area;
- provision of 'safe' access ways for movement within the area and hygiene prescriptions for management of movement of vehicles and equipment to and from those safe access ways; and
- workforce awareness and training in the nature and management of forest disease.

6. DISCUSSION

This report provides an updated summary of previous botanical studies within the Kemerton project area, previously collated for Gwalia Consolidated Ltd by Mattiske Consulting Pty Ltd's (1999).

The initial operation was assessed and approved by the Environmental Protection Authority in July 1994, subject to conditions stated in the *Kemerton Silica Sand Mining Proposal Gwalia Consolidated Ltd. Report and Recommendations, Bulletin 471* (Environmental Protection Authority 1994).

Eight botanical studies were undertaken in the project area between 1993 and the 1999 by Mattiske & Associates (1993 a,b,c,d), Ecos Consulting Pty Ltd (1998), Arbortech Pty Ltd (1997) and Muir Environmental (1999). A total of 65 families, 174 genera, and 365 plant taxon (including varieties and subspecies) were recorded. Species representation was greatest in the Papilionaceae (34 taxon), Myrtaceae (39 taxon), Proteaceae (18 taxon) and Cyperaceae (21 taxon) families. This flora composition is typical of the Bassendean (Central and South) Complex, as described by Heddle *et al.*, 1980. 58 introduced taxon were recorded, occurring predominantly in the Asteraceae (11 taxon), Poaceae (10 taxon) and Papilionaceae (7 taxon) families. Weed encroachment was low, with the exception of pasture and cleared areas within the project area.

As a result of the merging of the findings on the flora and also subsequent taxonomic changes, there is a need to update the information on the flora through some targeted survey work to search for a few species and subspecies. Further there is a need to update the information as collated with recent changes in taxonomic nomenclature.

Of particular significance in the specific project area, is the need to clarify the significance of the Declared Rare Flora species, *Conostylis micrantha* (R), pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950), was located by Ecos Consulting Pty Ltd (1998) and Arbortech Pty Ltd (1997). The collection needs verification as it has not been recorded on other surveys in the area. The latter species is listed as Endangered under the Environmental Protection and Biodiversity Conservation Act (1999). Further investigations are required to address the distribution of the rare and priority species on the project area, as defined above (E.M. Mattiske and Associates 1993a, 1993b, 1993c, 1993d; Ecos Consulting Pty Ltd 1998 and Arbortech Pty Ltd 1997). In addition surveys are required to search for the species as defined above, which may occur in the area (as defined by Keighery 1998 and Muir Environmental 1999).

In summary the key issues related to the flora and vegetation values on the Kemerton area:

- . The area is recognized as supporting regionally significant vegetation as large sections of the Swan Coastal Plain have been cleared and modified for agricultural and urbanization activities.
- . The southern section of the Kemerton survey area has been part of a previous negotiation to protect some of the values in a conservation area (see conservation zones in Bunbury regional planning reports).
- . There are a series of EPP wetlands within the Kemerton survey area.
- . There are a significant number of conservation category wetlands (including sumplands and damplands) in the Kemerton survey area.
- . There are a range of rare and priority species that have been either recorded in the Kemerton survey area or in adjacent areas (and consequently may potentially occur within the project area).
- . The vegetation communities provide an east-west corridor in an area where few corridors of native vegetation remain. The latter is significant for native fauna movement through the area.
- . The vegetation communities, as a result of their very structure and composition provide habitats for vertebrate fauna.
- . The structure of the vegetation in some areas has been modified by historical logging as sections of the area were logged in preparation for clearing and pine plantations, which did not eventuate.
- . There are several pockets of *Phytophthora cinnamomi* on the survey area and this has significant implications for operational activities as the area is low lying and seasonally wet. The dieback mapping which has been undertaken to date requires updating as the coverage of the area was relatively limited.

In addition, following the clarification of the status of targeted species as mentioned above, there is a need to update the presentation of the information as edited in relation to the recently published Guidance Statement by the Environmental Protection Authority (2003). Ideally this should be undertaken during the spring months, however in light of other schedules and the amount of work already undertaken on the project some of the work should commence sooner than spring.

Following the latter targeted research there is a need to finalize and update information in relation to the specific proposed area, once the proposed impact areas are defined.

7. LIST OF PARTICIPANTS

The following personnel of Mattiske Consulting Pty Ltd. were involved with this project:

Principal Ecologist: Dr E Mattiske

Senior Botanist: Mrs B Koch

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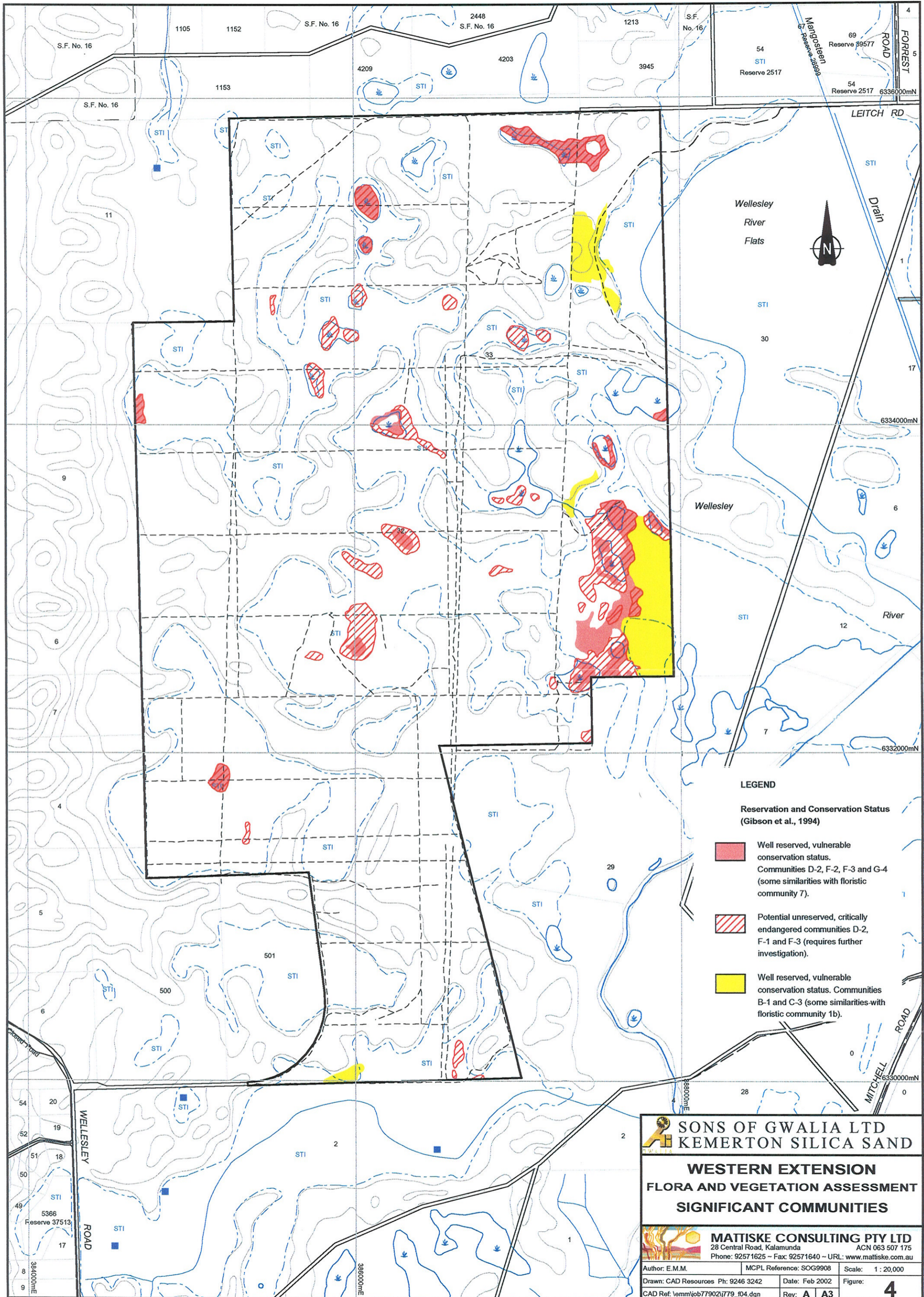
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LEGEND

Reservation and Conservation Status (Gibson et al., 1994)

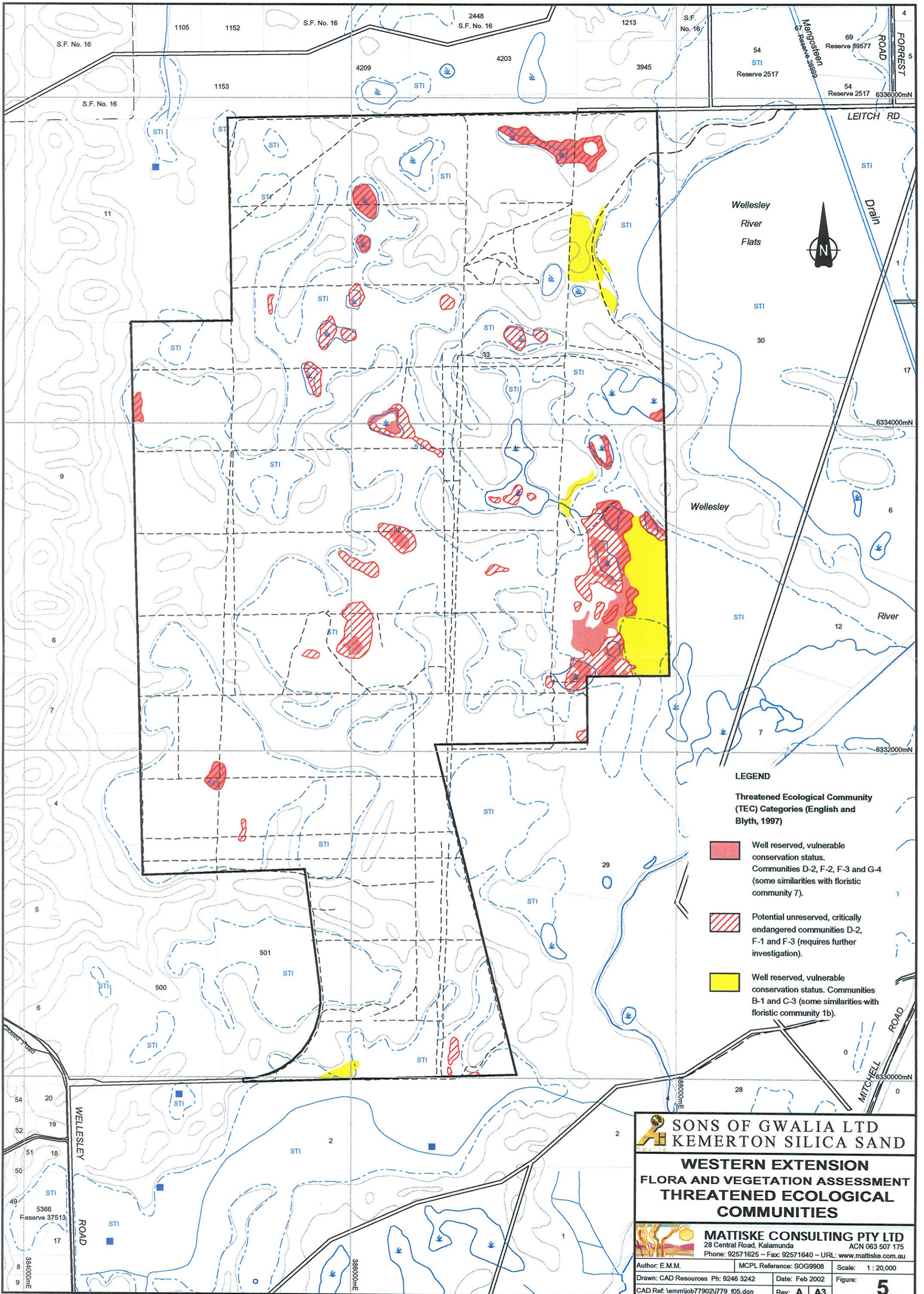
- Well reserved, vulnerable conservation status. Communities D-2, F-2, F-3 and G-4 (some similarities with floristic community 7).
- Potential unreserved, critically endangered communities D-2, F-1 and F-3 (requires further investigation).
- Well reserved, vulnerable conservation status. Communities B-1 and C-3 (some similarities with floristic community 1b).

SONS OF GWALIA LTD
KEMERTON SILICA SAND

WESTERN EXTENSION
FLORA AND VEGETATION ASSESSMENT
SIGNIFICANT COMMUNITIES

MATTISKE CONSULTING PTY LTD
 28 Central Road, Kalamunda ACN 063 507 175
 Phone: 92571625 - Fax: 92571640 - URL: www.mattiske.com.au

Author: E.M.M.	MCPL Reference: SOG9908	Scale: 1 : 20,000
Drawn: CAD Resources Ph: 9246 3242	Date: Feb 2002	Figure: 4
CAD Ref: \emm\job77902\779_f04.dgn	Rev: A A3	



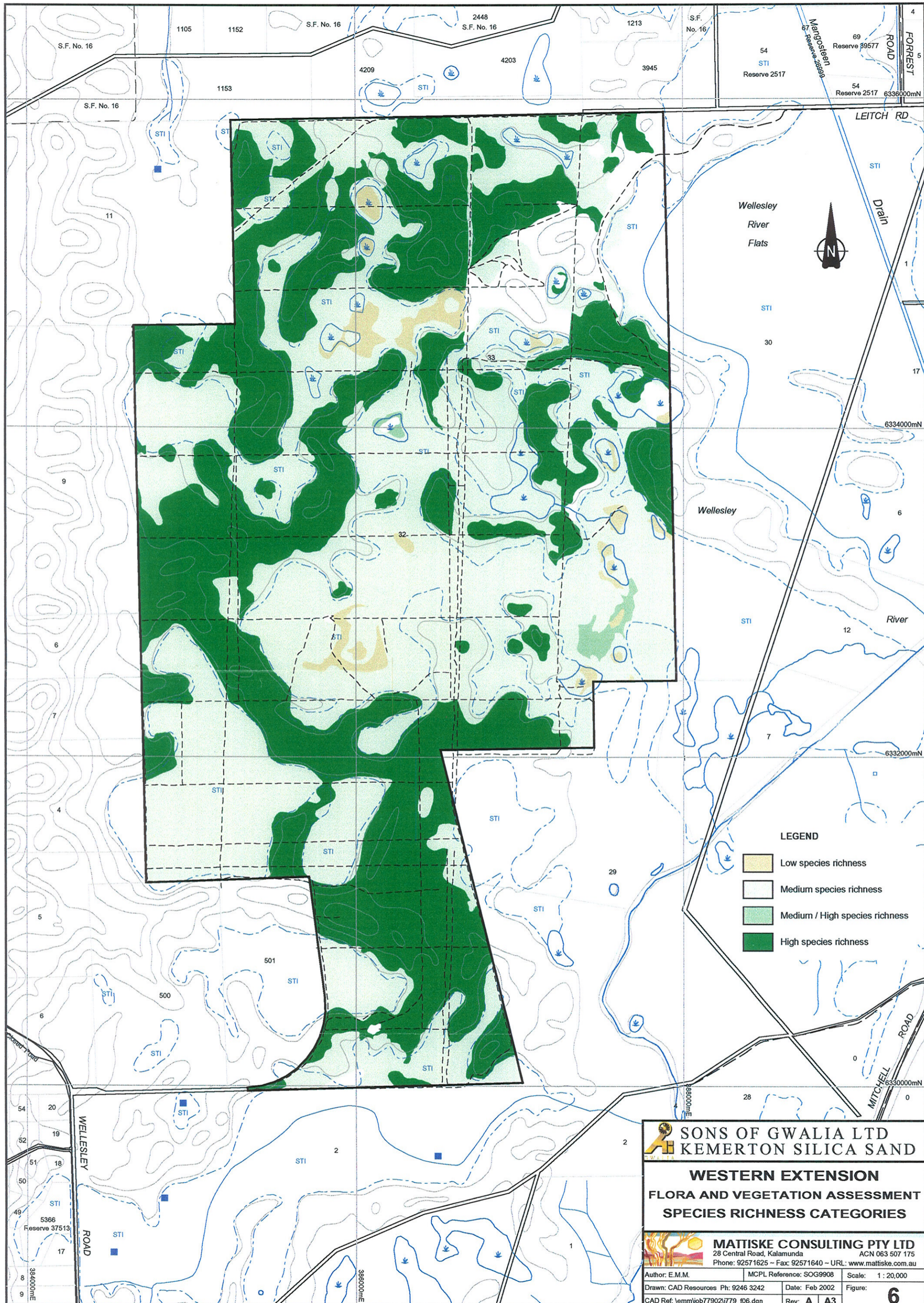
- LEGEND**
- Threatened Ecological Community (TEC) Categories (English and Blyth, 1997)**
- Well reserved, vulnerable conservation status. Communities D-2, F-2, F-3 and G-4 (some similarities with floristic community 7).
 - Potential unreserved, critically endangered communities D-2, F-1 and F-3 (requires further investigation).
 - Well reserved, vulnerable conservation status. Communities B-1 and C-3 (some similarities with floristic community 1b).

SONS OF GWALIA LTD
KEMERTON SILICA SAND

WESTERN EXTENSION
FLORA AND VEGETATION ASSESSMENT
THREATENED ECOLOGICAL COMMUNITIES

MATTISKE CONSULTING PTY LTD
 28 Central Road, Kalamunda ACN 063 507 175
 Phone: 92571625 - Fax: 92571640 - URL: www.mattiske.com.au

Author: E.M.M.	MCPL Reference: SOG9908	Scale: 1 : 20,000
Drawn: CAD Resources Ph: 9246 3242	Date: Feb 2002	Figure: 5
CAD Ref: lommjob77902\779_105.dgn	Rev: A A3	



LEGEND

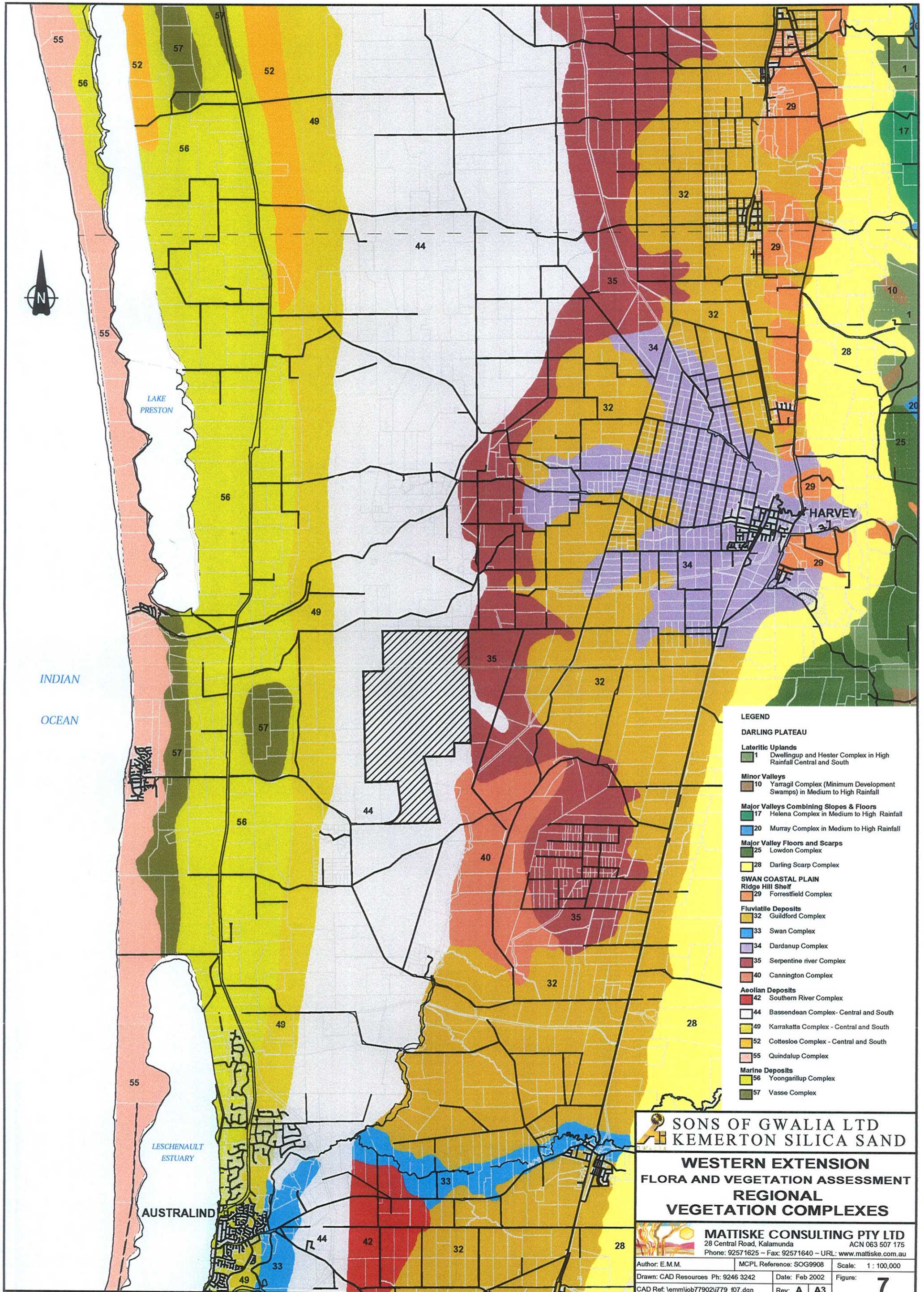
- Low species richness
- Medium species richness
- Medium / High species richness
- High species richness

SONS OF GWALIA LTD
KEMERTON SILICA SAND

WESTERN EXTENSION
FLORA AND VEGETATION ASSESSMENT
SPECIES RICHNESS CATEGORIES

MATTISKE CONSULTING PTY LTD
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 Phone: 92571625 - Fax: 92571640 - URL: www.mattiske.com.au

Author: E.M.M.	MCPL Reference: SOG9908	Scale: 1 : 20,000
Drawn: CAD Resources Ph: 9246 3242	Date: Feb 2002	Figure: 6
CAD Ref: \\emm\job77902\779_r06.dgn	Rev: A A3	



- LEGEND**
- DARLING PLATEAU**
- Lateritic Uplands
 - 1 Dwellingup and Hester Complex in High Rainfall Central and South
 - Minor Valleys
 - 10 Yarragil Complex (Minimum Development Swamps) in Medium to High Rainfall
 - Major Valleys Combining Slopes & Floors
 - 17 Helena Complex in Medium to High Rainfall
 - 20 Murray Complex in Medium to High Rainfall
 - Major Valley Floors and Scarps
 - 25 Lowdon Complex
 - 28 Darling Scarp Complex
 - SWAN COASTAL PLAIN**
 - Ridge Hill Shelf
 - 29 Forrestfield Complex
 - Fluvialite Deposits
 - 32 Guildford Complex
 - 33 Swan Complex
 - 34 Dardanup Complex
 - 35 Serpentine river Complex
 - 40 Cannington Complex
 - Aeolian Deposits
 - 42 Southern River Complex
 - 44 Bassendean Complex - Central and South
 - 49 Karakatta Complex - Central and South
 - 52 Cottesloe Complex - Central and South
 - 55 Quindalup Complex
 - Marine Deposits
 - 56 Yoongarillup Complex
 - 57 Vasse Complex

SONS OF GWALIA LTD
KEMERTON SILICA SAND

WESTERN EXTENSION
FLORA AND VEGETATION ASSESSMENT
REGIONAL
VEGETATION COMPLEXES

MATTISKE CONSULTING PTY LTD
 28 Central Road, Kalamunda ACN 063 607 175
 Phone: 92571625 - Fax: 92571640 - URL: www.mattiske.com.au


Author: E.M.M. MCPL Reference: SOG9908 Scale: 1 : 100,000
 Drawn: CAD Resources Ph: 9246 3242 Date: Feb 2002 Figure: **7**
 CAD Ref: lemjob77902j79_07.dgn Rev: **A A3**

DARLING PLATEAU



Lateritic Uplands

-  1. **Dwellingup and Hester Complex in High Rainfall Central and South:**
Open forest of *Eucalyptus marginata* - *Corymbia calophylla* . Dominant Vegetation types S, T; less consistently O, P, R.



Minor Valleys

-  10. **Yarragil Complex (Minimum Development Swamps) in Medium to High Rainfall:**
Open forest of *Eucalyptus marginata* - *Corymbia calophylla* on upper slopes with a mixture of *Eucalyptus patens* and *Eucalyptus megacarpa* on the valley floors. Dominant vegetation types C, D, W; less consistently Q, T, U.

Major Valleys Combining Slopes & Floors


-  17. **Helena Complex in Medium to High Rainfall:**
Vegetation ranges from open forest of *Eucalyptus marginata* - *Corymbia calophylla*- *Eucalyptus patens* through heath and herbland to lichens on granite rock. Dominant vegetation types G, R; less consistently C, Q, T.
-  20. **Murray Complex in Medium to High Rainfall**
Vegetation ranges from open forest of *Eucalyptus marginata* - *Corymbia calophylla* with *Eucalyptus patens* on the slopes to fringing woodland of *Eucalyptus rudis*-*Melaleuca raphiophylla* on the valley floors. Dominant vegetation types C, Q, U, T; less consistently D, O, R, W.

Major Valley Floors and Scarps




-  25. **Lowdon Complex:**
Open forest of *Eucalyptus marginata* - *Corymbia calophylla* and low open forest of *Agonis flexuosa* on the slopes, fringing woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* in the gullies. Less consistently woodland of *Eucalyptus wandoo* on slopes.
-  28. **Darling Scarp Complex:**
Vegetation ranges from low open woodland to lichens according to depths of soils. Woodland components chiefly *Eucalyptus wandoo* with *Eucalyptus laeliae* in the north. *Corymbia haematoxylon* in the south, and *Corymbia calophylla* throughout the region. Dominant vegetation types R, G.

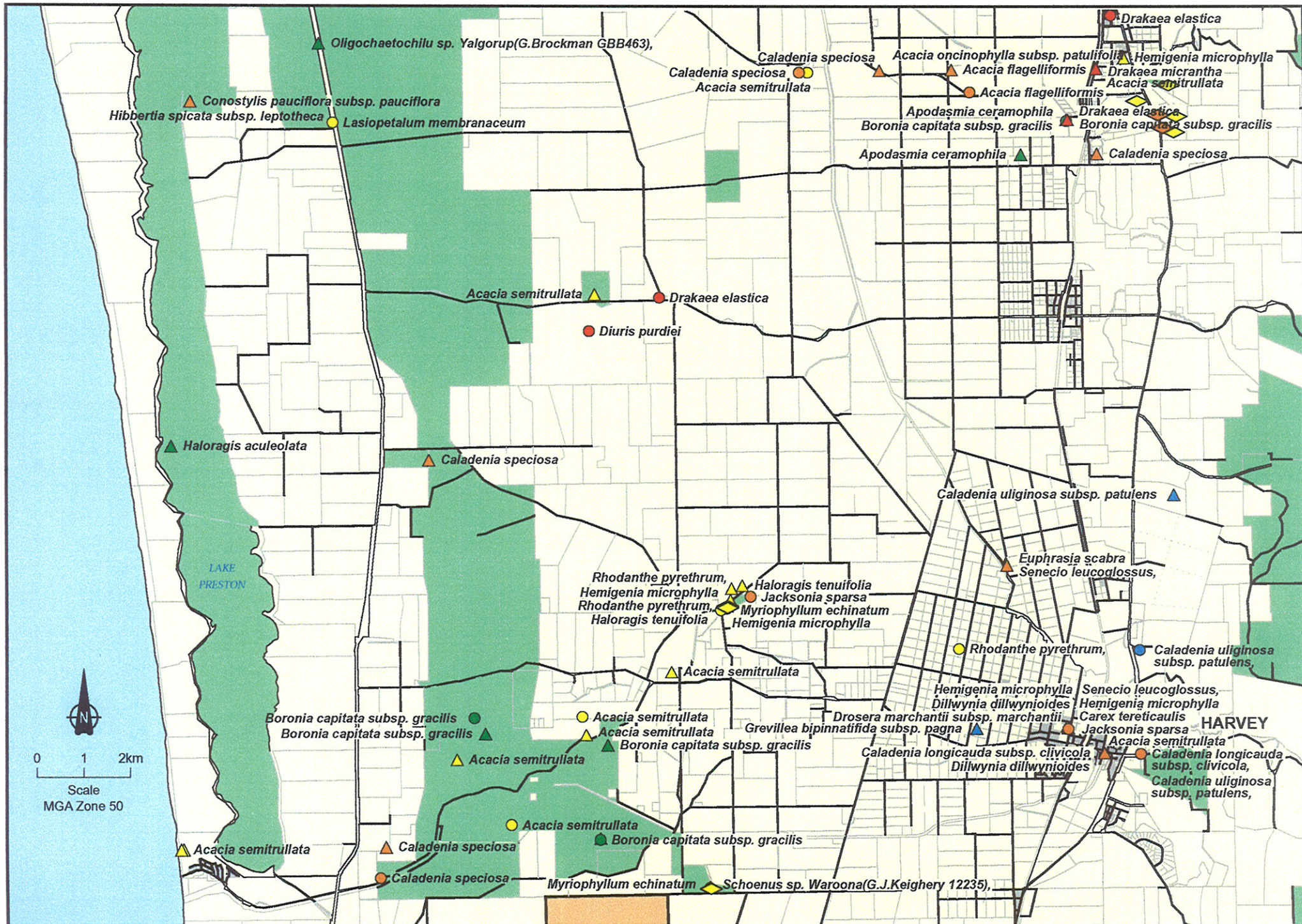
SWAN COASTAL PLAIN

Ridge Hill Shelf

-  29. **Forrestfield Complex:**
Vegetation ranges from open forest of *Corymbia calophylla* *Eucalyptus wandoo*- *Eucalyptus marginata* to open forest of *Eucalyptus marginata* - *Corymbia calophylla*- *Allocasuarina fraseriana* - *Banksia* spp. Fringing woodland of *Eucalyptus rudis* in the gullies that dissect this landform.

Fluviatile Deposits

-  32. **Guildford Complex:**
A mixture of open forest to tall open forest of *Corymbia calophylla* - *Eucalyptus wandoo* - *Eucalyptus marginata* and woodland of *Eucalyptus wandoo* (with rare occurrences of *Eucalyptus lane-pooli*). Minor components include *Eucalyptus rudis* - *Melaleuca raphiophylla* .
-  33. **Swan Complex:**
Fringing woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* with localised occurrence of low open forest of *Casuarina obesa* and *Melaleuca cuticularis* .
-  34. **Dardanup Complex:**
Mosaic of vegetation types characteristic of adjacent vegetation complexes such as Serpentine River, Southern River and Guildford.



APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON THE GWALIA PROJECT AREA
BETWEEN 1992 AND 1999

- Note: 1 - December 1992 Gwalia Project Area Survey (Mattiske, 1993a)
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832/0010 2/09/03

FAMILY	GENUS	SPECIES	Botanical Studies						
			1	2	3	4	5	6	
SELAGINELLACEAE	<i>Selaginella</i>	<i>gracillima</i>							+
DENNSTAEDTIACEAE	<i>Pteridium</i>	<i>esculentum</i>		+	+	+			+
ZAMIACEAE	<i>Macrozamia</i>	<i>riedlei</i>		+	+	+	+		
PODOCARPACEAE	<i>Podocarpus</i>	<i>drouynianus</i> N					+		
PINACEAE	* <i>Pinus</i>	<i>radiata</i>		+	+				
CUPRESSACEAE	<i>Actinostrobus</i>	<i>pyramidalis</i> (F1) S	+	+	+				
TYPHACEAE	* <i>Typha</i>	<i>orientalis</i>	+	+	+				
POACEAE	* <i>Aira</i>	<i>caryophylllea</i>	+	+	+	+			+
	<i>Austrostipa</i>	<i>compressa</i>							+
	<i>Austrostipa</i>	? <i>compressa</i>			+				
	<i>Austrostipa</i>	<i>flavescens</i>							+
	* <i>Avena</i>	<i>fatua</i>					+		
	* <i>Briza</i>	<i>maxima</i>	+	+	+	+			+
	* <i>Briza</i>	<i>minor</i>	+	+	+				+
	* <i>Cynodon</i>	<i>dactylon</i>							+
	<i>Dichanthium</i>	sp.			+	+			
	* <i>Holcus</i>	<i>lanatus</i>	+	+	+				
	* <i>Lagurus</i>	<i>ovatus</i>		+	+				
	* <i>Lolium</i>	sp.							+
	<i>Neurachne</i>	<i>alopecuroidea</i>			+	+			
* <i>Polypogon</i>	<i>monspeliensis</i>			+	+				
* <i>Vulpia</i>	<i>myuros</i>			+	+				
* <i>Vulpia</i>	sp.				+				
Poaceae	sp.			+	+			+	
CYPERACEAE	<i>Baumea</i>	<i>articulata</i>				+		+	+
	<i>Baumea</i>	<i>juncea</i>	+	+	+				
	<i>Cyathochaeta</i>	<i>avenacea</i>			+	+		+	
	<i>Cyathochaeta</i>	<i>stipoides</i> (P3)							+
	* <i>Cyperus</i>	<i>tenellus</i>				+			
	<i>Evandra</i>	<i>pauciflora</i>			+	+			+
	<i>Gahnia</i>	<i>trifida</i>	+	+	+				+
	<i>Gahnia</i>	sp.			+	+			
	* <i>Isolepis</i>	<i>marginata</i>							+
	<i>Lepidosperma</i>	<i>drummondii</i>			+	+		+	+
	<i>Lepidosperma</i>	<i>effusum</i>							+
	<i>Lepidosperma</i>	<i>longitudinale</i>			+	+			+
	<i>Lepidosperma</i>	<i>squamatum</i>			+	+	+		
	<i>Lepidosperma</i>	sp.	+	+	+				
	<i>Mesomelaena</i>	<i>graciliceps</i>			+	+			
<i>Mesomelaena</i>	<i>tetragona</i>			+	+				
<i>Schoenus</i>	<i>cruentus</i>			+	+				

* *Cent. rigidum*
Mic Shp
Amphib. nervosus

APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON THE GWALIA PROJECT AREA
BETWEEN 1992 AND 1999

- Note: 1 - December 1992 Gwalia Project Area Survey (Mattiske, 1993a)
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5 - Gwalia 1997 & 1998 Monitoring Plots (Ecos Consulting Pty Ltd & Arbotech Pty Ltd)
6 - Keighery (1998) & Muir (1999) Studies
* denotes Introduced Species

FAMILY	GENUS	SPECIES	Botanical Studies					
			1	2	3	4	5	6
CYPERACEAE (Continued)	<i>Schoenus</i>	<i>curvifolius</i>						+
	<i>Schoenus</i>	<i>efoliatus</i>	+	+	+			
	<i>Schoenus</i>	<i>pedicellatus</i>		+	+			
	<i>Schoenus</i>	?sp. Waroona (G.J.Keighery 12235)(P3)						+
LEMNACEAE	<i>Lemna</i>	<i>disperma</i>						+
RESTIONACEAE	<i>Anarthria</i>	<i>gracilis</i>		+	+	+		
	<i>Chaetanthus</i>	<i>aristatus</i>		+	+			
	<i>Chaetanthus</i>	<i>leptocarpoides</i>		+	+			
	<i>Desmocladus</i>	<i>flexuosus</i>		+	+	+		
	<i>Hypolaena</i>	<i>exsulca</i>		+	+		+	+
	<i>Hypolaena</i>	<i>pubescens</i>		+	+			
	<i>Lepidobolus</i>	sp.	+	+	+			
	<i>Leptocarpus</i>	<i>tenax</i>		+	+			
	<i>Leptocarpus</i>	sp.		+	+			
	<i>Lepyrodia</i>	<i>glauca</i>						+
	<i>Lepyrodia</i>	<i>muirii</i>					+	
	<i>Lyginia</i>	<i>barbata</i>	+	+	+			
	<i>Meeboldina</i>	<i>coangustata</i>	+	+	+			
	<i>Meeboldina</i>	<i>scariosa</i>	+	+	+	+	+	
<i>Meeboldina</i>	sp.						+	
Restionaceae	sp.		+	+				
CENTROLEPIDACEAE	<i>Aphelia</i>	<i>cyperoides</i>						+
	<i>Centrolepis</i>	<i>aristata</i>		+	+			+
XYRIDACEAE	<i>Xyris</i>	<i>lacera</i> (H)		+	+			
COMMELINACEAE	<i>Cartonema</i>	<i>philydroides</i>		+	+			
JUNCACEAE	* <i>Juncus</i>	<i>bufonius</i>			+			
	<i>Juncus</i>	<i>kraussii</i>	+			+		
	<i>Juncus</i>	<i>pallidus</i>	+	+	+	+	+	
DASYPOGONACEAE	<i>Dasyogon</i>	<i>bromeliifolius</i>		+	+	+	+	+
	<i>Lomandra</i>	<i>hermaphrodita</i>		+	+		+	
	<i>Lomandra</i>	<i>integra</i>					+	
	<i>Lomandra</i>	<i>micrantha</i> subsp. <i>micrantha</i>					+	
	<i>Lomandra</i>	<i>sericea</i>		+	+		+	
	<i>Lomandra</i>	<i>sonderi</i>		+	+			
	<i>Lomandra</i>	<i>suaveolens</i>		+	+			
	<i>Lomandra</i>	? <i>suaveolens</i>		+	+			
XANTHORRHOEACEAE	<i>Xanthorrhoea</i>	<i>brunonis</i>		+	+	+		+
	<i>Xanthorrhoea</i>	<i>preissii</i>		+	+	+	+	+
PHORMIACEAE	<i>Dianella</i>	<i>revoluta</i>		+	+	+		+

Lom pcli
Lom pep

APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON THE GWALIA PROJECT AREA BETWEEN 1992 AND 1999

Note: 1 - December 1992 Gwalia Project Area Survey (Mattiske, 1993a)
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FAMILY	GENUS	SPECIES	Botanical Studies					
			1	2	3	4	5	6
ANTHERICACEAE	<i>Agrostocrinum</i>	<i>scabrum</i>			+			
	<i>Chamaescilla</i>	<i>corymbosa</i>				+		
	<i>Johnsonia</i>	<i>acaulis</i>				+		
	<i>Thysanotus</i>	<i>manglesianus</i>				+		
	<i>Thysanotus</i>	<i>multiflorus</i>		+	+		+	+
COLCHICACEAE	<i>Burchardia</i>	<i>umbellata</i>		+	+	+		
HAEMODORACEAE	<i>Anigozanthos</i>	<i>manglesii</i> subsp. <i>manglesii</i>	+	+	+	+		+
	<i>Conostylis</i>	<i>aculeata</i>						+
	<i>Conostylis</i>	<i>juncea</i>		+	+	+		
	<i>Conostylis</i>	<i>micrantha</i>						+
	<i>Phlebocarya</i>	<i>ciliata</i>		+	+	+		
	<i>Tribonanthes</i>	?viotacea (F1)		+	+			
	<i>Patersonia</i>	<i>occidentalis</i>		+	+	+	+	+
	<i>Patersonia</i>	?occidentalis		+	+			
	<i>Patersonia</i>	<i>umbrosa</i>	+	+				
	<i>Patersonia</i>	sp.		+	+			
* <i>Romulea</i>	<i>rosea</i>		+		+			
* <i>Romulea</i>	<i>rosea</i> var. <i>australis</i>				+			
* <i>Watsonia</i>	<i>meriana</i> var. <i>bulbillifera</i>				+			
ORCHIDACEAE	<i>Caladenia</i>	<i>flava</i> subsp. <i>flava</i>			+	+		
	<i>Caladenia</i>	<i>flava</i> subsp. <i>sylvestris</i>			+			
	<i>Caladenia</i>	<i>paludosa</i>			+			
	<i>Caladenia</i>	<i>speciosa</i> (P4)			+			
	* <i>Disa</i>	<i>bracteata</i>			+			
	<i>Elythranthera</i>	<i>brunonis</i>			+			
	<i>Epiblema</i>	<i>grandiflorum</i> var. <i>grandiflorum</i>						+
	<i>Microtis</i>	<i>media</i> subsp. <i>media</i>			+			+
	<i>Praecoxanthus</i>	<i>aphyllus</i>	+	+				
	<i>Pyrorchis</i>	<i>nigricans</i>	+	+	+	+		
	<i>Thelymitra</i>	<i>flexuosa</i>			+			
	<i>Thelymitra</i>	sp.						+
	Orchidaceae	sp.						+
	Orchidaceae	sp.1						+
	Orchidaceae	sp.2						+
Orchidaceae	sp.3						+	
CASUARINACEAE	<i>Allocasuarina</i>	<i>fraseriana</i>	+	+	+			
	<i>Allocasuarina</i>	<i>humilis</i>		+	+			
PROTEACEAE	<i>Adenanthos</i>	<i>cygnorum</i>		+	+			
	<i>Adenanthos</i>	<i>meisneri</i>	+	+	+	+		+
	<i>Adenanthos</i>	<i>obovatus</i>	+		+			+
	<i>Banksia</i>	<i>attenuata</i>	+	+	+	+	+	+
	<i>Banksia</i>	<i>grandis</i>		+	+	+	+	
	<i>Banksia</i>	<i>ilicifolia</i>	+	+	+	+	+	+
<i>Banksia</i>	<i>littoralis</i>	+	+	+	+	+	+	

VSP
 HYPOXILID

Pterostylis
Thelymitra
Conopsea

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON THE GWALIA PROJECT AREA
BETWEEN 1992 AND 1999**

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FAMILY	GENUS	SPECIES	Botanical Studies						
			1	2	3	4	5	6	
PROTEACEAE (Continued)	<i>Banksia</i>	<i>menziesii</i> (C1) (P3)		+	+				+
	<i>Hakea</i>	<i>ceratophylla</i>	+	+	+				
	<i>Hakea</i>	<i>sulcata</i>			+	+			
	<i>Hakea</i>	<i>trifurcata</i> (small flowering form)	+	+	+	+			+
	<i>Hakea</i>	<i>varia</i>	+	+	+	+		+	
	<i>Hakea</i>	sp.	+	+	+				
	<i>Persoonia</i>	<i>longifolia</i> ? N			+	+	+		
	<i>Persoonia</i>	<i>saccata</i>			+	+			
	<i>Petrophile</i>	<i>linearis</i>			+	+	+		
	<i>Stirlingia</i>	<i>latifolia</i>			+	+	+		
	<i>Xylomelum</i>	<i>occidentale</i>			+	+	+		
SANTALACEAE	<i>Leptomeria</i>	<i>pauciflora</i>				+			
LORANTHACEAE	<i>Nuytsia</i>	<i>floribunda</i>	+	+	+	+	+	+	
CHENOPODIACEAE	* <i>Chenopodium</i>	<i>macrospermum</i>			+	+	+		
	<i>Chenopodium</i>	<i>pumilio</i> (F1)			+	+			
PHYTOLACCACEAE	* <i>Phytolacca</i>	<i>octandra</i>			+	+			
CARYOPHYLLACEAE	* <i>Petrorhagia</i>	<i>dubia</i>				+			
	* <i>Silene</i>	<i>gallica</i>							+
LAURACEAE	<i>Cassytha</i>	<i>flava</i>							+
	<i>Cassytha</i>	<i>racemosa</i>	+	+	+	+	+	+	+
DROSERACEAE	<i>Drosera</i>	<i>gigantea</i>				+	+		
	<i>Drosera</i>	<i>glanduligera</i>				+			
	<i>Drosera</i>	<i>nitidula</i> subsp. <i>nitidula</i>							+
	<i>Drosera</i>	? <i>occidentalis</i> subsp. <i>occidentalis</i> (P4)							+
	<i>Drosera</i>	<i>paleacea</i>			+	+			
	<i>Drosera</i>	<i>paleacea</i> subsp. <i>paleacea</i>							+
	<i>Drosera</i>	<i>platystigma</i>							+
	<i>Drosera</i>	<i>stolonifera</i> subsp. <i>stolonifera</i>				+			
	<i>Drosera</i>	sp.			+	+	+	+	
CRASSULACEAE	<i>Crassula</i>	<i>colorata</i>				+			+
PITTOSPORACEAE	<i>Billardiera</i>	<i>variifolia</i>			+	+			
MIMOSACEAE	<i>Acacia</i>	<i>barbinervis</i>			+	+			
	<i>Acacia</i>	<i>cyclops</i>							+
	<i>Acacia</i>	<i>divergens</i>							+
	<i>Acacia</i>	<i>extensa</i>			+	+	+		
	<i>Acacia</i>	<i>flagelliformis</i> (P4)			+	+			
	<i>Acacia</i>	<i>huegelii</i>			+	+	+		
	<i>Acacia</i>	<i>incurva</i>			+	+			
	<i>Acacia</i>	<i>pulchella</i>	+	+	+	+	+	+	+
	<i>Acacia</i>	<i>saligna</i>	+	+	+				
	<i>Acacia</i>	<i>semitrullata</i> (P3)			+	+	+		+
	<i>Acacia</i>	<i>stenoptera</i>							+

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			1	2	3	4	5	6	
PAPILIONACEAE	<i>Aotus</i>	<i>gracillima</i>		+	+				+
	<i>Aotus</i>	<i>procumbens</i>		+	+				
	<i>Bossiaea</i>	<i>eriocarpa</i>		+	+	+			+
	<i>Bossiaea</i>	<i>ornata</i>		+	+	+	+	+	
	* <i>Chamaecytisus</i>	<i>palmensis</i>						+	
	<i>Daviesia</i>	<i>incrassata</i> subsp. <i>incrassata</i>		+	+	+	+		
	<i>Dillwynia</i>	<i>dillwynioides</i> (P3)							+
	<i>Euchilopsis</i>	<i>linearis</i>		+	+	+			+
	<i>Eutaxia</i>	<i>virgata</i>			+	+			+
	<i>Gompholobium</i>	<i>aristatum</i>			+	+			
	<i>Gompholobium</i>	<i>capitatum</i>			+	+			+
	<i>Gompholobium</i>	<i>confertum</i>			+	+			
	<i>Gompholobium</i>	<i>tomentosum</i>			+	+	+	+	+
	<i>Gompholobium</i>	<i>venustum</i>			+	+			
	<i>Hardenbergia</i>	<i>comptoniana</i>			+	+			+
	<i>Hovea</i>	<i>trisperma</i>				+			+
	<i>Jacksonia</i>	<i>furcellata</i>		+	+	+	+	+	+
	<i>Jacksonia</i>	<i>sternbergiana</i>			+	+	+	+	
	<i>Kennedia</i>	<i>coccinea</i>			+	+			
	<i>Kennedia</i>	<i>prostrata</i>			+	+	+		
	<i>Latrobea</i>	<i>tenella</i> var. <i>tenella</i>			+	+			
	* <i>Lotus</i>	<i>subbiflorus</i>			+	+			+
	* <i>Lupinus</i>	<i>angustifolius</i>				+	+		
	* <i>Medicago</i>	sp.				+			
	<i>Nemcia</i>	<i>reticulata</i>			+	+			
	<i>Oxylobium</i>	<i>lineare</i>		+	+	+			+
	<i>Pultenaea</i>	<i>ochreatea</i>			+	+			
	<i>Pultenaea</i>	<i>reticulata</i>			+	+			
* <i>Trifolium</i>	sp.			+		+		+	
* <i>Trifolium</i>	sp. 1				+				
* <i>Trifolium</i>	sp. 2				+				
<i>Viminaria</i>	<i>juncea</i>		+	+	+			+	
Papilionaceae	sp.1			+					
Papilionaceae	sp.				+				
GERANIACEAE	* <i>Pelargonium</i>	sp.		+	+	+			
RUTACEAE	<i>Boronia</i>	<i>capitata</i> subsp. <i>gracilis</i> (P2)		+	+				
	<i>Boronia</i>	<i>dichotoma</i>		+	+			+	
	<i>Boronia</i>	<i>fastigiata</i>		+	+	+			
	<i>Boronia</i>	<i>juncea</i> subsp. <i>juncea</i> (P1)		+	+		+	+	
	<i>Boronia</i>	<i>ramosa</i> subsp. <i>anethifolia</i>						+	
	<i>Philotheca</i>	<i>spicata</i>		+	+	+			
TREMADRACEAE	<i>Platytheca</i>	<i>galioides</i>			+			+	
	<i>Tetratheca</i>	<i>hirsuta</i>		+	+	+			
	<i>Tetratheca</i>	? <i>hirsuta</i>			+				

Pink
Gomph.

Jack species

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POLYGONACEAE	* <i>Acetosella</i>	<i>vulgaris</i>		+	+				+
	<i>Comesperma</i>	<i>calymega</i>		+	+				
	<i>Comesperma</i>	<i>confertum</i>		+	+				
	<i>Comesperma</i>	<i>flavum</i>		+	+				
	<i>Comesperma</i>	<i>virgatum</i>		+	+	+		+	+
	<i>Comesperma</i>	sp.		+					
EUPHORBIACEAE	<i>Phyllanthus</i>	<i>calycinus</i>		+	+	+			
STACKHOUSIACEAE	<i>Stackhousia</i>	<i>monogyna</i>				+		+	
DILLENIACEAE	<i>Hibbertia</i>	<i>huegelii</i>		+	+	+			
	<i>Hibbertia</i>	<i>hypericoides</i>		+	+	+	+		
	<i>Hibbertia</i>	<i>perfoliata</i>		+	+				+
	<i>Hibbertia</i>	<i>racemosa</i>		+	+				
	<i>Hibbertia</i>	<i>stellaris</i>		+	+	+			+
	<i>Hibbertia</i>	<i>subvaginata</i>		+	+	+	+		
<i>Hibbertia</i>	<i>vaginata</i>		+	+				+	
THYMELAEACEAE	<i>Pimelea</i>	<i>angustifolia</i>		+	+				
	<i>Pimelea</i>	? <i>brevifolia</i>		+	+				
	<i>Pimelea</i>	<i>ciliata</i>		+	+				
	<i>Pimelea</i>	<i>lanata</i>		+	+				+
	<i>Pimelea</i>	<i>lehmanniana</i> subsp. <i>nervosa</i>		+	+				
	<i>Pimelea</i>	<i>rosea</i>							+
<i>Pimelea</i>	sp.		+						
LYTHRACEAE	* <i>Lythrum</i>	<i>hyssopifolia</i>							+
MYRTACEAE	<i>Agonis</i>	<i>flexuosa</i>		+	+	+	+		+
	<i>Astartea</i>	<i>fascicularis</i>		+	+	+	+	+	+
	<i>Calothamnus</i>	<i>lateralis</i>		+	+	+	+	+	+
	<i>Calytrix</i>	<i>angulata</i>		+	+	+			+
	<i>Calytrix</i>	<i>flavescens</i>		+	+	+		+	
	<i>Calytrix</i>	<i>fraseri</i>		+	+	+	+	+	
	<i>Calytrix</i>	sp.			+	+			
	<i>Corymbia</i>	<i>calophylla</i>		+	+	+	+	+	
	<i>Darwinia</i>	<i>oederoides</i>		+	+				
	? <i>Eremaea</i>	<i>pauciflora</i>							+
	<i>Eucalyptus</i>	<i>decipiens</i>			+	+			+
	<i>Eucalyptus</i>	<i>marginata</i> subsp. <i>marginata</i>		+	+	+	+	+	+
	<i>Eucalyptus</i>	<i>rudis</i>		+	+	+			+
	<i>Hypocalymma</i>	<i>angustifolium</i>		+	+	+	+	+	+
	<i>Kunzea</i>	<i>ericifolia</i> subsp. <i>ericifolia</i>		+	+	+	+	+	+
	<i>Kunzea</i>	<i>micrantha</i>							+
	<i>Kunzea</i>	<i>recurva</i>		+	+	+			
<i>Melaleuca</i>	<i>cuticularis</i>		+	+	+				
<i>Melaleuca</i>	<i>incana</i> subsp. <i>incana</i>		+	+	+			+	
<i>Melaleuca</i>	? <i>incana</i>			+	+				
<i>Melaleuca</i>	<i>lateriflora</i> subsp. <i>acutifolia</i>			+	+				

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			1	2	3	4	5	6
MYRTACEAE (Continued)	<i>Melaleuca</i>	<i>lateritia</i>	+	+	+			+
	<i>Melaleuca</i>	<i>pauciflora</i>		+	+			
	<i>Melaleuca</i>	<i>preissiana</i>	+	+	+	+	+	+
	<i>Melaleuca</i>	<i>rhapsiophylla</i>	+	+	+		+	+
	<i>Melaleuca</i>	<i>systema</i>						+
	<i>Melaleuca</i>	<i>teretifolia</i>		+	+			+
	<i>Melaleuca</i>	<i>thymoides</i>	+	+	+	+	+	+
	<i>Melaleuca</i>	<i>uncinata</i>	+	+	+			
	<i>Melaleuca</i>	<i>viminea</i>	+	+	+		+	
	<i>Melaleuca</i>	sp.	+					
	<i>Melaleuca</i>	sp. (<i>brachyphylla</i> B.Keighery)						+
	<i>Melaleuca</i>	sp.1		+	+			
	<i>Melaleuca</i>	sp.2		+	+			
	<i>Pericalymma</i>	<i>ellipticum</i>	+	+	+	+		+
	<i>Taxandria</i>	<i>linearifolia</i> ms		+	+			
	<i>Verticordia</i>	<i>nitens</i>		+	+			+
	<i>Verticordia</i>	<i>plumosa</i>	+	+	+			
	HALORAGACEAE	<i>Gonocarpus</i>	<i>cordiger</i>		+	+		
<i>Gonocarpus</i>		<i>pithyoides</i>						+
? <i>Gonocarpus</i>		sp.			+			
APIACEAE	<i>Centella</i>	<i>asiatica</i>	+	+	+	+		
	<i>Homalosciadium</i>	<i>homalocarpum</i>						+
	<i>Platysace</i>	<i>compressa</i>		+	+	+	+	+
	<i>Platysace</i>	<i>tenuissima</i>		+	+			
	<i>Trachymene</i>	<i>pilosa</i>			+			+
	<i>Trachymene</i>	sp.					+	
<i>Xanthosia</i>	<i>huegelii</i>			+				
EPACRIDACEAE	<i>Astroloma</i>	<i>drummondii</i>		+	+			
	<i>Astroloma</i>	<i>pallidum</i>					+	
	<i>Brachyloma</i>	<i>preissii</i>		+	+		+	
	<i>Conostephium</i>	<i>pendulum</i>		+	+		+	
	<i>Leucopogon</i>	<i>australis</i>	+	+	+	+		
	<i>Leucopogon</i>	<i>conostephioides</i>		+	+	+	+	
	<i>Leucopogon</i>	<i>polymorphus</i>		+	+			
	<i>Leucopogon</i>	<i>propinquus</i>		+	+			
	<i>Leucopogon</i>	<i>racemulosus</i>		+	+			
	<i>Leucopogon</i>	<i>sprengelioides</i>		+	+			
	<i>Leucopogon</i>	sp. (white)					+	
	<i>Lysinema</i>	<i>ciliatum</i>		+	+			+
	<i>Styphelia</i>	<i>tenuiflora</i>					+	
PRIMULACEAE	* <i>Anagallis</i>	<i>arvensis</i>			+	+		+
LOGANIACEAE	<i>Logania</i>	<i>vaginalis</i>		+	+			+
	<i>Phyllangium</i>	<i>paradoxum</i>			+			+
GENTIANACEAE	* <i>Centaurium</i>	<i>erythraea</i>	+	+	+			
	* <i>Centaurium</i>	<i>pulchellum</i>						+




A Woodland to Open Woodland of *Eucalyptus marginata* and *Banksia* spp.

-  A-1 Upper slope open woodland of *Eucalyptus marginata* - *Banksia attenuata* - *Banksia ilicifolia* and *Kunzea ericifolia* over *Stirlingia latifolia*, *Calytrix fraseri*, *Adenanthos meisneri* and mixed shrubs over *Dasyogon bromeliifolius*.
-  A-2 Upper slope open woodland of *Eucalyptus marginata* - *Banksia attenuata* - *Kunzea ericifolia* over *Allocasuarina humilis*, *Stirlingia latifolia* and mixed shrubs.
-  A-3 Lower slope open woodland of *Eucalyptus marginata* - *Banksia attenuata* - *Banksia ilicifolia* and *Kunzea ericifolia* with occasional *Nuytsia floribunda* and *Corymbia calophylla* over *Melaleuca thymoides*, *Calytrix fraseri*, *Acacia pulchella* and mixed shrubs.




B Open Woodland of *Eucalyptus marginata* and *Corymbia calophylla*

-  B-1 Open woodland of *Eucalyptus marginata* - *Corymbia calophylla* and *Kunzea ericifolia* over *Pericalymma ellipticum* and *Acacia pulchella* over Poaceae spp.





C Woodland to Forest of *Agonis flexuosa*

-  C-1 Open forest of *Agonis flexuosa* - *Eucalyptus marginata* over grasses.
-  C-2 Open woodland of *Agonis flexuosa*, with occasional *Banksia attenuata*, *Banksia ilicifolia* and *Nuytsia floribunda* over mixed shrubs.
-  C-3 Closed forest of *Agonis flexuosa* - *Corymbia calophylla* - *Eucalyptus rudis* with occasional *Banksia littoralis*, over *Xanthorrhoea preissii*, *Macrozamia riedlei* and sparse mixed shrubs and sedges.




D Woodland to Open Woodland of *Eucalyptus rudis*

-  D-1 Open woodland of *Eucalyptus rudis* and *Kunzea ericifolia* over *Hypocalymma angustifolium*, *Xanthorrhoea preissii* and mixed shrubs over mixed grasses and sedges.
-  D-2 Woodland of *Eucalyptus rudis* - *Melaleuca preissiana* and occasional *Banksia littoralis* over Myrtaceae spp. over mixed sedges.
-  D-3 Woodland of *Eucalyptus rudis* - *Melaleuca raphiophylla* over *Melaleuca teretifolia* and *Astartea fascicularis* over *Lepidosperma longitudinale*.





E Low Woodland to Forest of *Melaleuca preissiana*

-  E-1 Low open woodland of *Melaleuca preissiana* and occasional *Eucalyptus marginata* and *Kunzea ericifolia* over *Hypocalymma angustifolium* and *Calytrix* spp. over *Dasyogon bromeliifolius*.
-  E-2 Low woodland of *Melaleuca preissiana* and occasional *Nuytsia floribunda* over *Hypocalymma angustifolium*, *Pericalymma ellipticum* and mixed shrubs over sedges.
-  E-3 Low woodland of *Melaleuca preissiana* - *Agonis flexuosa* over *Astartea fascicularis* and mixed shrubs over *Lepidosperma longitudinale*.
-  E-4 Closed low forest of *Melaleuca preissiana* with occasional *Corymbia calophylla*, over dense *Agonis linearifolia* over *Pteridium esculentum* and dense *Lepidosperma longitudinale*.




F Low Woodland to Forest of *Melaleuca raphiophylla*

-  F-1 Seasonally inundated low closed forest of *Melaleuca raphiophylla* over Myrtaceae spp. over mixed sedges.
-  F-2 Seasonally inundated low open woodland of *Melaleuca raphiophylla* over *Melaleuca viminea* and *Melaleuca cuticularis* over mixed shrubs over mixed sedges.
-  F-3 Waterlogged, low woodland of *Melaleuca raphiophylla* over *Baumea articulata*.




G Shrubland of Myrtaceae and Proteaceae spp.

-  G-1 Tall shrubland of dense *Kunzea ericifolia* over *Hypocalymma angustifolium* and mixed shrubs over *Meeboldina scariosa*, with occasional emergent *Eucalyptus marginata*, *Banksia attenuata* and *Banksia ilicifolia*.
-  G-2 Dense shrubland of *Agonis linearifolia* with occasional *Eucalyptus marginata*, over grasses.
-  G-3 Shrubland of *Hakea varia* - *Melaleuca* spp. and *Astartea fascicularis* over *Lepidosperma longitudinale* and *Meeboldina coangustata*.
-  G-4 Waterlogged shrubland of *Melaleuca viminea*.




H Closed Heath of Myrtaceae spp.

-  H-1 Low closed heath of *Pericalymma ellipticum* - *Hypocalymma angustifolium* shrubs over mixed sedges, with occasional emergent *Melaleuca preissiana*, *Nuytsia floribunda* and very occasional *Banksia littoralis* trees.
-  H-2 Closed heath of *Astartea fascicularis* - *Calothamnus lateralis* and *Cassytha racemosa* over mixed sedges.
-  H-3 Closed heath of *Melaleuca lateritia* - *Astartea fascicularis* over *Lepidosperma longitudinale* and *Leptocarpus tenax*.

I Disturbed Communities

-  I-1 Disturbed lower slope of open woodland of *Eucalyptus marginata* and *Banksia* spp.
-  I-2 Cleared area with occasional *Eucalyptus marginata* over *Cartonema phylloides*.
-  I-3 Regenerating community beneath power line. Sparse *Kunzea ericifolia* over *Aotus gracillima*, *Pimelea angustifolia* and *Pericalymma ellipticum* over mixed sedges.

Miscellaneous

-  J Open water
-  Pasture
-  Pine Plantation

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6 - Keighery (1998) & Muir (1999) Studies
* denotes Introduced Species

FAMILY	GENUS	SPECIES	Botanical Studies					
			1	2	3	4	5	6
MENYANTHACEAE	<i>Villarsia</i>	<i>albiflora</i>					+	+
	<i>Villarsia</i>	<i>capitata</i>						+
ASCLEPIADACEAE	* <i>Gomphocarpus</i>	<i>fruticosus</i>		+	+			
LAMIACEAE	<i>Hemiandra</i>	<i>pungens</i>		+	+	+		
	* <i>Mentha</i>	<i>pulegium</i>		+	+			
	* <i>Mentha</i>	sp.	+					
SOLANACEAE	* <i>Solanum</i>	<i>nigrum</i>		+	+			+
SCROPHULARIACEAE	* <i>Dischisma</i>	<i>arenarium</i>				+		
	<i>Gratiola</i>	<i>pubescens</i>		+	+			
	* <i>Misopates</i>	<i>orontium</i>						+
	* <i>Parentucellia</i>	<i>latifolia</i>				+		
	* <i>Parentucellia</i>	<i>viscosa</i>						+
OROBANCHACEAE	* <i>Orobanche</i>	<i>minor</i>				+		+
LENTIBULARIACEAE	<i>Utricularia</i>	<i>multifida</i>				+		
	<i>U.</i>							
RUBIACEAE	<i>Opercularia</i>	<i>hispidula</i>		+	+		+	+
CAMPANULACEAE	<i>Wahlenbergia</i>	<i>preissii</i>				+		
LOBELIACEAE	<i>Lobelia</i>	<i>alata</i>		+	+			
	<i>Lobelia</i>	<i>tenuior</i>						+
	* <i>Monopsis</i>	<i>debilis</i>						+
GOODENIACEAE	<i>Anthotium</i>	<i>humile</i>		+	+			
	<i>Anthotium</i>	<i>junciforme</i> (P4)						+
	<i>Dampiera</i>	<i>linearis</i>		+	+	+		+
	<i>Goodenia</i>	<i>filiformis</i> (P3) = <i>pulchella</i>		+	+			
	<i>Lechenaultia</i>	<i>biloba</i>		+	+	+		
	<i>Lechenaultia</i>	<i>expansa</i>						+
	<i>Scaevola</i>	<i>calliptera</i>		+	+			
	<i>Sce.</i>	<i>prob. same.</i>						
STYLIDIACEAE	<i>Stylidium</i>	<i>amoenum</i>						+
	<i>Stylidium</i>	<i>brunonianum</i>		+	+	+		+
	<i>Stylidium</i>	<i>caespitosum</i>						+
	<i>Stylidium</i>	<i>calcaratum</i>		+	+			+
	<i>Stylidium</i>	<i>despectum</i>						+
	<i>Stylidium</i>	<i>divaricatum</i>		+	+			+
	<i>Stylidium</i>	<i>guttatum</i>		+	+			+
	<i>Stylidium</i>	<i>imundatum</i>		+	+			
	<i>Stylidium</i>	<i>juveum</i>		+	+			+
	<i>Stylidium</i>	<i>piliferum</i>		+	+			
	<i>Stylidium</i>	<i>repens</i>		+	+			
	<i>Stylidium</i>	<i>scandens</i>						
	<i>Stylidium</i>	<i>schoenoides</i>				+		
	<i>Stylidium</i>	sp.		+	+	+	+	

Stylidium

sp.

Styl.

sp. = *S. medjense*

**APPENDIX A : VASCULAR PLANT SPECIES RECORDED ON THE GWALIA PROJECT AREA
BETWEEN 1992 AND 1999**

- Note: 1 - December 1992 Gwalia Project Area Survey (Mattiske, 1993a)
 2 - April 1993 Gwalia Project Area Survey (Mattiske, 1993b)
 3 - October 1993 Gwalia Project Area Survey (Mattiske, 1993c)
 4 - October 1993 Proposed Transport Corridor Survey (Mattiske, 1993d).
 5 - Gwalia 1997 & 1998 Monitoring Plots (Ecos Consulting Pty Ltd & Arbotech Pty Ltd)
 6 - Keighery (1998) & Muir (1999) Studies
 * denotes Introduced Species

FAMILY	GENUS	SPECIES	Botanical Studies					
			1	2	3	4	5	6
ASTERACEAE	* <i>Arctotheca</i>	<i>calendula</i>			+	+		
	<i>Brachyscome</i>	<i>iberidifolia</i>				+		
	* <i>Conyza</i>	<i>bonariensis</i>		+	+			
	<i>Cotula</i>	<i>coronopifolia</i>				+		
	* <i>Ditrichia</i>	<i>graveolens</i>		+	+			
	<i>Gnephosis</i>	<i>drummondii</i>		+	+			
	<i>Hyalosperma</i>	<i>cotula</i>				+	+	
	* <i>Hypochaeris</i>	<i>glabra</i>		+	+	+		+
	<i>Ixiolaena</i>	<i>viscosa</i>						+
	<i>Myriophyllum</i>	<i>echinatum</i> (P3)						+
	<i>Olearia</i>	<i>elaeophila</i>		+	+			
	<i>Podotheca</i>	<i>angustifolia</i>				+		
	<i>Podotheca</i>	<i>chrysantha</i>				+		
	* <i>Pseudognaphalium</i>	<i>luteoalbum</i>						+
	<i>Rhodanthe</i>	<i>citrina</i>				+		
	<i>Senecio</i>	<i>lautus</i> subsp. <i>dissectifolius</i>				+		
	* <i>Senecio</i>	<i>vulgaris</i>						+
	<i>Senecio</i>	sp.		+	+			
	<i>Siloxerus</i>	<i>filifolius</i>		+	+			+
	* <i>Sonchus</i>	<i>oleraceus</i>						+
	* <i>Symphiotrichum</i>	<i>subulatum</i>		+	+			
	* <i>Taraxacum</i>	<i>officinale</i>			+	+		
	* <i>Ursinia</i>	<i>anthemoides</i>		+	+	+	+	+
* Asteraceae	sp. 1			+	+			
* Asteraceae	sp. 2			+	+			

APPENDIX B : SUMMARY OF PLANT SPECIES IN THE VEGETATION COMMUNITIES OF THE GWALIA PROJECT AREA, OCTOBER 1993 (Mattiske 1993c)

Note : * denotes introduced species; Disturbance communities I1, I2 and I3 not included in this Appendix

Species	Plant Communities																							
	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1	F-2	F-3	G-1	G-2	G-3	G-4	H-1	H-2	H-3
<i>Acacia barbinervis</i>	+	+	+	+							+	+						+						
<i>Acacia extensa</i>	+	+	+							+	+		+										+	
<i>Acacia flagelliformis</i> (P4)																							+	+
<i>Acacia huegelii</i>			+					+																
<i>Acacia pulchella</i>	+	+	+	+	+			+	+		+	+			+			+	+				+	+
<i>Acacia saligna</i>			+						+						+	+							+	
<i>Acacia semitrullata</i> (P3)	+		+	+							+	+						+	+				+	
* <i>Acetosella vulgaris</i>							+													+				
<i>Actinostrobos pyramidalis</i>															+									
<i>Adenanthos cygnorum</i>				+																				
<i>Adenanthos meisneri</i>	+		+	+					+		+	+						+				+		
<i>Adenanthos obovatus</i>				+					+		+	+			+			+		+		+	+	
<i>Agonis flexuosa</i>					+	+	+		+	+														
<i>Agrostocrinum scabrum</i>			+	+																				
* <i>Aira caryophyllea</i>				+																				
<i>Allocasuarina fraseriana</i>			+																					
<i>Allocasuarina humilis</i>		+																						
* <i>Anagallis arvensis</i>					+																			
<i>Anarthria gracilis</i>	+	+	+								+	+						+				+		
<i>Anigozanthos manglesii</i> subsp. <i>manglesii</i>			+																					
<i>Anthotium humile</i>															+									
<i>Aotus gracillima</i>																							+	
<i>Aotus procumbens</i>	+																							
* <i>Arctotheca calendula</i>					+																			
<i>Astartea fascicularis</i>									+	+	+	+	+	+	+	+		+	+	+		+	+	+
* Asteraceae sp. 1			+																					
* Asteraceae sp. 2								+																
<i>Astroloma drummondii</i>	+		+																					
<i>Austrostipa ?compressa</i>				+																				
<i>Banksia attenuata</i>	+	+	+			+												+						
<i>Banksia grandis</i>		+	+																					
<i>Banksia ilicifolia</i>	+		+			+			+		+							+				+		

APPENDIX B : SUMMARY OF PLANT SPECIES IN THE VEGETATION COMMUNITIES OF THE GWALIA PROJECT AREA, OCTOBER 1993 (Mattiske 1993c)

Note : * denotes introduced species; Disturbance communities I1, I2 and I3 not included in this Appendix

Species	Plant Communities																									
	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1	F-2	F-3	G-1	G-2	G-3	G-4	H-1	H-2	H-3		
<i>Euchilopsis linearis</i>		+							+						+				+				+	+		
<i>Eutaxia virgata</i>																								+	+	+
<i>Evandra pauciflora</i>																								+		
<i>Gahnia trifida</i>									+							+	+									
<i>Gahnia</i> sp.																								+		
<i>Gnephosis drummondii</i>																+										
* <i>Gomphocarpus fruticosus</i>																+										
<i>Gompholobium aristatum</i>	+		+	+																+						
<i>Gompholobium capitatum</i>			+																	+						
<i>Gompholobium confertum</i>			+																							
<i>Gompholobium tomentosum</i>	+	+	+					+	+											+						
<i>Gompholobium venustum</i>			+																							
<i>Gonocarpus cordiger</i>			+																	+						
? <i>Gonocarpus</i> sp.					+																					
<i>Goodenia filiformis</i> (P3)									+																+	
<i>Gratiola pubescens</i>																							+			
<i>Hakea ceratophylla</i>																+										
<i>Hakea sulcata</i>																+										
<i>Hakea trifurcata</i> (small flowering form)									+			+														
<i>Hakea varia</i>			+				+								+	+		+		+				+		
<i>Hakea</i> sp.																								+		
<i>Hardenbergia comptoniana</i>					+	+			+											+						
<i>Hemiandra pungens</i>	+	+	+																							
<i>Hibbertia huegelii</i>									+	+														+	+	
<i>Hibbertia hypericoides</i>	+	+	+	+		+	+													+						
<i>Hibbertia perfoliata</i>							+		+																	
<i>Hibbertia racemosa</i>	+						+													+						
<i>Hibbertia stellaris</i>																									+	
<i>Hibbertia subvaginata</i>	+		+			+														+					+	
<i>Hibbertia vaginata</i>	+	+	+				+		+											+		+		+		
* <i>Holcus lanatus</i>				+																						
<i>Hovea trisperma</i>																								+		

APPENDIX B : SUMMARY OF PLANT SPECIES IN THE VEGETATION COMMUNITIES OF THE GWALIA PROJECT AREA, OCTOBER 1993 (Mattiske 1993c)

Note : * denotes introduced species; Disturbance communities I1, I2 and I3 not included in this Appendix

Species	Plant Communities																								
	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1	F-2	F-3	G-1	G-2	G-3	G-4	H-1	H-2	H-3	
<i>Lomandra hermaphrodita</i>	+	+	+																					+	+
<i>Lomandra sonderi</i>			+	+					+															+	+
<i>Lomandra suaveolens</i>	+								+															+	
<i>Lomandra ?suaveolens</i>			+																					+	
* <i>Lotus subbiflorus</i>															+										
<i>Lyginia barbata</i>	+	+	+	+		+	+		+				+										+	+	+
<i>Lysinema ciliatum</i>																							+	+	+
<i>Macrozamia riedlei</i>	+	+	+		+		+																+		
<i>Meeboldina coangustata</i>			+						+																
<i>Meeboldina scariosa</i>	+	+	+	+		+		+	+		+	+	+		+					+			+	+	+
<i>Melaleuca cuticularis</i>																	+						+	+	+
<i>Melaleuca incana</i> subsp. <i>incana</i>			+						+						+	+									
<i>Melaleuca lateriflora</i> subsp. <i>acutifolia</i>															+										
<i>Melaleuca lateritia</i>														+	+									+	+
<i>Melaleuca pauciflora</i>									+						+						+				
<i>Melaleuca preissiana</i>			+	+		+	+		+		+	+	+	+	+		+	+	+	+	+	+	+	+	+
<i>Melaleuca raphiophylla</i>										+			+	+	+	+	+								+
<i>Melaleuca teretifolia</i>										+					+								+	+	
<i>Melaleuca thymoides</i>	+	+	+	+	+	+					+	+										+		+	+
<i>Melaleuca viminea</i>									+						+	+	+				+	+		+	+
<i>Melaleuca</i> sp. 1																								+	
<i>Melaleuca</i> sp. 2																								+	
* <i>Mentha pulegium</i>									+															+	
<i>Mesomelaena graciliceps</i>																							+		
<i>Mesomelaena tetragona</i>																								+	+
<i>Microtis media</i> subsp. <i>media</i>																							+		
<i>Nemcia reticulata</i>	+		+																			+			
<i>Neurachne alopecuroidea</i>																									
<i>Nuytsia floribunda</i>			+	+					+		+	+			+							+		+	
<i>Olearia elaeophila</i>	+											+													
<i>Opercularia hispidula</i>					+		+	+	+			+													
* <i>Orobanche minor</i>																							+		

APPENDIX B : SUMMARY OF PLANT SPECIES IN THE VEGETATION COMMUNITIES OF THE GWALIA PROJECT AREA, OCTOBER 1993 (Mattiske 1993c)

Note : * denotes introduced species; Disturbance communities I1, I2 and I3 not included in this Appendix

Species	Plant Communities																								
	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1	F-2	F-3	G-1	G-2	G-3	G-4	H-1	H-2	H-3	
<i>Oxylobium lineare</i>	+	+	+						+						+									+	
<i>Papilionaceae</i> sp.																								+	+
* <i>Parentucellia latifolia</i>					+																			+	
<i>Patersonia occidentalis</i>			+																					+	
<i>Patersonia ?occidentalis</i>																			+						
<i>Patersonia</i> sp.												+													
* <i>Pelargonium</i> sp.					+																				
<i>Pericalymma ellipticum</i>			+	+				+	+		+	+							+		+		+	+	
<i>Persoonia longifolia</i>	+		+																+		+		+	+	
<i>Persoonia saccata</i>	+	+	+																						
<i>Petrophile linearis</i>	+	+	+																						
<i>Philothea spicata</i>			+																						
<i>Phlebocarya ciliata</i>	+	+	+																						
<i>Phyllangium paradoxum</i>																								+	
<i>Phyllanthus calycinus</i>			+																					+	
<i>Pimelea angustifolia</i>									+										+				+		
<i>Pimelea ?brevifolia</i>																							+		
<i>Pimelea ciliata</i>																				+					
<i>Pimelea lanata</i>																								+	+
<i>Pimelea lehmanniana</i> subsp. <i>nervosa</i>																							+		
<i>Platysace compressa</i>	+		+	+		+		+				+	+						+	+					
<i>Platysace tenuissima</i>																				+				+	
<i>Platytheca galioides</i>	+		+																				+		
Poaceae sp.				+			+																		
<i>Podotheca angustifolia</i>		+																							
<i>Podotheca chrysantha</i>		+																							
* <i>Polypogon monspeliensis</i>																									
<i>Praecoxanthus aphyllus</i>			+																						
<i>Pteridium esculentum</i>										+				+											
<i>Pultenaea ochreatea</i>			+									+												+	
<i>Pultenaea reticulata</i>			+																				+		
<i>Pyrorchis nigricans</i>								+															+		

APPENDIX B : SUMMARY OF PLANT SPECIES IN THE VEGETATION COMMUNITIES OF THE GWALIA PROJECT AREA, OCTOBER 1993 (Mattiske 1993c)

Note : * denotes introduced species; Disturbance communities I1, I2 and I3 not included in this Appendix

Species	Plant Communities																								
	A-1	A-2	A-3	B-1	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1	F-2	F-3	G-1	G-2	G-3	G-4	H-1	H-2	H-3	
* <i>Typha orientalis</i>																+									
* <i>Ursinia anthemoides</i>	+		+																					+	
<i>Utricularia multifida</i>																			+						
<i>Verticordia nitens</i>			+																						
<i>Verticordia plumosa</i>																								+	
<i>Viminaria juncea</i>																	+								
* <i>Vulpia</i> sp.																+									
<i>Wahlenbergia preissii</i>	+		+	+															+						
* <i>Watsonia meriana</i> var. <i>bulbillifera</i>			+																						
<i>Xanthorrhoea brunonis</i>	+				+				+			+							+				+		
<i>Xanthorrhoea preissii</i>	+	+	+	+			+	+	+	+	+	+			+				+				+	+	
<i>Xanthosia huegelii</i>			+																						
<i>Xylomelum occidentale</i>			+																						
<i>Xyris lacera</i>																							+		